

Risk of incursion and establishment of certain exotic diseases and tick species to the UK via international pet travel

Qualitative Risk Assessment

Version No: 1.0

Date: 18 March 2011

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Suggested reference for this publication: Defra, (2011). Risk of incursion and establishment of certain exotic disease and tick species to the UK via international pet travel. (Toth, B. & Roberts, H.) Veterinary Science Team and VENDU, 17 Smith Square, London, SW1P 3JR, United Kingdom.

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Table of Contents

1	Acknowledgements.....	4
2	Summary.....	4
3	Introduction	5
4	Hazard identification	6
5	Risk question	8
6	Risk assessment.....	8
6.1	Scope.....	8
6.1.1	Inclusion	8
6.1.2	Exclusions	12
6.2	Terminology related to the assessed level of risk	14
6.3	Uncertainties	14
6.4	Release assessment.....	15
6.4.1	Risk pathways	15
6.5	Exposure assessment.....	19
6.5.1	Biological pathways for exposure	20
7	Commentary	21
7.1	General considerations	21
8	Overall conclusions.....	23
9	References.....	25

1 Acknowledgements

2 Summary

This risk assessment specifically addresses the risk of introduction and establishment of the brown dog tick *Rhipicephalus sanguineus* in the UK and risk of transmission of Mediterranean Spotted fever (MSF) under harmonisation of the UK pet travel regulations with those of other EU Member States. Consideration has also been given to other possible routes of entry of both ticks and pathogens.

We consider that:

- Current evidence indicates that the UK remains free of Mediterranean Spotted fever, which continues to have a limited geographic distribution around the Mediterranean basin.
- Current evidence indicates that the UK remains free of established populations of the brown dog tick, *Rh. sanguineus*, which has a global distribution in tropical and mild temperate climates.
- The risk that exotic ticks (*Rh. sanguineus*) potentially infected with MSF are being introduced to the UK by travelling pets under the current regime is considered to be **low**.
- The risk of introduction of exotic ticks (*Rh. sanguineus*) to the UK by humans is considered to be **very low**.
- The risk of introduction of either exotic tick species or tick-borne diseases through imports of scientific specimens is considered to be **negligible**.
- Wild birds are considered to represent a **negligible risk** for the spatial spread of *Rh. sanguineus* or MSF. Nevertheless, as the role of migratory birds in spreading tick-borne encephalitis virus infected ticks into Sweden was confirmed (Waldenström and others, 2007), the role of birds in spreading various other tick vectors and diseases should not be underestimated.
- The risk of introduction of novel tick species to the UK through shipment of bulk goods is considered to be **very low**.
- The risk that *Rh. sanguineus* is introduced to the UK by imported reptiles is assessed as being **negligible**.
- The risk of *Rh. sanguineus* being introduced into the UK by the importation of livestock, zoo animals and horses is considered to be **very low**.

- The risk of *Rh sanguineus* being introduced on untreated pets travelling under harmonised EU pet travel rules would increase to **medium** (ie could occur regularly) of which a proportion (generally < 15%) could be infected with MSF.
- On establishment of the tick vector in the UK environment we consider that the risk of this occurring in current climate conditions (temperate summers and cold winters) is **negligible**. As more information becomes available on climate change predictions, this may be a risk we should return to. However we consider the risk that *Rh. sanguineus* tick, could become established within households, leading to possible dissemination between households and kennels is **medium**.
- Therefore, the combined risk level for release and exposure (based on introduction and establishment) would be **negligible** for long term establishment of the tick in the UK under current conditions, but for short term establishment in UK households and kennels it would be **medium**.

3 Introduction

Regulation 998/2003/EC of the European Parliament and of the Council introduced harmonised animal health rules for the non-commercial movements of certain pets (dogs, cats and ferrets) between Member States of the European Union. The Regulation also sets the rules for entering the Community for such pets from specified categories of countries – different rules apply for those countries listed in Annex I and II of the Regulation (EU Member State and equivalent [I] and “listed third countries” [II]) than for those not appearing on that list (the “unlisted third countries”).

Based on their distinct animal health status, particularly as regards rabies, five countries (Ireland, Malta, Finland, Sweden and the UK) were granted a temporary derogation allowing them to continue applying their pre-existing national rules for the non-commercial movements of pets. The national rules, however also include controls against diseases and conditions other than rabies. All five countries are also allowed to continue to apply additional controls against tapeworms and, under the same derogation, the UK, Ireland and Malta may also require a treatment against ticks before dogs and cats enter their territories.

Under UK national rules, a certified pre-entry tick and tapeworm treatment 24-48 hours prior to entering the country is required for pets arriving through non-commercial movements from other EU Member States or listed third countries. No such requirements exist for the same pets arriving from unlisted third countries, which instead must enter a 6 month quarantine period and during this time these pets may or may not undergo treatment after arrival in the UK.

The pet movement derogations provided by the Regulation were originally due to expire in 2008 but were subsequently extended to 30th June 2010 and have been further extended until 31st December 2011. The presence of the tick vectors involved in the transmission of various zoonotic and animal diseases is of concern and interest to numerous UK stakeholders, which means that the risk of relaxing the requirement for tick treatment needs

to be assessed. In particular the risk of importing the brown dog tick, *Rh. sanguineus* and its role as a vector of transmission of Mediterranean Spotted Fever. This is because of the strong host preference of this tick for pets in comparison to other exotic ticks with less specific host preference.

Separate veterinary risk assessments have been conducted on the risk of the introduction of rabies and tapeworms (i.e. *E. multilocularis*) to the UK and some have covered the additional controls on ticks. However, no comprehensive document is available summarising the reasons behind the controls applied against ticks in pets from EU Member States and listed third countries. Also, as previous risk assessments did not consider any risk pathways other than pets, it is necessary to provide an assessment of alternative pathways through which these ticks or the diseases they transmit could enter the UK.

This document considers the benefit of the pre-entry tick treatment of dogs and cats arriving from either EU MSs or listed third countries relative to other risk pathways which may or may not be subject to risk management.

4 Hazard identification

Ticks are recognised as important reservoirs and potential vectors of numerous diseases of both animal and public health importance. If or when the current derogations expire dogs, cats and ferrets will not be routinely treated before entering the country and the UK may be exposed to a higher risk of introduction of either a novel tick species or certain exotic diseases carried by ticks on travelling pets. The presence of ticks and most of the diseases they transmit are not notifiable or reportable in most countries in the EU or elsewhere and systematic and comparable surveillance data are lacking. Available information on the spatial distribution of both the diseases and the vectors is limited and prevents an accurate quantification of the increase in risk.

The current tick treatment requirement, which only applies for pets arriving from EU MSs and listed third countries (but is not required for pets going into quarantine), was first introduced in the year 2000 as part of the PETS scheme following recommendations of the Kennedy report on quarantine (Kennedy and others, 1998). It came after the Kennedy report assessed the potential impact of the introduction of the PETS scheme allowing larger numbers of pets to be moved into the UK without being put in quarantine. According to the report, the bypassing of the quarantine arrangements by a potentially large number of pets would change the risk of introduction of either novel tick species or diseases transmitted by ticks. The Kennedy Report acknowledged that *“the quarantine system does not explicitly prevent this from occurring”* (treatments against ticks and tapeworms are not compulsory in the quarantines) but assumed that *“an effect of isolation in quarantine and of any health checks which animals may receive, is that these diseases would normally be identified and dealt with”* before the animal is released from quarantine.

As the assessment of the risk of a high number of animal diseases was beyond the resources of the Kennedy Report, it focused on five zoonotic diseases transmissible from cats and dogs that occur in the EU and have the potential to become established in Great Britain. These were

- Leishmaniasis
- Dirofilariasis
- Alveolar echinococcosis (AE) (*Echinococcus multilocularis* infection)
- Mediterranean Spotted fever (MSF) (*Rickettsia conorii* infection) and
- Cat scratch disease (caused by *Bartonella henselae*).

From the above five zoonotic diseases, the Kennedy report identified **Mediterranean Spotted fever** (MSF) as the disease the introduction of which could be mitigated by a tick treatment upon entry to the UK.

Since the introduction of PETS, further risk papers supported the regime on tick treatments but neither the Kennedy Report, nor the subsequent papers considered risk pathways for the entry of MSF or its main vector, *Rh. sanguineus* other than through the non-commercial movements of pets between the UK and EU MSs / listed third countries.

Rh. sanguineus has a global geographic distribution from the Americas, to Africa, Asia and Europe between 35° S and 50° N. It has been implicated as a vector of several human and animal pathogens including *R. conorii conorii*, the causal agent of MSF. However, despite the global distribution of the tick, the disease remains limited in distribution to the Mediterranean Basin. The precise reason for this is not known, but may be climatic or may be because of the corresponding distribution of an unidentified reservoir host (Rovero and others, 2008).

Ticks and/or diseases currently exotic to the UK can also find their way into the UK through wild birds as was the case with tick-borne encephalitis (TBE) in Sweden (Waldenström and others, 2007). There are a number of potential alternative risk pathways involving the movements of animals as there is no compulsory tick treatment applied for

- Pets other than cats, dogs and ferrets (i.e. rabbits, rodents, pet birds, reptiles etc.).
- Pet animals arriving as part of a commercial movement (5 or more pets in one consignment).
- Pets arriving at quarantines from the unlisted third countries.
- Livestock or any other animals other than cats, dogs and ferrets.

Pathways not involving the movements of animals at all should also be considered as *Rh. sanguineus* was introduced into the UK on previous occasions via goods (EFSA, 2007). Camping equipment and people who have been involved in outdoor activities abroad have also been highlighted as a potential route of entry for ticks.

Finally, the actual pathogens responsible for tick borne diseases could also have the potential to spread to new areas and enter the UK via animals or humans incubating the disease.

These alternative pathways were not directly considered in the risk assessments leading to the current policy of tick treatments. Also, none of these alternative pathways for ticks or tick-borne diseases are actively or systemically monitored or controlled for, and therefore no comprehensive data are available to quantify the relative risks posed by them.

5 Risk question

The main reason for putting in place the current tick controls was to mitigate the risk of the introduction and establishment of MSF in the UK by reducing the risk of its main vector, *Rh. sanguineus* (the “kennel tick” or “brown dog tick”) being imported by travelling pets.

Taking into account currently available information on *Rh. sanguineus* and the epidemiology of MSF, this risk assessment considers the possible pathways of its introduction into the UK, the risk of establishment and potential to further spread by considering the following question:

“What is the change in the risk that Mediterranean Spotted fever or an exotic tick species will be

a) imported into and/or

b) established in

the UK if the current tick control measures are discontinued?”

6 Risk assessment

6.1 Scope

6.1.1 Inclusion

Ticks can carry and transmit several pathogens causing diseases of both animal and public health importance. Therefore, pets travelling internationally and carrying infected ticks may act as potential vehicles for the spatial spread of certain diseases via their vectors and could facilitate the expansion of tick range (i.e. the establishment of new tick species in an area) if other important factors such as climate, the presence and availability of host species etc. match the requirements of the specific tick concerned (Gray and others, 2009).

There are approximately 889 species of ticks worldwide. Of these, approximately 702 are classified in the family *Ixodidae* (so-called ‘hard-ticks’ because of the presence of a dorsal plate also known as scutum). Within this family, the genus *Ixodes* includes approximately 245 species. Of these, 14 belong to the ‘*ricinus*’ complex, which includes 4 species (*I. scapularis*,

I. pacificus, *I. ricinus* and *I. persulcatus*) that are considered responsible for the transmission of the majority of pathogens of tick-borne diseases of animal and public health importance. These four species are widely distributed throughout the world (Swanson and others, 2006).

Other ixodid ticks of concern known to parasitise dogs include *Rh. sanguineus*, *Dermacentor marginatum* (the ornate sheep tick) and *Dermacentor reticulatus* (the ornate cow tick). Of these three species, *Rh. sanguineus* is the most concern as it parasitizes a large number of dogs in countries where it is endemic and acts as the reservoir and vector of MSF, an emerging zoonosis from the spotted fever group of rickettsiae.

There are several other tick species which also parasitize dogs and could act as vectors of diseases thought to be currently exotic to the UK but most have a much broader host range. Control of these would require the risk mitigation measures to be applied to a substantially wider range of possible hosts moved internationally.

According to the most widely accepted hypothesis, *Rh. sanguineus* is thought to be of African origin from where its distribution spread mainly by the movement of dogs. With current climatic conditions, it can be found almost worldwide, mainly between the latitudes 35°S and 50°N (Dantas-Torres, 2007). It favours warmer climates and is most common in the Mediterranean countries but also found regularly in Africa and South America where climate is ideal for its life cycle. The optimum temperature for egg laying is 20-30°C, the temperature threshold for the hatching of the eggs is 18°C and molting requires a temperature of at least 10-15°C. (Heath and others, 1980 and Dantas-Torres, 2008). In general, there appears to be a strong association between ambient temperature and population size.

Only sporadic infestations by *Rh. sanguineus* have been described in Northern and Central Europe where it is usually introduced through the movement of dogs and sometimes by the transport of other goods (Gray and others, 2009, Fox and others, 1985, EFSA, 2007, AFSSA, 2005). This is supported by data obtained from the Veterinary Laboratories Agency and the UK tick recording scheme. These and other data suggest that *Rh. sanguineus* is not currently permanently established in the UK. Altogether some 15 records exist where *Rh. sanguineus* was found here but there are no records for this tick species in the tick recording scheme between 2005-2009. Nevertheless, *Rh. sanguineus* was recorded on several previous occasions in the UK associated with either human dwellings or kennels (Figure 1).

There have been several recent studies on surveillance of tick populations in the UK (Jameson and others, 2010; Jameson & Medlock, 2010; Tjisse-Klasen and others, 2010). Between 2002 and 2009 11 *Rh. sanguineus* ticks were removed from dogs which entered under the PETS scheme, three of which were from Cyprus (the other 8 from dogs of no specified origin), indicative that acaricide treatment is not always completely effective and that without controls the number of imported *Rh. sanguineus* on travelling dogs is likely to be higher (Jameson and others, 2010), while 53 *Rh. sanguineus* ticks were removed from dogs in quarantine between 1976 and 2007.

Rh. sanguineus seems to be an endophilous tick as it is usually found in and around buildings, even in areas where it is endemic. To help its offspring to find available hosts more easily, female ticks tend to lay their eggs close to the resting areas of the canine host such as

in cracks of walls. Populations can survive and complete whole reproduction cycles indoors, in heated accommodation practically anywhere in the world which can lead to heavy local infestations as described in literature. However, despite its ability to survive in isolated indoors foci outside its normal range, conditions of the outer environment are critical for its long-term establishment in an area (Gray and others, 2009).

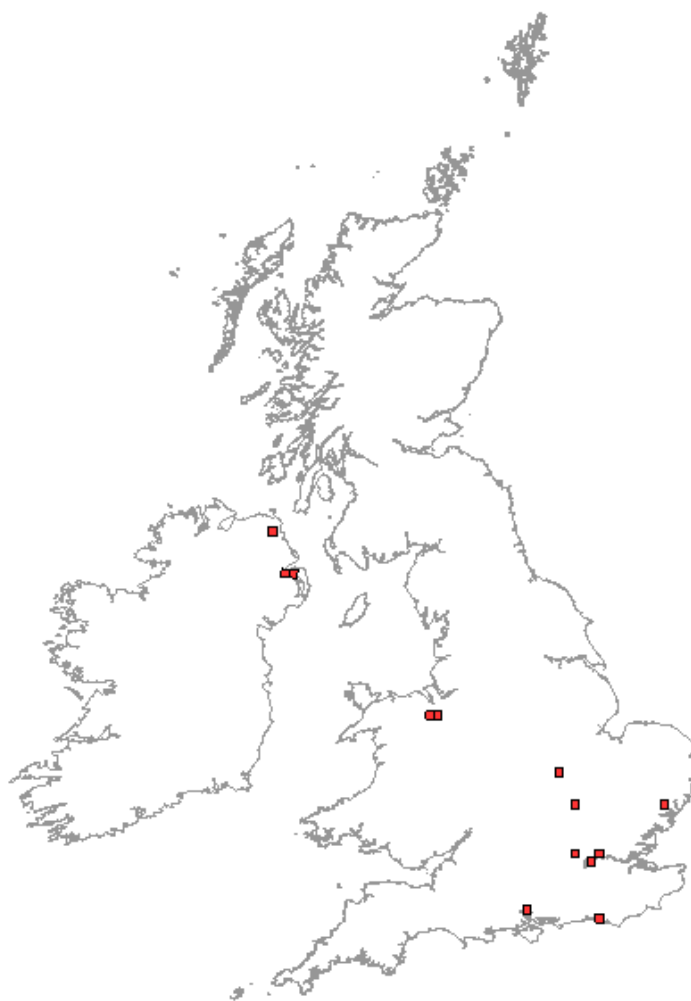


Figure 1. Historical records of *Rh. sanguineus* on imported dogs in the UK (Source: Biodiversity Network, www.nbn.org.uk)

The above provides an explanation of why, despite the likely introduction of this tick into the UK through a variety of pathways (*Rh. sanguineus* is reported to be the most frequently imported tick species on pets), this has not resulted in the permanent establishment of this tick species in the wider environment in the UK. The same applies for Northern and Central European EU Member States, which do not require pets to be treated against ticks upon entry from a Southern Member State and are only seeing local and temporary infestations. Indeed it is of note that the geographic range of MSF remains restricted to the Mediterranean region, as far as current reports suggest.

The risk of the establishment of *Rh sanguineus* and the putatively associated public health risk of MSF in the UK has been mimicked in continental Europe. France in particular has a high population of dogs (approximately 7,500,000; Intervet, personal communication) but no compulsory vaccinations for any diseases unless the dog travels outside France. Under French law, all holiday lets and campsites must allow pets to stay with their owners. What can be surmised from this is that large numbers of French dogs will be travelling during the summer particularly from the north to the south coast during traditional holiday periods in August and yet there has been no spread of MSF to northern France beyond sporadic cases (AFSSA, 2005).

Rh. sanguineus feeds primarily on dogs (the largest number of records are associated with dogs) but can occasionally be found on other wild or domestic animal hosts such as cats, sheep, goats, cattle, horses, rabbits, hedgehogs, wild boars, foxes, opossums, small rodents etc. and also humans (ICTTD, 2009; Dantas-Torres, 2007). However it is considered to have weak affinity for humans (Rovero and others, 2008).

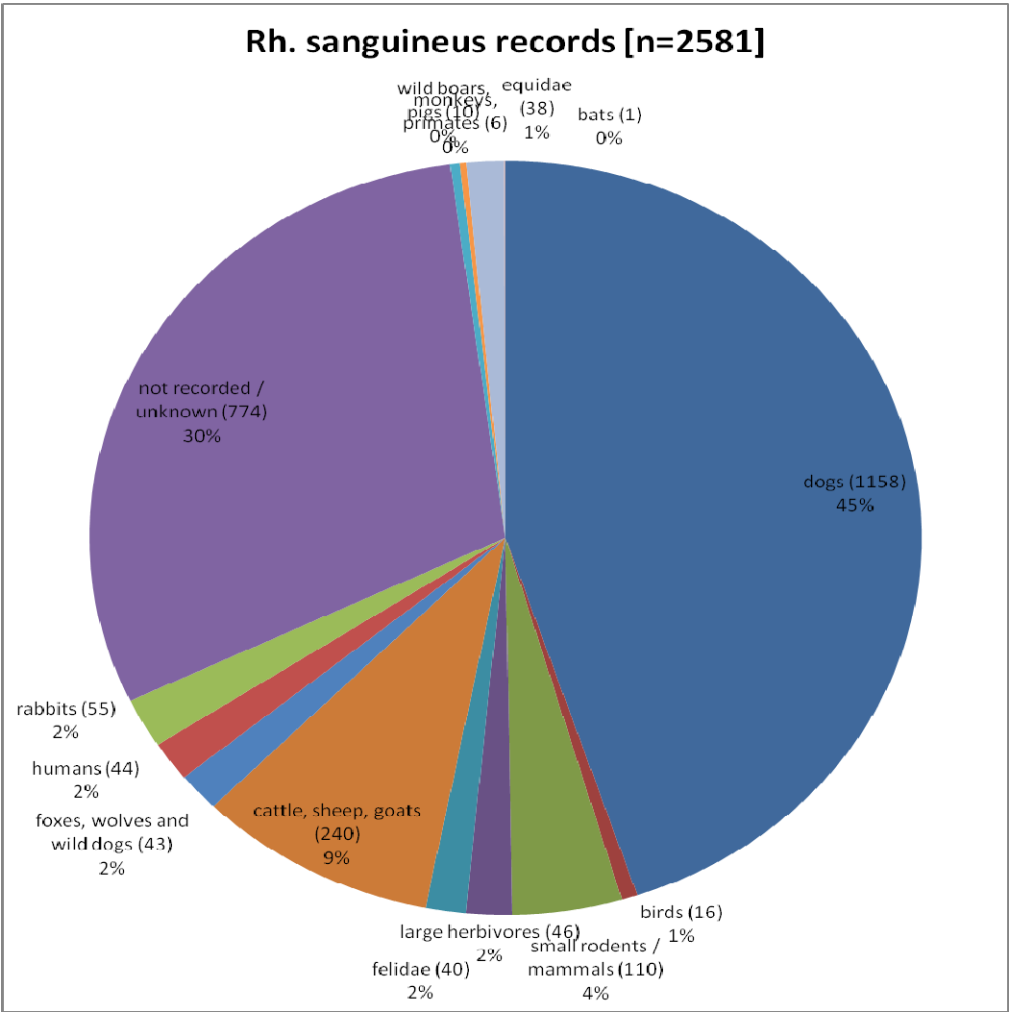


Figure 2. Host range for *Rh. sanguineus*. (Source: Integrated Consortium on Ticks and Tick-borne Diseases, www.ictttd.nl)

Rh. sanguineus is the main vector for *R. conorii conorii*, the causal agent of MSF, which is endemic in Mediterranean countries where *Rh. sanguineus* is abundant and is not seen in temperate countries such as the UK. *Rh. sanguineus* also acts as a reservoir of MSF in that area through transovarial and transstadial transmission of the pathogen.

This veterinary risk assessment considers the likelihood of introduction of exotic ticks, mainly *Rh. sanguineus* and MSF via alternative risk pathways and the potential for their establishment in the UK by using a generalised framework for considering probabilities, as outlined in Figure 3.

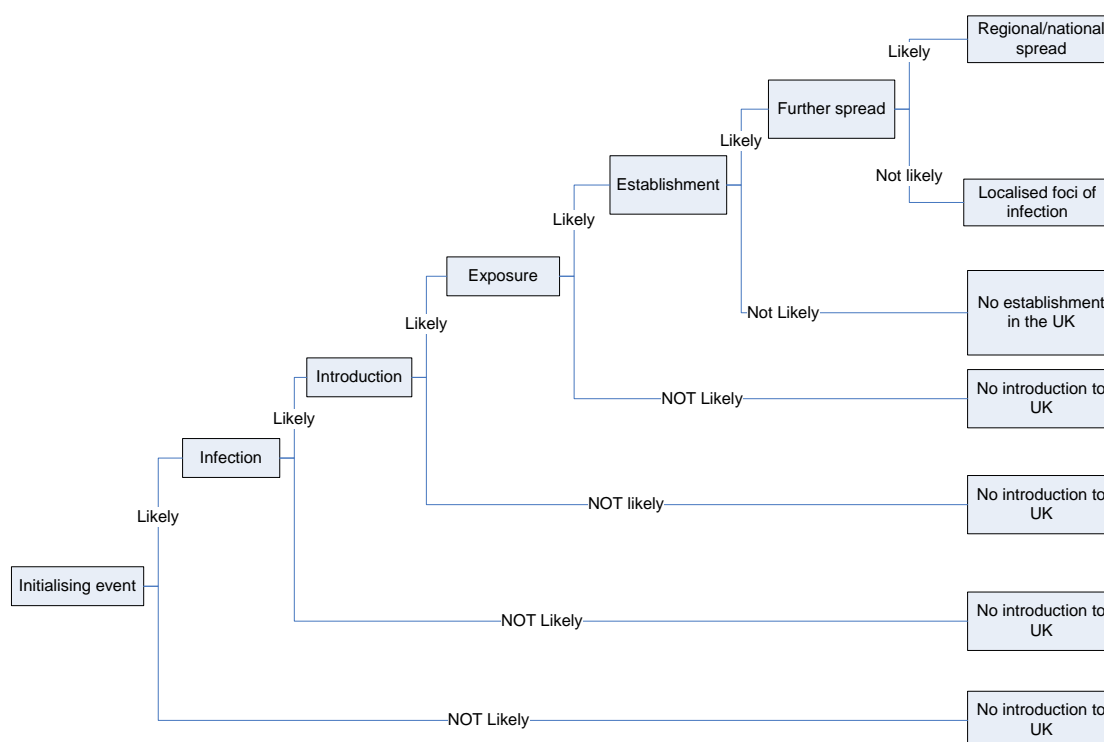


Figure 3. Generalised framework considering probabilities

6.1.2 Exclusions

This risk assessment does not consider:

- a) The derogation for additional rabies and tapeworm controls.
- b) Any other pathogens in the spotted fever group rickettsiae which can also be transmitted by ticks other than *Rh. sanguineus*.
- c) *Dermacentor marginatus* (the ornate sheep tick) and *D. reticulatus* (the ornate cow tick) which are vectors of *Rickettsia slovaca* (the causal agent of tick-borne lymphangitis and Dermacentor-borne DEBONEL) and tularemia – neither of which diseases occur in the UK. *D. marginatus* is not native, and although it is a southern species and requires high

temperatures for its developmental cycle, climatic parameters suggest that UK winters would not inhibit it overwintering. However, it was decided to exclude this tick from the scope of this VRA mainly because of its wide host range (see Fig. 4.) – which suggest that controls applied only to a subset of travelling pets would not substantially change the risk of this tick species being introduced to the UK.

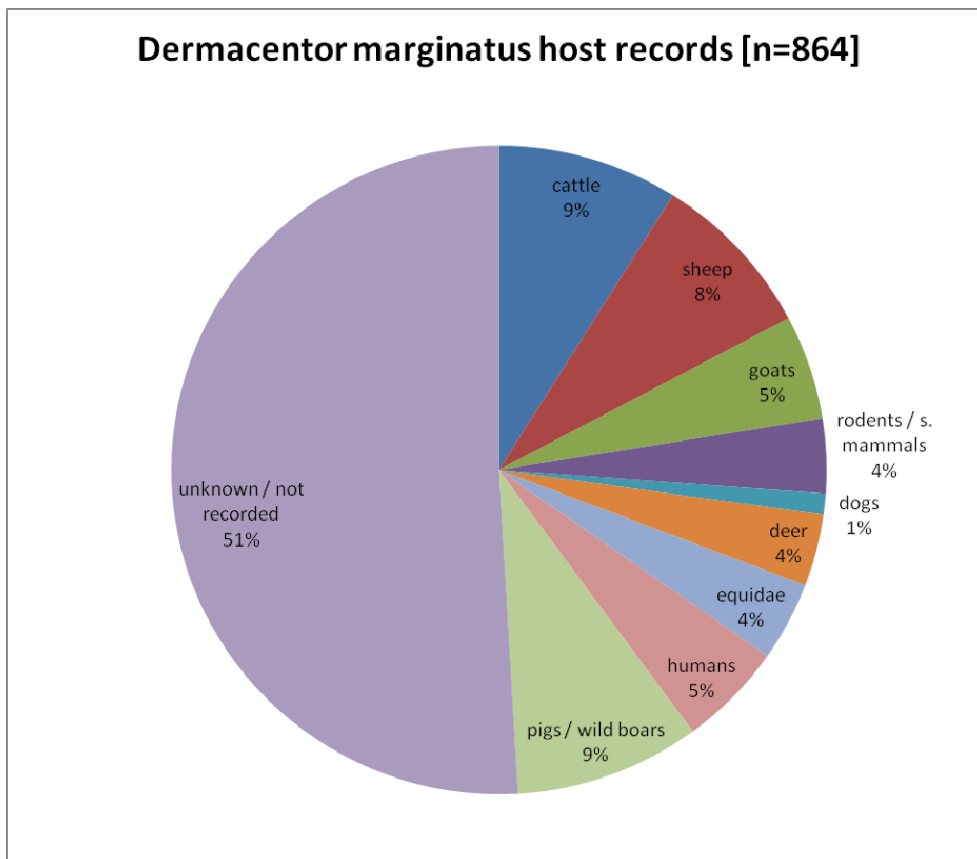


Figure 4. Host range for *D. marginatus*. (Source: Integrated Consortium on Ticks and Tick-borne Diseases)

D. reticulatus appears to be established in the UK and is therefore excluded from the scope of this paper.

d) *Ixodes ricinus* is widely established in the UK and elsewhere in Europe and contributes to the spread of diseases endemic here such as Lyme borreliosis (Lyme disease). Although it readily parasitizes dogs in the UK, to date there are no reports of some other diseases this tick species is associated with elsewhere in Europe such as Tick-borne encephalitis however recent evidence indicates the presence of *Rickettsia Helvetica* distributed widely across GB (Tjisse Klasen and others, 2010). Evidence suggests however that the spread of TBEV can be facilitated by migrating birds as TBEV has been recorded from several bird species,

especially anatids and gallinaceous birds as well as from *I. ricinus* ticks parasitizing these birds (Waldenström and others, 2007).

6.2 Terminology related to the assessed level of risk

For the purpose of the release assessment, the following terminology will apply (OIE, 2004):

Negligible	So rare that it does not merit to be considered
Very low	Very rare but cannot be excluded
Low	Rare but does occur
Medium	Occurs regularly
High	Occurs very often
Very high	Events occur almost certainly

6.3 Uncertainties

In general, risk for all vector-borne infections depend on the degree of contact between target animal species (and humans) and infected vectors as determined by their spatial distribution and abundance. Variables such as seasonal geographic population dynamics and natural host-vector relationships of ticks are additional critical factors (Randolph, 1998).

Our knowledge of tick-borne diseases has increased over the past few decades. Nevertheless, the knowledge on the ecology of tick-borne zoonoses still has limitations and any risk assessment made in this document may have a degree of uncertainty.

With regard to MSF in particular, uncertainties remain about its true natural reservoir, modes of transmission and susceptibility to infection. It is well known that *Rh. sanguineus* ticks act as reservoirs as they are capable of transovarial transmission of the pathogen but the geographical distribution of MSF suggests the presence of a currently unidentified reservoir. Although *Rh. sanguineus* is considered to be the principal vector of MSF in this risk assessment, evidence suggests that *R. conorii conorii* is present in other tick species such as *Rh. simus* and *Haemaphysalis leachi*.

Furthermore, underlying data used in this risk assessment is from scientific literature and independent databases as currently no official, comparable or systematic surveillance data are available for the tick species and the transmitted diseases discussed.

6.4 Release assessment

6.4.1 Risk pathways

When current rules for pet movements are fully complied with, there is an inherent risk that potentially infected exotic ticks are introduced by pets arriving under the PETS scheme from EU MSs or listed third countries. Therefore, this risk assessment considers the alternative pathways (Fig.5.) that could result in the introduction of new tick species or exotic tick borne diseases (or both) to the UK.

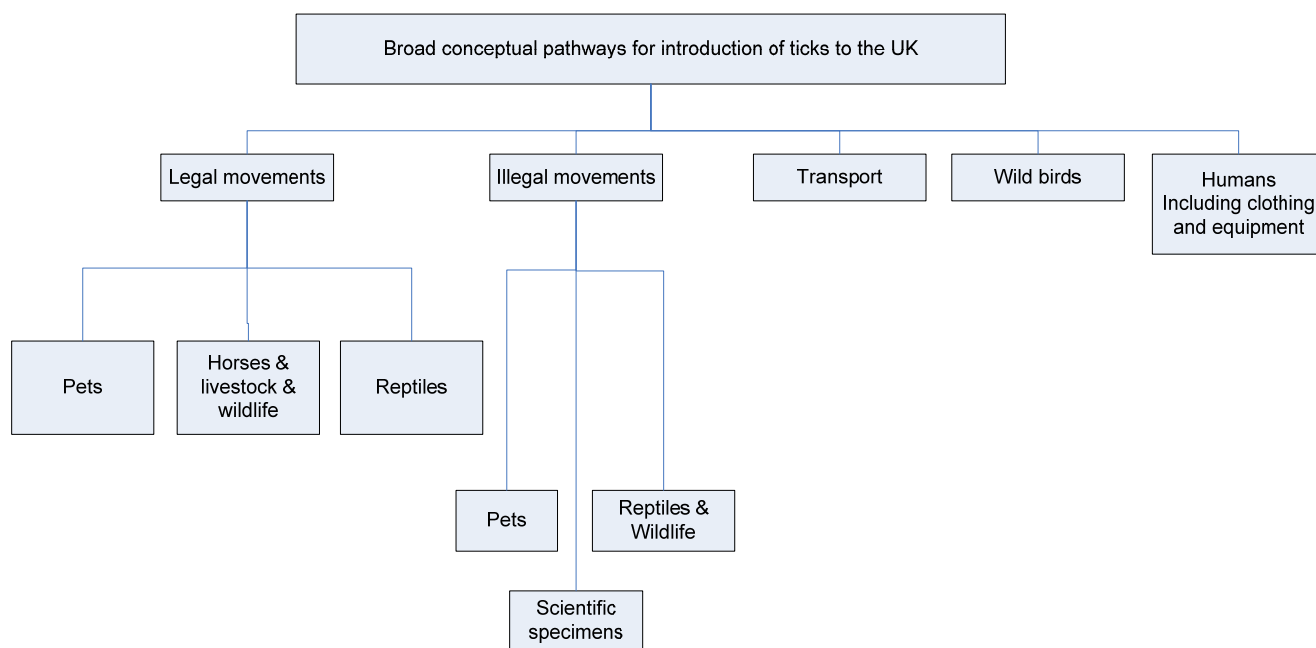


Figure 5. Introduction of ticks to the UK - Conceptual pathways

The majority (approximately 99% or 114,000 in 2008) of pets arriving in the UK are subject to the conditions of the pet travel scheme and are treated against ticks. Even so the treatment cannot guarantee 100% freedom of ticks upon arrival, which may be as early as 24 hours after the application of the treatment. Pets arriving from unlisted third countries – the areas considered to pose the highest risk and going through quarantine (1% or 1300 in 2008) are not subject to compulsory tick treatment before or after arrival in the UK although some quarantines adopted good practice by doing so.

6.4.1.1 Humans

Travellers may also play a role in introducing exotic tick species to areas they are not found normally. Although the risk of humans importing engorged ticks is currently considered to be low as humans are likely to be aware of ticks before they are engorged, clothing and personal luggage provide an excellent opportunity for transporting unfed larvae and remain unnoticed due to their very small size (520 x 440µm) to even long distances where they can continue their development and complete the reproductive cycle if climatic conditions allow (Heath and others, 1980). As human dwellings are heated to temperatures above the tick's threshold to complete its reproductive cycle, occasional (and temporary) infestations can

occur theoretically anywhere in the world due to the tick's endophilous nature, as discussed earlier.

The UK tick recording scheme shows three reports of ticks imported on travellers into the UK, *I. ricinus* from Portugal and Italy, and an unspecified *Amblyomma* from Peru. Therefore, especially considering the potential underreporting, we assume that humans, their clothing and personal luggage may also act as potential carriers of ticks to the UK. The risk of introduction of exotic ticks (*Rh. sanguineus*) to the UK by humans is considered to be **very low**.

6.4.1.2 Wild birds

The role of wild birds in dispersing zoonotic diseases is not fully understood. Nevertheless, wild birds can provide a pathway for the dispersal of various pathogens of animal and public health significance, whether as a reservoir or by dispersing infected arthropod vectors. Pheasants were identified as reservoirs of *Borrelia* spp. and, being also a target for *Ixodes* ticks endemic in the UK.

A wide range of bird species have been found to be infested with ticks, especially the skin around the eyes and ears and on the head (Reed and others, 2003). Although *Rh. sanguineus* also was found on birds of various species, less than 1% of such records refer to birds in countries where this tick is endemic (ICTTD, 2009). The dog therefore appears to remain the main host of this particular tick species. *D. marginatus* and *D. reticulatus* were also reported to parasitize birds (Siuda and others, 2006). In the UK, apart from *I. ricinus* the majority of ticks on birds are bird-specific ticks. A few records of *Hyalomma marginatum* have been recorded on migratory birds but there is no evidence that they survived in the UK.

A British study in 2004 carried out by Health Protection Agency and the Central Science Laboratory demonstrated that ticks are being imported into the British Isles on migratory birds (Pietzsch and others, 2008) as they found a total of 38 ticks of 4 species (*I. ricinus*, *I. lividus*, *I. frontalis*, *I. arboricola*) parasitizing 12 species of birds. All species were native species and three were bird-specific tick species.

Considering the above evidence, wild birds are considered to represent a **negligible risk** for the spatial spread of *Rh. sanguineus* or MSF. Nevertheless, as the role of migratory birds in spreading tick-borne encephalitis virus infected ticks into Sweden was confirmed (Waldenström and others, 2007), the role of birds in spreading various other vectors and diseases cannot be ignored.

6.4.1.3 Transport of bulk goods

In the UK, there is no specific legislation for the cleansing and disinfection of 'non-livestock' transport vehicles or the inspection of any goods for the presence of ticks. There would be a general expectation that such items are not grossly contaminated. Despite the general lack of surveillance, earlier reports state that introduction of ticks into the UK via goods such as furniture and bedding has occurred (EFSA, 2007). Such shipments may arrive in the UK

through container transport from any country and the risk of introduction of novel tick species to the UK through this pathway is considered to be **very low**.

6.4.1.4 Illegal movements and illegal trade

Any animal that may come from a third country and is not presented for veterinary checks at a Border Inspection Post but would be subsequently detected in the UK (or at a UK border) would be deemed an illegal import. Any reported non-compliance would be investigated by the local authorities in conjunction with the Animal Health agency.

Considering the lack of data on the level of illegal movements, the risk of introducing specifically *Rh. sanguineus*, would be **unquantifiable but non-negligible**.

6.4.1.5 Movements of reptiles

The UK, in line with Community law, does not require any tick treatment of any reptile species that may be imported to the UK, either from the EU or third countries.

A study by HPA (Pietzsch *et al.*, 2006) on Heathrow airport found five species of tropical tick imported into the UK on importation of reptiles. The study considered that none of these species would survive in the UK, given their environmental requirements, and none were considered a public health concern. Furthermore none of the dog-associated ticks of concern were imported. The risk that *Rh. sanguineus* is introduced to the UK by imported reptiles is assessed as being **negligible**.

6.4.1.6 Horses, zoo animals and livestock

The UK does not require any tick treatment of horses, zoo animals and livestock when receiving consignments from the EU or third countries. Although none of these species are the main hosts of *Rh. sanguineus*, it is found occasionally parasitizing these hosts (approx. 10% of records on equidae, cattle, sheep and goats in endemic countries – see Figure 2.) and these species are indeed hosts of other tick species currently exotic to the UK and therefore the introduction of exotic ticks through this pathway cannot be excluded. Out of 2581 records of finding *Rh. sanguineus* in countries where it is endemic, on 278 occasions (11%) were such ticks recovered from cattle, sheep, goats or equidae (ICTTD, 2009).

Livestock imports into the UK in 2008		
	EU	Non-EU
Pigs	84,332	233
Cattle	32,580	157
Sheep	44,197	5

Goats	20	0
Other	12	39

(Source: Global Animal Health, Defra)

Live animals may only be traded between member states or regions that are free of serious diseases of the animal species concerned but MSF is not one of these diseases. In general, imports of live animals and animal products to the EU may only come from selected third countries that have been approved after an assessment of their animal health status but again, such status of a country is not influenced by the presence or absence of MSF. In all cases animals will have to have undergone a health check and in most cases be certified that they were found free of disease.

It is unlikely that inspecting veterinarians would certify animals with obvious and heavy tick infestations. However, we cannot exclude a possibility that exotic ticks can be brought into the UK via this pathway as ticks, especially during their earlier developmental stages or shortly after they have attached themselves to the host, are small in size and extremely hard to detect and can hide in areas of the body not routinely inspected. Therefore, the risk of *Rh. sanguineus* being introduced into the UK by the importation of livestock, zoo animals and horses is considered to be **very low**.

6.4.1.7 Pets

Currently, the Regulation provides derogation from the harmonised EU rules on non-commercial movements of certain pets and allows the UK to temporarily maintain the requirement of compulsory tick treatment upon (re)entry of certain categories of dogs and cats into the UK. The treatment must be carried out by a veterinarian 24-48 hrs before entry into the UK and must be certified in the pet passport.

Not all pets arriving in the UK are required to be treated against ticks upon entry. There is no tick treatment requirement for

- Pets other than dogs, cats and ferrets;
- Commercially traded dogs and cats that are outside the PETS Scheme, and
- Pets arriving from unlisted third countries and going into 6 months quarantine.

Furthermore, treatment of an infested pet only 24 hrs before entry may not result in all ticks being killed by the time the animal enters the UK. Also, the products usually do not guarantee 100% tick freedom following treatment and datasheets suggest that the possibility of transmission of infectious diseases cannot be excluded.

Data from either quarantine kennels (53 dogs) or PETS (9 dogs) indicate that dogs are occasionally imported with the exotic tick *Rh. sanguineus*. The difference in these figures may reflect the fact that no tick treatment is compulsory if the pets are arriving in the UK from unlisted third countries via quarantine but may simply be the result of veterinary supervision in the quarantine where underreporting may be less of an issue. Given the large numbers of

dogs imported under the PETS scheme we consider the potential for underreporting to be significant.

For the above reasons, the risk that ticks potentially infected with MSF are being introduced to the UK by travelling pets under the current regime is considered to be **low**, although difficult to estimate exact numbers.

Should the current risk mitigation measures be discontinued, significant numbers of untreated pets could arrive in private homes from areas where this tick species (and MSF) is endemic. There is then a strong likelihood that the above risk will be higher than the current level and more *Rh. sanguineus* ticks would be imported into the UK resulting in a potential increase in the number of local infestations of buildings by this species. This risk is considered to be **medium**.

The risk that *Rh. sanguineus* establishes itself in the UK on a permanent basis in the environment is considered to be **negligible** as long as climatic conditions remain below the tick's threshold to complete its reproductive cycle outside heated buildings (see 7.1.1 above). Nevertheless, it is considered to be highly likely the tick would be capable of surviving inside buildings, and this would lead to an increased risk of dissemination between households and kennels in the UK. This risk of *Rh. sanguineus* being able to establish within households once introduced by pets is considered to be **medium**.

6.4.1.8 Scientific specimens

Such consignments of ticks are subject to the conditions of a risk based import licence which takes into account the possibility that the ticks could be vectors of serious livestock diseases. Any such materials are expected to be shipped, stored and handled in a way that prevents these specimens being incidentally released into the environment. Generally, such specimens shall be destroyed on completion of the work. Therefore, we consider the risk of introduction of either exotic tick species or tick-borne diseases to be **negligible** through this risk pathway.

6.5 Exposure assessment

Exposure of a person or an animal of MSF susceptible species to an infected tick is required for infection to occur. However, exposure will not necessarily result in initiating infection and illness in all cases. This correlation depends on the degree of host susceptibility and a dose response which, for rickettsiae is relatively low (<10%) (Rovero and others, 2008). This suggests that for MSF infection to occur, multiple biting is required by vector ticks, most probably *Rh. sanguineus*. This tick species however has a low probability of biting humans and therefore, the probability of being bitten by multiple infected *Rh. sanguineus* is **low**.

In considering exposure, the following broad conceptual exposure pathways would have to be considered:

6.5.1 Biological pathways for exposure

Conceptual biological pathways are outlined in Figure 7.

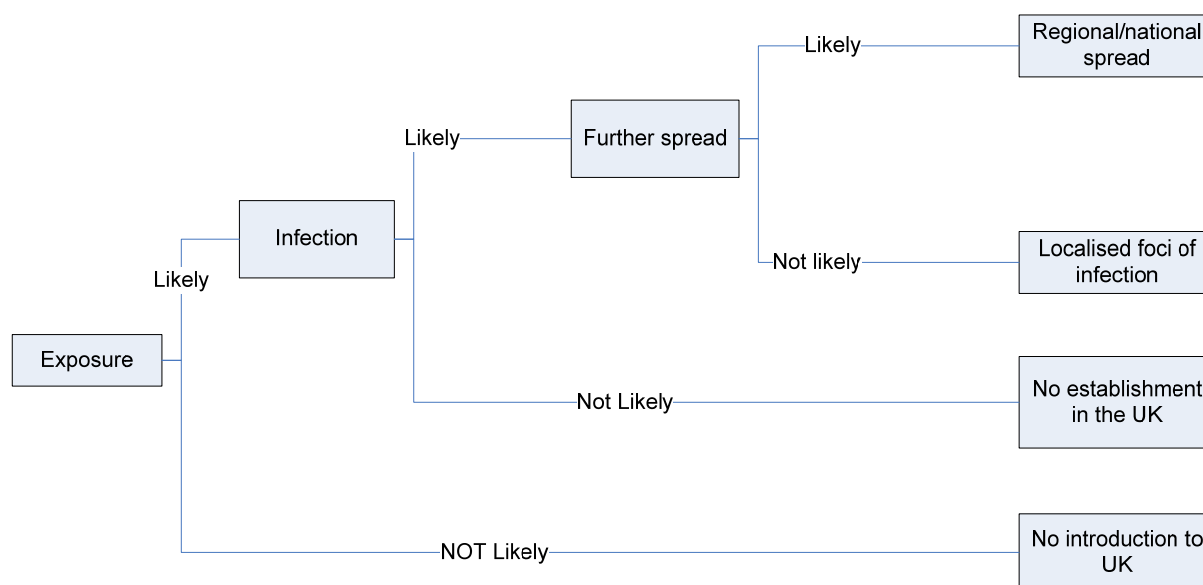


Figure 6. Conceptual exposure pathways

There have been several recent studies on surveillance of tick populations in the UK (Jameson and others, 2010; Jameson & Medlock, 2010; Tjisse-Klasen and others, 2010), although we do not have systematic information on a proportion of ticks that may be infected with various pathogens of concern. These recent studies indicate the UK has tick surveillance which documents no reports of *Rh. sanguineus* during 2005-2009, and that the historical reports have all been associated with imported pet dogs. Preliminary surveillance conducted by the HPA has found evidence of spotted fever rickettsiosis in two species of British ticks distributed widely across GB, but still no evidence of Mediterranean Spotted Fever.

Literature suggests that the proportion of *Rh. sanguineus* infected with *R. conorii conorii* can be significant, as much as 15% (Rovero and others, 2008). Limited evidence suggests that for other pathogens this rate may vary from a very small to a relatively high proportion, on a pathogen by pathogen basis (Charrel and others, 2004; Randolph, 2006). Nevertheless, in the context of the pathogen establishment and further spread, it could be expected that this would depend on the transmission dynamics which are very complex and could be broadly summarised as follows (Swanson and others, 2006):

a) Generally, a reservoir is required for the maintenance of the pathogen in nature and must be present (i.e. the cycle is perpetuated if transmission cycle is directed towards the maintenance host as transmission towards dead-end host is unlikely to result in high level of viraemia, sufficient enough to infect a vector). With some pathogens e.g. *R. conorii conorii*, the vertebrate reservoir host is not known and the tick itself, in this case *Rh. sanguineus* is currently considered to be the main reservoir of infection. However, interestingly, MSF does not occur in all areas where *Rh. sanguineus* is present. The disease is limited to the Mediterranean Basin, which suggests that a real reservoir is still to be identified for this disease.

b) In some cases, the host develops sufficient level of viraemia, so that the pathogen could be passed during the tick blood meal (this could also be a chance event in opportune time of tick activity/biological life-cycle). In the case of MSF, dogs only show a transient rickettsaemia which makes them only a temporary reservoir of the disease.

c) The ticks that acquire a pathogen must be able to maintain it during non-feeding, including moulting into subsequent life stages and pass infection to other hosts and humans – as it is the case with MSF, where vertical transmission is important. However, most *Rh. sanguineus* ticks infected either experimentally or naturally with MSF die (Rovero and others, 2008) which has hampered efforts to determine the success of the tick in transmitting disease.

d) A sufficient number of susceptible vertebrate hosts must be present to enable the transmission cycle to be maintained (population threshold).

In the context of Fig.7 above and potential maintenance of infection and further spread, it is important to note that ticks vary in their degree of host generalisation, ranging from a very few to at least several dozen host species in three vertebrate classes (various authors cited in Ostfeld and Keesing, 2000). The host range of *Rh. sanguineus* is relatively narrow with the domestic dog being its main host – however, as records of the ICTTD show (Fig.2), even this brown dog tick can be found on a range of various other hosts, including humans, in countries where it is endemic.

Transmission routes (i.e. transovarial, venereal, oral) of a pathogen also vary on a vector by vector basis resulting in various levels of prevalence of infection in hatched larvae.

Rh. sanguineus has been identified in Northern USA and Sweden, regions which could be considered to have a similar climate to the UK. In both cases, populations of this tick are considered to be non-indigenous, but carried on imported or introduced dogs, and that the populations are not able to over-winter unless inside a heated building (Lord, 2008; Jaenson and others, 1994). However there are no data on the frequency of this occurrence. What is known is that household infestations can be heavy, by which time the owner would be aware and would call pest control (Lord, 2008).

7 Commentary

7.1 General considerations

Since the recommendations of the Kennedy Report in 1998 and the subsequent introduction of the tick treatment for pets entering the UK from certain countries, additional risk assessments carried out in the UK and by the European Food Safety Authority (EFSA) provide a detailed overview on various exotic diseases and their vectors which could be potentially spread through international pet travel.

Broadly, they conclude that there would be an increased risk for the introduction of new and exotic tick species to the UK if the tick controls applied under the UK's derogation were to be abolished.

However, none of these risk assessments took into account alternative pathways of entry of the tick vectors (and tick-borne diseases) other than those related to pet movements. Likewise, no assessment was made on each tick species of concern whether they would have the potential to establish themselves permanently under the current UK climatic conditions. Nevertheless, they all identify the need that more active surveillance of livestock, companion animals, wildlife and their tick parasites would be necessary to gather more information.

Rh. sanguineus was recorded in the UK on several previous occasions and, available evidence suggests that this tick species could establish itself permanently in the UK in the domestic environment but would be unlikely to establish permanently in the wider environment due to current climatic conditions limiting its reproductive cycle (*Rh. sanguineus* lay their eggs between 20-30°C which then do not hatch under 18°C) to be completed outdoors.

Pathogens of concern could equally enter the UK through the infected host, which in some cases may question the effect of risk mitigation achieved by any treatment against the vector only. However, while there may be a limited window of opportunity for the infected host to be exposed to the native tick population in the UK, other important factors such as low level of pathogens in the blood of the infected host and immunity may be limiting in a transfer of a pathogen to the 'domestic' tick population in the UK. Also, the above can only partially be applied to MSF, as the "true" reservoir of MSF is yet unknown and *Rh. sanguineus* is the only known reservoir in areas where it is endemic. Specific comparable information on the incidence of rickettsial infections (e.g. MSF) in dogs in Europe and elsewhere is lacking and the dog seems to be a transient reservoir only because of their transient rickettsaemia after infection. The role of the dogs in the spatial spread of MSF therefore seems to be restricted to the role of a vehicle of the infected host/vector, the ticks (Rovero and others, 2008).

Considering the above, without knowing the real reservoir of the disease, it is not possible to compare the relative importance of this risk pathway with the importation of MSF by infected ticks. The fact that both dogs and *Rh. sanguineus* occur almost worldwide while MSF seems to only be endemic in the Mediterranean and Africa with only sporadic cases imported by tourists elsewhere could indicate that the real reservoir of the disease is a wildlife species whose habitat covers the above area.

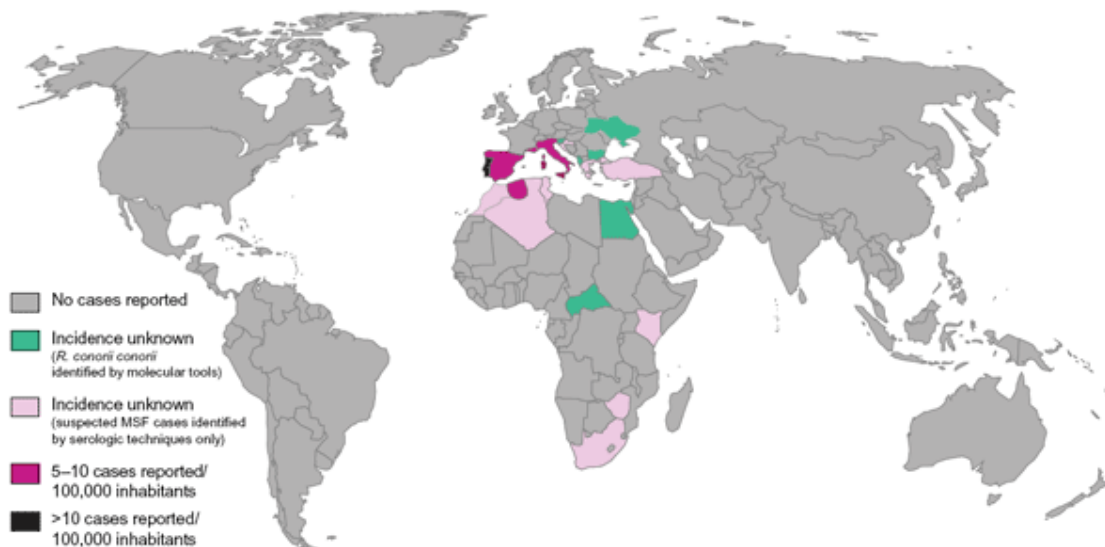


Figure 7. Distribution of the cases of Mediterranean Spotted fever (MSF) in the world and incidence of the disease in countries where the disease is endemic. (Source: Rovery and others, 2008)

While other ixodid ticks have a wide host range which include dogs, other pets and humans, *Rh. sanguineus* ticks have a significant preference towards domestic dogs (see Fig.2) being occasionally detected on other animal species and only rarely on humans with a low biting probability. This tick species, as discussed previously, is often found indoors (considered to be endophilous) and, unlike other Ixodid ticks which prefer to rest outdoors, it has a tendency to infest buildings even under warmer climates. This feature enables it to infest heated houses under any climate anywhere in the world but does not mean that the tick can be established permanently in the environment outside its range (Lord, 2008; Jaensen and others, 1994).

The life cycle of this tick (i.e. egg, larval, nymph and adult stages) requires 33 to 236 days to be completed, depending on the temperature of the environment. The larval, nymph and adult stages must all feed on blood; each stage requires a host. However, all developmental stages survive for extended periods without a blood meal (larvae: 8 months, nymphs: 6 months, adults: 19 months – Dantas-Torres, 2008).

8 Overall conclusions

The current tick treatment regime aims to reduce the risk of introduction to the UK of the brown dog tick, *Rh.sanguineus* and the disease, Mediterranean Spotted Fever for which it is a vector.

Risk assessments carried out in the past supported the UK position on tick treatment of some pet cats and dogs upon entry into the UK. Previous risk assessments did not consider other possible routes of introduction or the epidemiology of MSF when assessing the risk of *Rh. sanguineus* or MSF being introduced and established in this country. We consider that climate plays a major role in the potential long term establishment of tick species, *Rh.*

sanguineus in particular. This could suggest that one possible reason for the absence of *Rh. sanguineus* in the wider UK environment is because current temperatures limit completion of its reproductive cycle.

This risk assessment outlines further possible pathways that could potentially result in the introduction of the exotic tick, *Rh.sanguineus* and/or tick-borne disease, Mediterranean Spotted Fever. It remains uncertain to what extent each of these pathways may contribute to this overall risk.

It remains largely unknown why MSF remains restricted in areas where it is currently endemic despite the almost global distribution of its vector/reservoir tick and the preferred host of that particular tick. Nevertheless, only sporadic imported cases of MSF are being reported from areas other than where MSF is known to be historically endemic despite the high number of (unrecorded) movements of pets as a consequence of tourism and migration and the fact that no tick treatment is applied for the majority of dog movements within and outside Europe.

We consider that the existing risk management measures with regard to movement of some pets within the EU do provide certain assurances in mitigating the risk of introduction of ticks, in the first instance. Treatment of dogs in particular reduces the risk of tick introduction by travelling pets from medium to low. On the other hand, pets arriving from unlisted Third countries are not subject to compulsory tick treatment upon entry in the UK. Other animal species (including livestock) can also carry ticks and no risk mitigation measures are in place for these species. Some tick borne diseases can also be spread through their reservoir bird species or via infected ticks parasitizing migrating birds, although there is no evidence for this route being important in the spread of MSF.

We also consider that pets themselves may harbour some pathogens of concern (with the possible exception of rickettsiae) without ticks being present on them at the time of movement into the UK. This, in itself, would question the effectiveness of a treatment as a risk reduction measure for some of the diseases as these pets could themselves be a source of the pathogen for 'domestic' and uninfected ticks in the UK for a limited period of time after their arrival.

The ecology and endophilous nature of *Rh. sanguineus* suggest that the uncontrolled international travel of dogs may result in an increase in the number of indoor populations of these ticks being detected in the UK. However, the risk of its long term establishment in the wider environment remains unchanged as the current environmental conditions in the UK remain outside the preferred range of this tick species.

In the event of harmonisation with EU pet travel rules we consider

- There would be an increased risk from low to medium of incursion of ticks on untreated dogs, particularly *Rh. sanguineus*;
- There could be a significant proportion of these ticks infected with the MSF pathogen, but it is not possible to quantify this risk;

- That *Rh. sanguineus* could overwinter in households leading to dissemination to other pets and households.

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Unless otherwise stated, this document uses official information received from the World Organisation for Animal Health, Paris, France
http://www.oie.int/eng/info/hebdo/A_INFO.HTM) and the European Commission, Brussels,

Belgium (Animal Disease Notification System, Weekly Reports, CVO Emergency Notifications, SANCO Documents). Maps were produced using ESRI Data and maps CD - 2002. **Note:** All maps in this document are for visual purposes only.

Note: Maps are based on numbers reported to the OIE and WHO for 2008. Not all countries fully declare the numbers of cases in wildlife. The USA did not declare any cases in wildlife in 2008, yet in 2007 reported nearly 7,000 (Sterner and others, 2009).