SCIENTIFIC OPINION

Scientific Opinion on Geographic Distribution of Tick-borne Infections and their Vectors in Europe and the other Regions of the Mediterranean Basin[1]

EFSA Panel on Animal Health and Welfare (AHAW)[2, 3]

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ABSTRACT

This report is the second of a series of two technical assessments of the role of ticks in transmission of animal diseases and zoonoses in Eurasia. A previous published scientific opinion (EFSA Journal 2010; (8)8, 1703) focused on two diseases- Crimean-Congo haemorrhagic fever and African swine fever in Eurasia. The aim of this report is to provide an overview of the geographic distribution of tick species which have proven involvement in the transmission of pathogens causing animal diseases and zoonoses in Eurasia. The report provides maps of the region that display the occurrences of ticks and tick-borne pathogens. Systematic literature review of available publications for the last 10 years and other available literature from the experts were used in the retrieval of the geographical reported cases for the presence of ticks and tick borne pathogens. The report includes a description of the factors that influence the dynamics of the relevant tick species and identify possible high-risk areas in the EU for introduction, considering the biological and ecological characteristics of the ticks and their ability to adapt to new areas. Findings from this review have provided evidence of the extent of ticks and tick-borne diseases (TBDs) in geographical ranges and the existing risk areas that should be considered as baseline information to assess potential risk of these diseases. The report indicates the validity of using available literature to support the presence of ticks and TBDs without further predication using weather and other environmental factors associated with the ticks' survival. The report concluded that animal and human movement play more impact on the spread of the ticks and TBDs. Climate changes and flight pattern of migratory birds can influence the presence and spread of the ticks and TBDs, but have not been determined to be responsible for the widespread distribution of ticks.

KEY WORDS

Tick, systematic review, geographic distribution, tick-borne pathogen, zoonosis, ixodid, argasid, Europe

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SUMMARY

This report is the second of a series of two technical assessments of the role of ticks in transmission of animal diseases and zoonoses in Eurasia. A previous published scientific opinion (EFSA 2010a) focused on two diseases- Crimean-Congo haemorrhagic fever and African swine fever in Eurasia. The aim of this report is to provide a general overview of the geographic distribution of tick species which have proven involvement in the transmission of pathogens causing animal diseases and zoonoses in Eurasia.

The report provides a review of the geographic distribution of the relevant tick species and tick-borne diseases (TBDs) in Eurasia by producing maps of the region that display the occurrences of ticks and tick borne pathogens. Systematic literature review of available publications for the last 10 years and other available literature from the experts were used in the retrieval of the geographical reported cases for the presence of ticks and tick borne pathogens. The report includes a description of the factors that influence the dynamics of the relevant tick species and identify possible high-risk areas in the EU for introduction considering the biological and ecological characteristics of the ticks and their ability to adapt to new areas. Surveillance tools and control measures for ticks were discussed.

Findings from this review have provided evidence of the extent of ticks and TBDs in geographical ranges and the existing risk areas that should be considered as baseline information to assess potential risk of these diseases. The report indicates the validity of using available literature to support the presence of ticks and TBDs without further predication using weather and other environmental factors associated with the survival of the ticks. Surveillance tools for the detection of the ticks and their control measures are discussed in this report. The report concluded that animal and human movement play a significant impact on the spread of the ticks and TBDs. Climate changes and flight pattern of migratory birds can influence the presence and spread of the ticks and TBDs, These two factors acting by themselves have not been determined be responsible for the widespread distribution of ticks.

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF FIGURES

BACKGROUND

Article 36 of the European Parliament and Council Regulation (EC) No 178/2002[4], foresees the possibility to financially support a networking of organisations operating in the fields within the EFSA's mission. Under this framework, a call for proposals was published on the EFSA website in August 2007 (CFP/EFSA/AHAW/2007/02) to review three specific animal diseases (African Horse Sickness, African Swine Fever and Classical Swine Fever) and to provide an evaluation of the distribution of arthropod vectors and their potential for transmitting exotic or emerging vector-borne pathogens causing animal diseases and zoonoses. In August 2008 another call for proposals was published (CFP/EFSA/AHAW/2008/04) to review Epizootic haemorrhagic disease and Crimean-Congo haemorrhagic fever.

The topics for the call were selected respecting previous recommendations from the Animal Health and Welfare Panel and/or were based on recent occurrences of vector-borne animal diseases and zoonoses in the EU. The proposed topics were considered to be in line with the Community Animal Health Policy (CAHP), since one of the key elements of the CAHP is the early detection of exotic and new/emerging disease threats. The scientific reviews will support the preparedness for issuing scientific opinions on exotic or emerging diseases and/or their vectors.

The focus of this mandate is on the role of the tick vectors in the epidemiology of Crimean-Congo haemorrhagic fever and African swine fever. Ticks (Order Ixodida) are arthropods that suck blood from animals and humans. Two major families can be distinguished: the hard ticks (Family Ixodidae), include the genera *Amblyomma*, *Dermacentor*, *Hyalomma*, *Ixodes*, *Rhipicephalus* (previously called *Boophilus*); and the soft ticks (Family Argasidae), including the genera *Argas* and *Ornithodoros* amongst others.

Ticks occur around the world and can be mechanical and/or biological vectors of bacteria, protozoons, and viruses. In many cases the presence of the disease is linked to the presence of vector-competent tick species in a specific area. The movement of livestock, pets, humans and undetected ticks in planes, lorries and ships may be associated with the introduction of exotic vector-borne microbes.

Most species of hard tick (Family Ixodidae) feed on different hosts (one host for each life stage: larva, nymph and adult), and can remain attached to them for several days and be carried over large distances which partly explain their importance as vectors of disease agents.

Soft ticks (Family Argasidae), instead, feed for short periods on their hosts, varying from several minutes to days, depending on such factors as life stage, host type, and species of tick. The feeding behaviour of many soft ticks can be compared to that of fleas or bedbugs, as they often reside in the nest of the host, feeding rapidly when the host returns.

The abundance, feeding patterns, longevity of the ticks, and environmental factors such as vegetation, temperature and rainfall, play a role in the transmission of disease agents. The presence and persistence of tick-borne diseases depend on biological and ecological relationships between vertebrates, ticks and disease agents. All of these factors should be taken into account when trying to determine the importance of a particular tick species as a potential vector.

In regions and countries where tick-borne diseases are present, abundance, seasonality and distribution of the different tick species can be assessed by catching their specimens on the usual hosts and by collecting methods of unfed ticks from the environment. Control and prevention of pathogens transmitted by ticks may be through the application of acaricide on the hosts or in the environment.

Crimean-Congo haemorrhagic fever (CCHF) is a zoonotic viral disease that is asymptomatic in infected animals, but a serious threat to humans. The virus is mainly transmitted by tick species of the

[4] Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. OJ L 31, 1.2.2002, p. 1–24.

genus *Hyalomma.* Some species of the genera *Dermacentor* and *Rhipicephalus*, however, have also been shown to be capable of transmitting CCHFV. Various mammals and possibly some avian species serve as amplifying hosts on which the feeding ticks can be infected with the virus. Animal-to-human (for example, through contact with infected animal blood or ticks), and human-to-human (by contact with infectious blood or body fluids) transmission also can occur.

African swine fever (ASF) is a highly contagious virus infection of domestic and wild pigs/ suidae that can be transmitted by certain soft tick species of the genus *Ornithodoros*. There are different epidemiological scenarios depending on the specific circumstances in each geographical area regarding virus strains, host susceptibility, vector presence and/or vector interaction with susceptible hosts. In the Iberian Peninsula, *O. erraticus* was the main vector, associated with domestic pigs. In Sardinia and some African countries, the virus is maintained by free range/backyard pigs that have recovered from infection and remain in a carrier state. In the Caucasus, contacts between diseased wild boars and free ranging pigs seem to play an important role in the spread of ASF and the role of ticks still needs to be clarified.

Because the paucity of data on vector competence for many tick species and the lack of information on the effect of environmental factors on CCHFV transmission, studies are needed to evaluate relevant tick species as well the various factors that might affect virus transmission. Also the role of ticks in the epidemiology of ASF in the Caucasus needs to be elucidated.

TERMS OF REFERENCE

1. Provide a general overview of the geographic distribution of tick species which have proven involvement in the transmission of pathogens causing animal diseases and zoonoses in Eurasia.

2. Provide an update on the role of the tick vectors in the epidemiology of African swine fever and Crimean-Congo haemorrhagic fever in Eurasia[5], more in particular:

- provide a review of the geographic distribution of the relevant tick species and produce maps of Eurasia displaying their occurrences;

- review surveillance data to provide estimates of the relevant tick abundance and disease incidence in Eurasia;

- describe the factors that define the dynamics of the relevant tick species and identify possible high-risk areas in the EU for introduction considering the biological and ecological characteristics of the ticks and their ability to adapt to new areas;

- provide an update on the role of the relevant vectors in the transmission and the maintenance of viruses of Crimean-Congo haemorrhagic fever and African swine fever in Eurasia;

- review available methods for the control of the relevant tick vectors.

This report is the second of a series of two reports. The current report focuses on the first term of reference. A previous published scientific opinion (EFSA 2010a) focused on the second term of reference.

[5]Eurasia, in this report, is referred to the following areas: Europe, a buffer zone of about 600 km along the Russian Federation border, the Caucasus region, North Africa, Turkey, and Middle East.

ASSESSMENT

1. Introduction

This scientific report is aimed to provide a general overview of the geographic distribution of different tick species which have proven involvement in the transmission of the pathogens causing animal diseases and zoonoses in Europe, Middle East and the Mediterranean basin. Therefore it is aimed to address the first term of reference. The second term of reference has been addressed in the scientific report EFSA 2010a, on the role of tick vectors in the epidemiology of Crimean Congo haemorrhagic fever and African swine fever in Eurasia.

Ticks as blood feeding parasites, are able to transmit to their hosts a wide variety of pathogens which may cause tick-borne infections and diseases (TBDs) affecting wild and domestic animals, including companion animals. The transmission of pathogens may occur both transovarially (i.e. the infection is transmitted via the eggs from the mother to her offspring) and transstadially (i.e. from larva to nymphs and/or from nymphs to adults). The vector competence is tick species specific, which implies that as tick species transmit pathogens to a range of receptive vertebrate hosts. Therefore TBDs usually are geographically distributed within the range of their vectors. TBDs can cause clinical signs from severe (in the acute phase) to sub-clinical forms (mainly in endemic areas). Furthermore, co-infection with different pathogens can occur in the same vertebrate animal and is caused by the fact that the same tick species may transmit different pathogens (e.g. *Hepatozoon canis*, *Ehrlichia canis* and *Anaplasma platys* by *Rhipicephalus sanguineus*). TBD co-infections are frequent in companion animals living in TBD endemic areas and may often impair an appropriate etiological diagnosis (EFSA 2007).

Several recent reports indicated the wider spread of specific tick species as vectors in geographic areas that were not considered previously infested with these tick species (e.g. Gray et al., 2009, for *Ixodes ricinus* and *D. reticulatus*; Nijhof et al., 2007, for *Dermacentor reticulatus*; Jääskelainen et al., 2006, for *Ixodes persulcatus*). Furthermore other reports have shown that the host range of some tick species was wider than previously known. There are limited data on vector competence for many tick species and a lack of information on the effect of environmental factors, including climate factors, on transmission of pathogens. The aim of this scientific report is to assess the distribution of tick species and their potential to transmit pathogens of veterinary and medical importance in Europe and other regions of the Mediterranean basin.

The taxonomy of tick-borne pathogens is also evolving and subjected to changes. Based on recent molecular studies, the taxonomy of certain tick species has been adapted accordingly. This report uses the taxonomy proposed by Uilenberg et al., 2004.

2. Methods for the Systematic Literature Review

To gather the information for the geographic distribution of tick species and tick-borne pathogens, a systematic literature review was carried out, based on the general principles of the systematic review methodology. EFSA (2010c) published guidelines on the systematic review methodology. The steps of the process we followed are described in appendix G of EFSA 2010a scientific opinion (EFSA Journal 2010;8(8):1703). The systematic literature procedure is summarised in the next paragraphs:

To address this term of reference, data originated basically from three different sources:

- A systematic literature review, based on scientific papers retrieved from the databases integrated in ISI web of knowledge and Pubmed in the last 10 years; and on a pool of papers considered relevant by the WG experts, coming from their private collections, regardless of the time frame;

- Published validated data from the integrated consortium on ticks and tick-borne diseases (ICTTD-3 European project, http://www.icttd.nl/index.php?id=2), collected by one of the experts of the WG.

All data derived from these sources were collated in a relational database (using Filemaker software - www.filemaker.com), from which the maps were issued.

For the systematic literature review, we searched in the databases integrated in ISI Web of Knowledge and Pubmed. We used two different strings: one for the ticks and another for the tick-borne pathogens. These strings were applied to the title and the abstract. The search was limited to the last 10 years, (since 2000), and it was updated to March 11th 2010, No language restrictions were set. The search in ISI Web of knowledge was made per topic. The geographical scope is described in section 3 chapter 3.1 of this scientific opinion.

The strings for the ticks:

(Argas OR Ornithodoros OR Dermacentor OR Haemaphysalis OR Hyalomma OR Ixodes OR Rhipicephalus OR Boophilus) AND (Distribution OR presence OR occurrence OR reported) AND (Aland OR Albania OR Andorra OR Austria OR Belgium OR Bosnia and Herzegovina OR Bulgaria OR Croatia OR Cyprus OR Czech Republic OR Denmark OR Germany OR Spain OR Estonia OR Finland OR Faroe islands OR France OR Greece OR Hungary OR Ireland OR Italy OR Kosovo OR Latvia OR Liechtenstein OR Lithuania OR Luxembourg OR Macedonia OR Malta OR Montenegro OR The Netherlands OR Norway OR Poland OR Portugal OR Slovenia OR Romania OR San Marino OR Serbia OR Slovakia OR Switzerland OR Sweden OR United Kingdom OR Turkey OR Israel OR Palestine OR Jordan OR Lebanon OR Syria OR Morocco OR Algeria OR Tunisia OR Libya OR Egypt OR Western Sahara OR Armenia OR Belarus OR Georgia OR Moldova OR Ukraine OR Russia OR USSR)

The strings for the tick-borne pathogens:

(African Swine Fever virus OR ASF virus OR ASFV OR Anaplasma OR A phagocytophilum OR Ehrlichia phagocytophila OR Babesia OR Crimean Congo Haemorrhagic Fever virus OR CCHF virus OR CCHFV OR Hepatozoon OR Lyme disease agent OR Borrelia OR B burgdorferi OR B garinii OR B spielmanii OR B lusitaniae OR Rickettsia OR R conorii OR Ehrlichia canis OR Borrelia hispanica OR B hispanica OR Theileria OR T parva OR T hirci OR T ovis OR T lestoquardi OR Tick borne encephalitis virus OR Louping ill virus OR TBE virus OR TBEV OR tick borne flavivirus OR TBEF OR TBEFV OR TBE group OR Francisella OR F tularensis OR Bartonella OR Q fever OR Coxiella OR African horse sickness virus OR AHSV OR tick borne orbivirus) AND (Distribution OR presence OR occurrence OR reported) AND (Aland OR Albania OR Andorra OR Austria OR Belgium OR Bosnia and Herzegovina OR Bulgaria OR Croatia OR Cyprus OR Czech Republic OR Denmark OR Germany OR Spain OR Estonia OR Finland OR Faroe islands OR France OR Greece OR Hungary OR Ireland OR Italy OR Kosovo OR Latvia OR Liechtenstein OR Lithuania OR Luxembourg OR Macedonia OR Malta OR Montenegro OR The Netherlands OR Norway OR Poland OR Portugal OR Slovenia OR Romania OR San Marino OR Serbia OR Slovakia OR Switzerland OR Sweden OR United Kingdom OR Turkey OR Israel OR Palestine OR Jordan OR Lebanon OR Syria OR Morocco OR Algeria OR Tunisia OR Libya OR Egypt OR Western Sahara OR Armenia OR Belarus OR Georgia OR Moldova OR Ukraine OR Russia OR USSR)

Duplicate references were deleted automatically by means of the EndNote reference management system. References were then checked manually and duplicates removed. The search in ISI web of knowledge and in Pubmed produced a list of 2197 references.

The title and abstract were screened following the criteria described below:

Table 1: Criteria used in the first screening for relevance

Criterion	Included	Excluded
Concerns a tick species or a tick-borne pathogen occurrence in the area considered	Yes	No
Concerns a tick species with proven involvement in transmitting animal diseases or zoonoses	Yes	No
Contains geographic information on the distribution of the tick species or the tick-borne pathogen	Yes	No

After the fist screening 1222 references were considered relevant, 309 doubtful and 666 Non relevant. The doubtful references (title and abstract) were further revised by two WG experts who retrieved 10 relevant references. By checking the full text, other 43 initially doubtful references were considered as relevant. This produced a total of 1275 relevant references and 822 non relevant references. We retrieved the full article of the relevant references, but we did not found all them. We miss 125 scientific articles (6 in English language, and 119 in other languages).

The second screening of articles was performed in parallel with the data extraction. It was performed by two experienced veterinary parasitologists of the Veterinary School of the University of Zaragoza (Spain), one of those was a WG expert. The other WG experts were consulted when doubts arose. Apart from the three first criteria considered in the first screening, they checked:

Table 2: Criteria used in the second screening for relevance

Criterion	Included	Excluded
Language publication	English abstract and text available in English, French, German, Italian, Spanish, Hungarian, Bulgarian and Dutch	Abstract not available or text not in English, French, German, Italian, Spanish, Hungarian, Bulgarian or Dutch
Original work (not a review document)	Yes	No
Contains geographic information on the distribution of the tick species or the tick-borne pathogen	Yes	No
Does not specify a concrete geographic location. Rather refers it to the entire country.	No	Yes
Concerns a prompt importation of a tick species that does not reach sufficient epidemiological threshold for its establishment in the specified location.	No	Yes
Case-reports of human infections that, in order to protect the privacy of personal data, provide the address of a reference hospital instead of the residence of the infected patient.	No	Yes
Tick identification is unequivocal and appropriate.	Yes	No
The diagnostic method for the tick-borne pathogen is appropriate (serology, isolation, biological methods as PCR)	Yes	No

This second screening resulted in a total of 637 scientific papers considered appropriate to be included in the review. They are listed in appendix R, sorted by the identification number of the reference.

Data was extracted to an excel spreadsheet containing the following fields:

- Tick genus and species, recorded as in the original paper;

- Location of the tick: based on the nomenclature of statistical territorial units (NUTS) for the EU countries. For non EU countries that did not have the NUTS established, we recorded the name of the location provided in the original report, at equivalent level of precision. The coordinates (latitude/longitude) were recorded if given in the article;

- If molecular techniques were used to identify the tick (yes/no);

- The source of the tick specimen: free living (questing), livestock, pet, human, wildlife (taxonomic order of the host);

- The corresponding bibliographic reference;

- The tick-borne pathogen genus and species (as it appeared in the original work);

- Location of the pathogen: NUTS for European countries, For the countries that do not have the NUTS, the name of the administrative region at the level of precision provided in the scientific paper. Geographical coordinates if provided;

- Diagnostic/identification method of the pathogen: isolation, molecular, serology;

- Source of the sample (pathogen): livestock, pet, human, wildlife (taxonomic order of the host), tick; and

- The corresponding bibliographic reference.

Other data sources:

- Gathering scientific papers from the personal collections of the WG members

- Integrated Consortium of Ticks and Tick-borne Diseases (ICTTD3): http://www.icttd.nl/index.php?id=2;

- Official reports of diseases, not indexed journals (at the knowledge of the WG members)

- PromedMail.org (for CCHF cases)

OIE web page: data of the distribution of the ASF outbreaks in the Caucasus (accessed the 5 of May of 2010)

Uncertainties:

- the strings could be improved to cover a wider range of scientific papers

- there were scientific papers that could not be retrieved on time for data extraction

- there were scientific papers that could not considered because we did not know the language

- other sources of data could be explored, as databases of doctoral thesis

3. Tick-borne animal infections and zoonoses in Eurasia

3.1. Geographic region of concern

The list of countries to be included in the project includes the European countries (Albania, Andorra, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Germany, Estonia, Faroe islands, Finland [including Åland Island], France, Greece, Hungary, Ireland, Italy, Kosovo, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Malta, Montenegro, The Netherlands, Norway, Poland, Portugal, Rumania, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom).

In addition the following countries are also included: Turkey, Israel, Jordan, Lebanon, Syria, Morocco, Algeria, Tunisia, Libya, Egypt, and the geographic areas covering Western Sahara and Palestine. These neighbouring countries were included due to their proximity to Europe and the potential for ticks to be spread from.

The eastern border of Europe included Armenia, Belarus, Georgia, Moldova, Ukraine, and a buffer zone of some 600 km in the European Russia, to account for the important tick species recorded in that area and of potential interest for Europe under future scenarios.

3.2. Tick-borne infections of vertebrate animals

Infections with certain pathogens in domestic animals that are transmitted by ticks were reviewed with the following summary associated with each.

3.2.1. African Swine Fever

African swine fever (ASF) is a viral swine disease caused by ASF virus (ASFV), an icosahedral complex DNA virus, unique member of the Asfarviridae family. It affects only porcine species of all breeds and ages. The disease was described for the first time in Kenya by Montgomery in 1921 when the virus spread from infected warthogs (*Phacochoerus aethiopicus*) to domestic pigs (*Sus scrofa*) causing a disease with a 100% case-fatality rate. The disease is currently present in Africa, mainly in many countries located south of the Sahara, in most of which the disease is endemic. In Europe, ASF is still endemic in Sardinia. More recently in 2007, ASFV spread to the Trans-Caucasic countries (TCC) and the Russian Federation (RF) (EFSA2010b).

Pigs are the only domestic animal species which are naturally infected by ASFV. Wild boar have also been identified as susceptible to ASFV infection with clinical signs and case-fatality rates similar to those observed in domestic pigs in Spain and Portugal, in Sardinia (Italy) and, experimentally, in feral pigs in Florida (McVicar et al., 1981; Sanchez-Vizcaino 2006). Wild boar and feral pigs can transmit the virus directly to domestic swine as well as among them. In Africa, it has been observed that ASFV induces an unapparent infection in three species of wild pigs (warthogs, bush pigs and red river hog), while the role played by the giant forest hog has not been yet clarified (Jori and Bastos, 2009).

Some species of soft ticks have proved to be ASFV reservoirs and vectors, such as *Ornithodoros moubata* and *O. porcinus* in Africa and *O. erraticus* in the Iberian Peninsula (Spain and Portugal). In *O. moubata*, transovarial and transstadial ASFV transmission have been described; in *O. erraticus* only transtadial transmission has been demonstrated. Other soft tick species widely distributed in North and South America have been identified as harbouring and transmitting ASFV, and the soft tick, *Ornithodoros savignyi*, present in Africa, can transmit ASFV to domestic pigs experimentally.

ASFV is spread among domestic pigs via the oral-nasal route. However, it has also been demonstrated that the virus can be infectious by a number of other routes, including tick bites, and experimental inoculation via cutaneous scarification, and by the intramuscular, intravenous, subcutaneous and intra-peritoneal routes. The infection usually commences in the monocytes and macrophages of tonsils and mandibular lymph nodes. From there, it spreads through the draining lymph nodes and blood to the target organs (lymph nodes, bone marrow, spleen, lung, liver and kidney) which are the principal sites of secondary replication.

The clinical signs of ASF can resemble a variety of other swine haemorrhagic diseases and can easily be confused with classical swine fever (hog cholera) and erysipelas. Laboratory tests are necessary to confirm diagnosis. On the other hand, ASF can present different clinical signs, mostly depending on the virulence of the virus, infectious dose and mode of infection, with a range of clinical forms varying from acute to subclinical and chronic.

ASFV is maintained in Africa by a cycle of infection between wild pigs / suidae and soft ticks. In some of these wild pigs / suidae, ASFV infection is characterised by low levels of virus in the tissues and low or undetectable levels of viraemia, but this is sufficient to infect soft tick vectors and for tick transmission to domestic pigs. This cycle of the virus makes ASF very difficult to eradicate in Africa. In Sardinia, where ASF is still present, wild boars are as susceptible as domestic pigs. No ticks from the *O. erraticus* complex have been found in Sardinia.

Experience of past outbreaks outside Africa has shown that the introduction of ASFV into a non-infected pig population in free regions is most often related to the entry through international ports or airports of garbage containing uncooked pork which is used for pig feeding. Therefore all waste food from planes and ships should be incinerated (Sánchez-Vizcaíno, 2006). Once ASFV is established in domestic swine, infected animals are the most important source of virus dissemination for susceptible pigs. In Europe, ASFV was introduced for the first time in 1957 in Portugal, through waste from international flights. Although this first outbreak was rapidly eradicated, in 1960 the virus entered again in Lisbon (Portugal) and spread through the rest of Portugal and Spain, where ASFV remained endemic until 1995. During this period, some other outbreaks occurred in other European countries, affecting Andorra (1975), Belgium (1985), France (1964, 1967 and 1974), Malta (1978), The Netherlands (1986) and Italy (1967, 1969 and 1993), including Sardinia island, where ASF has remained endemic since 1978. All these virus introductions were also related with swill feeding.

At present, no treatment or effective vaccine against ASFV is available. Since 1963, when the first live-attenuated vaccine was used in Portugal, many efforts have been made in this area with unsatisfactory results. Since no vaccine for ASFV is yet available, the control of this disease in free areas depends on preventing the introduction of the virus.

In Europe, several epidemiological paths are known to be able to maintain the virus in domestic pig populations and this complicates the control of the disease. The main routes of transmission are: swill, domestic pig and wild boar interactions, and pig-tick interactions. EFSA scientific opinion (2010b) on ASF contains an assessment of the risk of introduction of this virus into the EU especially from the Caucasus. EFSA scientific report (EFSA 2010a) treats the role of tick vectors in the epidemiology of Crimean Congo haemorrhagic fever and African swine fever in Eurasia and contains geographic distribution maps of the tick vector and the ASFV.

3.2.2. Crimean-Congo Haemorrhagic Fever

Crimean-Congo haemorrhagic fever (CCHF) is a tick-borne zoonosis that is a public health concern in many regions of the world including Africa, the Middle East, parts of Europe (the Balkans region, Greece and Turkey), and western Asia. It is caused by a virus belonging to the genus *Nairovirus* (family Bunyaviridae) and is transmitted by several species of hard (ixodid) ticks, particularly by those belonging to the *Hyalomma* genus (Horak et al., 2001).

Phylogenetic analyses performed on S-, M- and L-RNA segments of the *CCHF virus* showed that virus strains grouped in seven different clades (Deyde et al 2006). Three of them are distributed in Africa, two of them in Europe and the other two clades are in Asia. Despite the potential of dispersal of the virus in Africa and Eurasia, it appears that circulation of the virus is largely localised within the two regions (Africa and Eurasia) that are also associated with the distribution and dispersal of tick vectors of the virus (Burt and Swanepoel, 2005; Paweska, 2007). It has been also concluded that viral strains have a latitudinal relationship, without much interchange of the strains from different latitudes (i.e. Africa and Europe).

The virus may be maintained in tick populations during inter-epizootic periods through several mechanisms, such as transstadial and transovarian transmission, and non viraemic transmission of ticks aggregated on the same host. Epidemics usually take place during the peak activity periods of *Hyalomma* ticks that coincide with the hot and dry season (Swanepoel, 2006).

There are large number of potential hosts vertebrate reservoirs for Crimean-Congo haemorrhagic fever virus (CCHFV), reflecting the diverse feeding preferences of the immature and adult tick vectors. Antibodies against CCHFV have been detected in domestic and wild animals including hares, hedgehogs, rodents, bats, and large mammals such as giraffes and rhinoceroses. The most important source of virus transmission is immature ticks of *Hyalomma* genus, which have fed on the blood of small vertebrates. Once infected, the tick remains infected throughout its life (transstadial transmission), and the mature tick may transmit the virus to large vertebrates, such as livestock. Domestic ruminants, such as cattle, sheep, and goats will have viraemia for about a week after becoming infected. They may be the source of infection for humans during slaughtering and veterinary procedures such as castration. The level of viraemia in birds is usually low and unnoticeable, even though migratory birds may play role in the epidemiology of the virus disseminating infected *Hyalomma* ticks. Birds migrating from Russia with their ticks across the Black Sea were suggested to be the cause of virus introduction in Turkey (Karti et al., 2004).

Humans can become infected by tick bites through direct contact with blood or tissues of infected humans or livestock. The highly pathogenic nature of the virus occasionally results in serious nosocomial outbreaks (Swanepoel, 1995). Clinical disease in humans is initially manifested as an acute febrile illness followed by a fatal haemorrhagic syndrome with mortality rates of up to 50% (Swanepoel et al., 1987). In other cases, like in the still growing outbreak in Turkey, the most common cause of infection has been through the bite of an infected tick.

Outbreaks in South Africa arose in slaughterhouse operators during the slaughter of ostriches, which were heavily infested with ticks. The infection occurred when the infected ticks present on the carcasses were squashed during skinning (Swanepoel, 1998). Nevertheless meat from butchered animals do not pose a risk as in this substrate the CCHFV is quickly inactivated by a drop in pH, as occurs during the maturation process that the meat undergoes after slaughter. EFSA scientific report (EFSA 2010a) treats the role of tick vectors in the epidemiology of Crimean Congo haemorrhagic fever and African swine fever in Eurasia. It contains geographic distribution maps of either the tick vectors or the CCHFV.

3.2.3. Tick-borne encephalitis group

Tick-borne encephalitis

Tick-borne encephalitis (TBE) is one of the most important and serious human infections occurring in Europe and many parts of Asia. The etiological agent, *Tick-borne encephalitis virus* (TBEV), is a member of the genus *Flavivirus* of the family Flaviviridae. TBEV is believed to cause at least 11,000 human cases of encephalitis in Russia and more than 3000 cases in the rest of Europe annually (Donoso Mantke et al., 2008). Related viruses are *Langat virus* (LGTV) and *Powassan virus* (POWV), which also cause human encephalitis, and *Omsk haemorrhagic fever virus* (OHFV), *Kyasanur Forest disease virus* (KFDV) and *Alkhurma virus* (ALKV), that cause serious haemorrhagic fevers rather than encephalitis (Gritsun et al., 2003).

Until recently, three subtypes of the *Tick-borne encephalitis virus* were recognized, i.e.: the Western or Central European subtype including the *Kumlinge virus* on Åland in Finland; the Siberian subtype; and the Far Eastern subtype. Recently the Siberian subtype was recognized as a human pathogen in western Finland where also populations of the vector, *Ixodes persulcatus* were recorded. More recently, Grard et al., (2007) assigned the *Tick-borne encephalitis* and *Louping ill* viruses to a unique species (*Tick-borne encephalitis virus*) including four viral subtypes, i.e. Western TBEV, Eastern TBEV, Turkish sheep TBEV and Louping ill TBEV.

Ixodes ricinus is the main tick vector involved in the TBEV infections in Europe. All its stages can attack humans. However the most involved stage is the nymphal stage. This is due to several factors: the unfed larvae are uninfected and become infected while taking their first blood-meal on viremic host or by co-feeding; the nymphs are far more abundant in nature than the adult ticks; the colourful adult females are relatively large (3.5 mm) compared to the dull-coloured smaller (1.5 mm) nymphs and therefore more easily detected and removed when encountered on the human body. In TBE foci in Central and Northern Europe the infection prevalence of TBEV in nymphs ranges around 0.1-0.5% and in adults about 0.3-6.0%. The infection prevalence in adult females of *I. persulcatus*, which is the main vector stage for the Eastern TBEV, tends to be much higher (up to 40%) than in *I. ricinus* (Labuda and Nuttall, 2008). Co-circulations of both Western TBEV and Eastern TBEV occur in some foci in the Baltic States, where the distribution of the two tick species overlap. The Far Eastern subtype has been discovered not only in Siberia but also in some European localities (Chausov et al., 2010). In Estonia, all three human-pathogenic subtypes of TBEV have been found in the same areas (Golovljova et al., 2004). Apart from the two main vector species, *I. ricinus* and *I. persulcatus,* several other tick species including *I. hexagonus, I. arboricola, Haemaphysalis concinna, Ha. inermis* and *Ha. puctata* are competent but secondary vectors (Labuda and Nuttall, 2008).

Until recently, it was thought that viraemic small rodents, particularly the bank vole *Clethrionomys glareolus* and the field mouse *Apodemus flavicollis*, and insectivores were the principal reservoirs of TBEV, infecting the vectors. However, the viraemia in these rodents is usually of short duration (a few days). For maintenance of TBEV in *I. ricinus* populations co-feeding transmission between infective nymphs and susceptible larvae feeding adjacent to and on the same small mammal is now considered to be more important than transmission via viraemic small mammals (Labuda and Nuttall, 2008).

Many cases in humans are unrecognized and they are without clinical signs or symptoms. In some cases however, the clinical syndrome of TBE disease is severe, with life-threatening neurologic disease including high case fatality (5 to 35%) in its Eastern form, mainly in Russia. In contrast the case fatality in Western Europe, mainly in Central and Northern Europe is usually low (approximately 1%) with nearly all deaths confined to patients above 60 years old. Patients infected with the Siberian subtype suffer from a milder but often chronic disease compared to the disease caused by the Far Eastern subtype,

TBE incidence fluctuates from year to year but an increase of TBE incidence has been noted in some countries (Danielova et al., 2006; Lindquist and Vapalahti, 2008) and new TBE foci have appeared, especially in the last decade. This is presumably due to a complex interaction of factors such as the changing climate affecting the vector directly as well as the plant and host communities, socio-political changes, and technological factors, e.g., better diagnostic methods and increased awareness (Telford III and Goethert, 2008; Donoso Mantke et al., 2008).

Louping ill

Louping ill virus (LIV) or ovine encephalitis/encephalomyelitis virus is another subtype of the *Tick-borne encephalitis virus* and the only member of the TBEV complex present in the British Isles where the vector is *I. ricinus* (Reid, 1988). LI is endemic in sheep-farming areas of northern England, Scotland, Wales, Ireland, Norway. Many tick hosts, such as red grouse, willow grouse; field vole and deer become viraemic when infected with LIV. However, the viraemia is usually too low to be infective to feeding tick larvae. In contrast to these wild hosts, sheep and red grouse consistently develop viraemia sufficient to infect tick larvae and amplify the virus. Occasionally horses, cattle and goats) develop high viraemias sufficient to be infective to the tick larvae (Reid, 1988). Mountain hares, *Lepus timidus*, may be maintenance hosts for LIV by non-viraemic transmission between co-feeding ticks as experimentally demonstrated by Jones et al. (1997). One of the main assumptions for transmission of a vector-borne pathogen is usually that feeding by the vector is the sole or main route of host infection. However, Gilbert et al. (2004) demonstrated experimentally a transmission route whereby an important tick host, the red grouse (*Lagopus lagopus scoticus*) became infected with LIV, after eating infected *I. ricinus* ticks. Gilbert et al. (2004) estimated from field observations conducted in Scotland that this mode of infection could account for 73-98% of all virus infections in wild red grouse in their first season. Certainly, this way of transmission has potential implications for the understanding of other vector-borne pathogens where hosts may ingest vectors through foraging or grooming.

LI is principally a disease of sheep and less commonly of cattle, other domesticated animals and birds, especially red grouse. Dogs and particularly sheep-dogs and hunting-dogs in endemic areas, are occasionally infected. Clinical signs include fever, ataxia, trembling, salivation, coma and death. The virus can cause severe encephalitis in humans; about 35 cases are on record. Most of them are due to accidents while handling the virus in the laboratory (Labuda and Nuttal, 2008). Definitive diagnosis is based upon the isolation and identification of the virus (Reid, 1988; Lobetti, 2007). LIV infection in sheep is exacerbated by co-infection with *Anaplasma phagocytophilum* (Reid, 1988).

Experimental and transstadial transmission have been reported in *Rh. appendiculatus* and *Hy. anatolicum*, but there is no evidence that they are natural vectors or that any other tick species except *I. ricinus* play any significant role in the epidemiology of the disease (Reid ,1988).

Although *I. ricinus* is the primary vector and virus reservoir with transstadial, but presumably not transovarian transmission, the vector efficiency of this species is relatively restricted. Even when virions are acquired by the feeding larvae only few of the nymphs become infected. Similarly to the prevalence of TBEV in *I. ricinus* population, the prevalence of LIV in *I. ricinus* is also low.

Other TBEV-group viruses

Infections of domesticated animals, similar to TBE and LI also occur in other European countries (Spain, Bulgaria, Greece, Turkey). *Greek goat encephalitis virus* (GGEV), which was isolated from the brain of a newborn goat with neurological symptoms, is currently classified in the TBEV group. The vector of GGEV has not yet been specifically identified but is considered likely to be *I. ricinus*. A study during 2003-2006 in goat and sheep farming rural areas of Northern Greece suggested the presence of TBEV in two pools of *I. ricinus* ticks. Sequence analysis showed that the virus was GGEV. These virus-positive ticks were detected in regions where a high prevalence of TBE antibodies in humans was present. TBEV is considered not to be endemic in Greece, so most probably the seroprevalence of TBE antibodies in humans is due to cross-reactivity to GGEV (Grard et al., 2007). The Turkish subtype (Turkish sheep encephalitis virus) is more closely related to LIV and should be reclassified (ICTV Data Base 2006).

3.2.4. Anaplasmoses

Alphaproteobacteria of the order *Rickettsiales* are obligate intracellular organisms with a wide range of eukaryotic hosts. There are two well characterized families: *Anaplasmataceae* and *Rickettsiaceae*. In the family *Anaplasmataceae*, four genera have been identified: *Anaplasma, Ehrlichia, Wolbachia, and Neorickettsia*. Several species of the genus *Anaplasma* pose severe threats to livestock and human health. Main *Anaplasma* species responsible of animal infections or zoonosis in the EU and the Mediterranean basin are listed in Table 1. As a result of a taxonomic reorganization of the order *Rickettsiales* (Dumler et al., 2001), some species of the genus *Ehrlichia* (*E. equi, E. phagocytophila* and *Ehrlichia* spp. causing human granulocytic ehrlichiosis - HGE) were renamed as *Anaplasma phagocytophilum* in the genus *Anaplasma*. This species is the etiological agent of human and animal granulocytic anaplasmosis. Similarly, *Ehrlichia bovis* and *Ehrlichia platys* are now known as *Anaplasma bovis* and *Anaplasma platys*.

Infection of domestic and wild animals, and humans, with these organisms may lead to clinical disease collectively called anaplasmosis, manifested as a febrile systemic illness with haematological abnormalities, and lymphadenopathy (Rikihisa, 2006).

Table 3: Anaplasmoses in the EU and in the Mediterranean basin transmitted by hard ticks

Anaplasma **spp**	**Disease**	**Host range**	**Tick involved (in EU and in the Mediterranean basin)**
A. phagocytophilum	Tick borne fever	sheep	*Ixodes ricinus, Ha. punctata, I. persulcatus, I. trianguliceps, Rh sanguineus*
	Pasture fever	cattle, wild ruminants	
	Human granulocytic anaplasmosis	human	
	Equine granulocytic anaplasmosis	horse, lama, rodents	
	Canine granulocytic anaplasmosis	dogs	*Ixodes ricinus, Ha. punctata, I. persulcatus, I. trianguliceps, Rh sanguineus*
A. marginale	Bovine anaplasmosis	ruminants	*I. ricinus, I. persulcatus, Rh. sanguineus, Rh. bursa, Rh. annulatus*
A. centrale	Bovine anaplasmosis	cattle	*I. ricinus, I. persulcatus, Rh. sanguineus, Rh. bursa, Rh. annulatus*
A. bovis	Bovine mononuclear or agranulocytic anaplasmosis	cattle, small mammals	*Hy. excavatum, Rh. sanguineus, Rh. turanicus*
A. ovis	Ovine anaplasmosis	goat, sheep, clattle	*Rh. bursa*
A. platys	Canine infectious cyclic trombocytopenia	dog	*Rh. sanguineus, Rh. turanicus*

A: *Anaplasma*; *I: Ixodes*; *Rh*: *Rhipicephalus*; *Ha*: *Haemaphysalis*; *Hy*: *Hyalomma*.

Anaplasma phagocytophilum

Anaplasma phagocytophilum, formely known as *Ehrlichia phagocytophila*, *Ehrlichia equi* and the agent of HGE, is a commonly found bacterium causing tick-borne fever in sheep; pasture fever in cattle, wild ruminants (deer, bison and wild goat), and dog; granulocytic anaplasmosis in horses and humans; and canine granulocytic anaplasmosis in dogs (Strle, 2004, Rymaszewska and Grenda, 2008). It was first recognized in Scotland in 1932 and is now identified in most other European countries. Apart from domestic ruminants, free-living ruminants like feral goats, red, fallow and roe deer have been tested positive for A. *phagocytophilum*. Not only a tick-ruminant cycle is believed to maintain the TBF variants, but also a rodent-tick cycle. The wood mouse (*Apodemus sylvaticus*), yellow-necked mouse (*Apodemus flavicollis*), field vole (*Microtus agrestis*) and bank vole (*Myodes glareolus*) are found to be competent reservoirs of infection (Barandika et al., 2007). The bacterium infects granulocytic leucocytes (neutrophils, eosinophils and basophils), monocytes and tissue macrophages.

Tick-borne fever in sheep, and pasture fever in cattle are caused by A. *phagocytophilum*, and is characterized by fever, neutropenia, lymphopenia, thrombocytopenia and general immunosupression (Woldehiwet, 2006).

Human granulocytic anaplasmosis is a multisystemic disease that occurs more in adults, in particular in those above the age of 60 years, than in children and is characterized by acute fever, headache, myalgia, nausea and lethargy, similar to symptoms of the common flu. In particular, immunocompromised patients are at high risk. Meningoencephalitis, respiratory distress, shock and opportunistic infections are occasional complications. In Europe, no fatal cases have been reported but in the USA, the mortality rate was between 7 and 10% (reviewed by Rymaszewska and Grenda, 2008, Bakken and Dumler, 2008).

Equine granulocytic anaplasmosis occurs in horses as their natural host but as well in lama and rodents. It is generally a benign disease, yet fulminating cases are described. Mortality is low, and the disease is always acute, never chronic.

The main vector of *A. phagocytophilum* is found to be *Ixodes ricinus* (Strle, 2004) and the prevalence of infection varies among regions and development stage (Stuen, 2007). In unfed nymphs, the infection rate varied between 0.25 and 25% (Walker et al., 2001). The survival of the parasite is believed to be over a year while ticks are awaiting a new host. Only transstadial transmission occurs.

The transmission of *A. phagocytophilum* has also been associated with other tick species, such as *Haemaphysalis punctata* in areas in the UK where *I. ricinus* was not present (MacLeod, 1936) but also with *I. persulcatus, I. trianguliceps* and *R. sanguineus* (Alekseev et al., 1998; Ogden et al., 1998; Alberti et al., 2005). The vector role of the latter species is however not determined yet as only one *R. sanguineus* was found positive and this tick was removed from a dog showing tick-borne disease symptoms.

Anaplasma marginale

Bovine Anaplasmosis, caused by *A. marginale*, was formerly known as gall sickness, a disease affecting domestic and wild ruminants (water buffalo, bison, African antelopes and mule deer). The disease is characterised by fever, anemia, weight loss, reduction of milk production, abortion in pregnant females, and it may lead to death (Rymaszewska and Grenda, 2008, Kocan et al., 2010). *Anaplasma marginale* is present in tropical and sub-tropical regions although this bacterium species is frequently detected in Europe (Sicily, Hungary and Spain) (de la Fuente et al., 2005; Naranjo et al., 2006; Hornok et al., 2007; Torina et al., 2007; Torina et al., 2008). It is an obligate intracellular bacterium species invading erythrocytes mostly of ruminants, both domestic and wild, i.e. calves, water buffalo, bison, African antelopes and mule deer. The disease in cattle causes considerable losses to dairy and beef industries worldwide. Transmission of the bacteria is effected by ticks of approximately 20 species, in Europe mainly *Ixodes. ricinus, I. persulcatus, Rhipicephalus sanguineus, Rh. bursa* and *Rh.* (*Boophilus*) *annulatus* (Kocan et al., 2004).

Mechanical transmission occurs by contaminated mouthparts of biting flies but can only be achieved within a few minutes after the initial bite, although the pathogen can remain viable and infective in arthropods for several days after ingestion (Ewing, 1981, Hornok et al., 2008).

It appears that *A. marginale* is often introduced in a herd by ticks but subsequently mechanical transmission may become more important. Calves under the age of six months have innate resistance and will not develop clinical anaplasmosis, no matter the immune status of the mothers. Thereafter the risk for serious disease increases with age, unless sufficient contact in the fist months of live allows for the development of immunity. Therefore cattle reared in endemic regions develop a naturally acquired immunity, quite often without passing through a stage of clinical disease. This endemic stability means that all calves need to come into contact with the infectious agent, reservoirs and stable vector populations.

Wild ruminants (antelopes, buffalo, deer, eland) can function as reservoirs of *A. marginale* and the infection can be maintained in game resorts (deer to deer transmission) without bovine intervention being necessary (Potgieter and Stoltsz, 2004).

Anaplasma centrale

Anaplasma centrale is considered as a separate species or subspecies of *A. marginale*, and is also an intraerythrocytic tick-borne pathogen that causes mild infections in cattle. A cross-immunity between the two bacteria exists and because of its mild virulence, it is used in live-blood vaccines to protect cattle from the more virulent *A. marginale* (Potgieter and Stoltsz, 2004). These vaccines are mainly used in Africa, Australia, Latin America and Israel (Rymaszewska and Grenda, 2008). A first case of bovine anaplasmosis caused by *A. centrale* in Europe was reported in 2008 in Italy (Carelli et al., 2008).

Anaplasma bovis

Anaplasma bovis is the etiological agent of bovine mononuclear or agranulocytic anaplasmosis, a disease mainly detected in cattle and small mammals (Goethert and Telford, 2003). Infection may occur with limited or no clinical signs.The disease is characterized by weakness, weight loss, fever, enlargement of prescapular lymph nodes, paleness of the mucous membranes and mucous nasal secretion (Uilenberg, 1997). This disease has been reported in Italy (Georges et al., 2001) and Israel (Harrus et al., 2010) but is most commonly present in South America, West, Central and southern Africa, and the Indian subcontinent. The transmission of the disease is transstatial by known vectors *Amblyomma variegatum*, *Rh. appendiculatus* and *Hy. excavatum* (Coetzer and Tustin, 2004). The pathogen has recently been detected in Israel in unfed *Rh. sanguineus* and *Rh. turanicus* adults collected from the vegetation (Harrus et al., 2010).

Anaplasma ovis

Anaplasma ovis mainly infects small ruminants like sheep and goats and is prevalent worldwide (Rymaszewska and Grenda, 2008). In Europe it has been detected in Italy, Hungary and Turkey (de la Fuente et al., 2002; de la Fuente et al., 2005; Hornok et al., 2007; Christova et al., 2003). The bacterium also infects erythrocytes but in general anaplasmosis due to *A. ovis* in small ruminants is a benign infection with low morbidity and mortality. Goats are normally more susceptible than sheep or cattle. The biological vector of *A. ovis* in the Mediterranean basin is *R. bursa*, and *Dermacentor andersoni* in the America (Friedhoff, 1997).

Anaplasma platys

Canine anaplasmosis or canine infectious cyclic thrombocytopenia (CICT) is caused by *Anaplasma platys*. The bacterium multiplies in platelets, but infected dogs may remain asymptomatic (Harvey et al., 1978). The infection has been detected worldwide and in Europe cases have been reported from Spain, France, Greece and Italy (Sainz et al., 1999; Torina et al., 2008; Yabsley et al., 2008; Sparagano et al., 2003; Mylonakis et al., 2004; Alberti and Sparagano, 2006). Cases of import of both the infectious agent and the vector have been reported in dogs visiting the Mediterranean region (Heyman et al., 2007; Nijhof et al., 2007). The implicated vector seems to be *Rhipicephalus sanguineus* (Inokuma et al., 2000; Sanogo et al., 2003; Sparagano et al., 2003), a cosmopolitan tick species that also transmits *Ehrlichia canis*, although *Rh. sanguineus* fed on experimentally infected dogs were not able to infect naïve dogs in the adult stage (Simpson et al., 1991). Similarly, as mentioned for *A. bovis*, unfed *Rh. turanicus* adults collected from the vegetation also showed to harbour *A. platys* (Harrus et al., 2010).

3.2.5. Ehrlichioses

Ehrlichia canis

Ehrlichia canis is a tick-transmitted obligate intracellular Gram-negative bacterium, which in dogs, infects monocytes and causes classical canine monocytic ehrlichiosis. It is also known by other names such as tracker dog disease, tropical canine pancytopenia, canine haemorrhagic fever, and canine typhus. The disease has been known since 1935 as a disease of dogs and other canids (Donatein and Lestoquard, 1935) but its importance was not seriously considered until an epizootic occurred in 1968 in Vietnam among military working dogs.

Ehrlichia canis is transmitted by the kennel tick (brown dog tick) *Rhipicephalus sanguineus* transstadially and is widespread in tropical and temperate areas of the world. Its distribution has expanded with the distribution of its vector. The disease has three clinicopathological stages, German shepherd dogs being apparently susceptible to the chronic phase, as seen in the military dogs in Vietnam.

Human infections with *E. canis* have been reported in several cases (Maeda et al., 1987; Sambri et al., 2004). Clinical signs of canine monocytic ehrlichiosis in humans are very similar to those of human monocytic ehrlichiosis, a zoonosis in the USA, caused by the closely related *E. chaffeensis* (Perez et al., 2006).

Ehrlichia ruminantium

Ehrlichia ruminantium, previously known as *Cowdria ruminatium*, causes Heartwater or Cowdriosis (other names are black gall sickness, mad gall sickness, infectious exudative pericarditis, or malignant rickettsiosis of ruminants). Heartwater is an infectious tick-transmitted disease of ruminants i.e. bovines, sheep, goats and various wild species. Transmission is related to the *Amblyomma* vector, of which in Africa at least ten species are capable of transmission. The most important are *Am. variegatum* and *Am. hebraeum*, the adults of both species parasitize cattle. The most widely distributed *Amblyomma* species in Africa is *Am. variegatum*, which even has spread outside the continent. *Am. hebraeum* is the most important vector in southern Africa.

Heartwater occurs in sub-Saharan Africa and in several African islands, the islands in the Indian Ocean and several Caribbean islands i.e. Guadeloupe and Antigua. In continental America it has not been observed, in spite of the presence of potential vectors (Coetzer and Tustin, 2004). The control of *Am. variegatum* in the Caribbean has been a daunting task and after many years unsuccessful as those islands from which the ticks were eradicated, got infested again after the import of immature stages on migrating cattle egrets (Corn et al., 1993).

Amblyomma variegatum sporadically occurs in the Mediterranean basin, most probably imported on migratory birds (Papadopoulos et al., 1996). The survival of *Am. variegatum* and *Am. hebraeum* in this region would be best suited in Sardinia, Sicily and the south-western part of the Italian peninsula, according to a predictive GIS model using temperature and land use (Pascucci et al., 2007), posing a possible risk of the introduction of *E, ruminantum* in the Mediterranean region.

3.2.6. Rickettsioses

Rickettsiae are gram-negative, alphaproteobacteria belonging to the family Rickettsaceae and the order Rickettsiales. The genus *Rickettsia* harbours many species, mainly of medical importance. They are almost all vector-borne zoonoses with a rodent reservoir and widely distributed throughout the world. Rickettsiae have an obligate intracellular existence in both human and arthropod hosts where they multiply in the cytoplasma by binary fission (Jongejan, 2001). Arthropod vectors consist of lice, fleas, mites and ticks. The genus is divided into three groups based mainly on clinical signs: the typhus group, the scrub typhus group and the spotted fever group. The typhus group (TG) Rickettsiae are associated with insects and are rapidly spread among susceptible populations (Azad and Beard, 1998) whereas the spotted fever group (SFG) Rickettsiae is transmitted by ixodid ticks, except for mite-borne *Rickettsia akari* causing Rickettsialpox in house mice and rats (Azad and Beard, 1998). Additionally the scrub typhus group is equally transmitted by mites.

The differences observed in disease epidemiology of the different Rickkettsial groups is a result of the different vector feeding behaviours. Ticks only feed once per life-cycle stage and therefore can transmit to only one host per stage, whereas fleas and lice feed repeatedly allowing multiple transmissions. Tick-borne rickettsiae are transmitted to humans by tick saliva, whereas flea- and louse-borne rickettsia are transmitted through contamination of broken skin and mucosal surfaces by infected vector faeces (Azad and Beard, 1998).

With the first report in 1899, these zoonoses are among the oldest known vector-borne diseases (Maxey, 1899). In 1910 the first case of Mediterranean spotted fever was reported in Tunis (Conor and Bruch, 1910) and two decades later the role of *Rhipicephalus sanguineus* as vector of *Rickettsia* *conorii*, was elucidated (Brumpt, 1932). Especially with the development of molecular tools and cell-culture systems, distinct tick-borne SFG rickettsioses were identified (Parola et al., 2005). The spotted fever group Rickettsiae consist of approximately 20 different species, of which half of them cause spotted fever syndrome of humans in Europe (Heyman et al., 2010). Several *Rickettsia* species have been isolated from ticks without any clear pathogenicity to humans although they might be etiological agents of undiscovered rickettsioses.

Table 4: Rickettsioses in the EU and in the Mediterranean basin.

***Rickettsia* spp**	**Disease**	**Host range**	**Tick involved**
R. conorii conorii	Mediterranean spotted fever (MSF)	dog, human, rabbit, rodents	*Rh. sanguineus, I. ricinus, I. hexagonus, D. reticulatus, D. marginatus*
R. c. israeliensis	Israelian Spotted fever		*Rh. sanguineus*
R. sibirica sibirica	Siberian tick typhus		*D. nuttallii, D. marginatus, D. salivarum. Ha. concinna*
R. s. mongolitimonae	Lymphadenopathy[1]		*Hyalomma spp.*
R. s. caspica	Astrakhan fever	human, dog, rabbit	*Rh. sanguineus, Rh. pumilio*
R. slovaca			*D. marginatus, D. reticulatus*
R. massiliae	Spotted fever		*Rh. sanguineus, Rh. turanicus, Rh mushamae, Rh. lunulatus*
R. aeschlimannii			*Hy. marginatum, Hy. rufipes, Hy. aegyptium, I. ricinus, Ha. punctata, Rh. bursa, Rh. sanguineus, Rh. turanicus*
R. helvetica	(perimyocarditis, meningitis)[1]	human	*I. ricinus*

R: *Rickettsia*; *E*: *Ehrlichia*; *Rh*: *Rhipicephalus*; *I: Ixodes*; *Hy*: *Hyalomma*; *Ha*: *Haemaphysalis*; *Am*: *Amblyomma*
[1] No official disease name has been identified however it is considered as part of spotted fever

Rickettsia conorii conorii

Rickettsia conorii subsp. *conorii* is the causative agent of Mediterranean spotted fever (MSF) also known as boutonneuse fever because of the papular rash seen at the tick bite site. This pathogen is mainly transmitted by the dog tick *Rhipicephalus sanguineus* and occurs in the Mediterranean basin including Northern Africa. MSF is a notifiable disease in Portugal with an incidence rate of almost 1/10,000 persons recorded between 1989 and 2000, the highest of all Mediterranean countries (de Sousa et al., 2003). Most cases of MSF coincide with the peak of tick activity, meaning late spring and summer. Human cases however, are relatively low due to the host preference of the main vector *Rh*. sanguineus, which feeds on dogs. When no dogs are available, humans are considered for feeding. Rabbit and rodents also serve as reservoir for the bacteria but because of the close relationship between humans and dogs, the latter mainly bring ticks in contact with humans (Hillyard, 1996).

MSF is asymptomatic in humans for about 6 days post infection, after which high fever and flu-like symptoms are observed and a black eschar or “tache noire” at the site where the tick attached. About four days after the onset of fever, a generalized maculopapular rash develops at the palms and soles. In most cases patients recover within 10 days.

An increased number of cases of MSF in Europe and similarly Rocky Mountain spotted fever (RMSF) in the United States were observed in the 1970s, most likely because of higher temperatures and lower rainfall (Parola et al., 2005).

Rickettsia conorii subsp. israelensis

Israeli spotted fever caused by *Rickettsia conorii* subsp. *israeliensis* is a typical spotted fever but without the typical eschar in most of the cases but the disease may be severe. Similarly to the Mediterranean spotted fever it is transmitted by the dog tick *Rh. sanguineus*.

The first cases of Israeli spotted fever were reported in late 1940s from Israel but recent studies from Portugal indicated the larger geographical extent of this pathogen/disease complex (Parola et al., 2005).

Rickettsia sibirica sibirica

Rickettsia sibirica subsp. *siberica* causes Siberian tick typhus or North Asian tick typhus. It was first described in 1935 and most cases are reported from Western Siberia. The principal vector of the disease are *Dermacentor nuttallii* in the mountain steppe of Western and Eastern Siberia (Parola et al., 2005) and *D. marginatus marginatus* of the steppe and meadow regions of western Siberia and northern Kazakhstan, *D. salivarum* in forest and shrubs, and *Haemaphysalis concinna* in swampy tussocks of some southern and far eastern territories of Siberia (Parola et al., 2005). These vectors can also act as reservoirs of the bacteria as transstadial and transovarial transmission occurs.

The infection is normally established after an incubation period of 7 days. Fevers associated with a scar at the tick bite site are the common clinical features. Concomitant symptoms are severe headache, myalgia and digestive disturbances, which can last 6 to 10 days without treatment.

In northern China the disease caused by *R. sibirica* subsp. *sibirica* is know as North Asian tick typhus (Fan et al., 1987).

Rickettsia sibirica mongolitimonae

Rickettsia sibirica subsp. *mongolitimonae* was described as a new subspecies of *R. sibirica* after being isolated from *Hyalomma asiaticum* in Inner Mongolia and China. It differed antigenetically and genotypically from the spotted fever group rickettsia (Yu et al., 1993) and presents specific characteristics: it causes multiple eschars, draining lymph nodes, a lymphangitis that extends from the inoculation eschar to the draining node. These symptoms can be presented alone or in combination.These clinical findings were observed in patients in the Mediterranean region where the parasite was isolated in 1996 (Fournier et al., 2005). In a time span of 10 years, 8 other cases of *R. sibirica* subsp. *mongolitimonae* were diagnosed in France. Similarly, cases were reported from Algeria, Greece and South Africa (Fournier et al., 2005; Pretorius and Birtles, 2004; Psaroulaki et al., 2005). Possible vectors of *R. sibirica* subsp. *mongolotimonae* are ticks of the *Hyalomma* spp. The reported case in France was from a patient who collected compost from a garden where migratory birds were resting (Raoult and Roux, 1997). The reported case in Algeria was associated with camels (Fournier et al., 2005), wich are preferential host of some species of the genus *Hyalomma*.

Rickettsia sibirica caspica

Close to the Caspian Sea *Rickettsia sibirica* subsp. *caspica* causes Astrakhan fever, a disease similar to MSF causing fever an the typical maculopapular rash. As most of the patients were dog owners, and appeared to have been in contact with the dog tick *Rh. sanguineus*, this tick seemed to be the vector of the disease. Molecular studies confirmed the vector competence of the dog tick but also of *Rh. pumilio*, a tick that usually feeds on domesticated and wild animals, including rabbits and large rodents, and occasionally also bites humans (Eremeeva et al., 1994).

Rickettsia slovaca

Rickettsia slovaca was first isolated from a *Dermacentor marginatus* tick in Slovakia (Rehacek, 1984). However, the first confirmed case was reported in France in 1997 (Raoult et al., 1997). Subsequently it has been detected or isolated in many European countries where *Dermacentor marginatus* and *D. reticulatus* have been screened for rickettsiae, including France, Switzerland, Slovakia, Ukraine, Yuguslavia, Armenia, and Portugal (Parola et al., 2005). *Dermacentor* ticks frequently bite people particularly on the scalp. As in many other species of *Rickettsia*, ticks can act as vector but also as reservoir of the pathogen due to transovarial and transstadial transmission. These tick species are active during early spring, summer, autumn and winter in southern Europe (Nijhof et al., 2007; Raoult et al., 2002). Recent spread of *D. reticulatus* in The Netherlands may be a result of changing agricultural land into seminatural reserves combined with the introduction of southern European cattle breeds imported directly into these reserves and may lead to the geographical extension of this parasite. Molecular studies of the ticks in The Netherlands only revealed *Rickettsia helvetica* (Nijhof et al., 2007). In Belgium a local population of *D. reticulatus* have also been found on fallow land near Antwerp (Claerebout pers. comm.) possibly as a result of dogs traveling from infested areas. This may constitute a possible risk not only for the spread of *Rickettsia* spp. but also for *Babesia canis*.

Rickettsia massiliae

Recently another distinct species of the SFG has been identified as *Rickettsia massiliae*, first isolated from in ticks in France near Marseille (Beati et al., 1992; Beati and Raoult, 1993). The clinical symptoms seem to be similar as those of the SFG Rickettsiae. This rickettsia has been detected in several countries in Europe (Greece [Babalis et al., 1994], Portugal and South America [Labruna, 2009], and Africa [Dupont et al., 1994; Bitam et al., 2006; Berrelha et al., 2009]). In all cases the vector of *R. massiliae* appeared to belong to the genus *Rhipicephalus*: *Rh. sanguineus* and *Rh. turanicus* in Europe, and *Rh. mushamae*, *Rh. lunulatus* and *Rh. sulcatus* in Africa. Transstadial and transovarial transmission has been demonstrated in *Rh. turanicus*.

Rickettsia aeschlimannii

Another emerging pathogen is *Rickettsia aeschlimannii*, first isolated and characterized in 1997 from *Hyalomma marginatum marginatum* ticks from Morocco (Beati et al., 1997). Symptoms exhibited by the patient in a study by Raoult et al. (2002) were similar to those of Mediterranean spotted fever (MSF) caused by *R. coronii*. This parasite has been linked to the ticks *Hy. m. marginatum* in Portugal, Spain, Croatia, Algeria and Greece (Beati et al., 1997; Punda-Polic et al., 2002; Fernandez-Soto et al., 2003; Santos-Silva et al., 2006), *H. margintum rufipes* in Chad, Ethiopia, Niger and Mali (Bitam et al., 2006; Mura et al., 2008) and migratory birds coming from Africa and arriving in Sicily (Matsumoto et al., 2004) and *H. aegyptium* in Algeria (Bitam et al., 2009). Recent studies in Spain also revealed five other tick species to be involved in the transmission of *R. aeschlimannii*: *I. ricinus, Hy. marginatum, Ha. punctata, Rh. bursa, Rh. sanguineus* and *Rh. turanicus* (Fernandez-Soto et al., 2003). The distribution in Europe would be at least that of *Hy. m. marginatum* (Matsumoto et al., 2004). *Rickettsia aeschlimannii* was shown to be transstadially and transovarially transmitted in ticks indicating that *Hyalomma* species may be not only vectors but also reservoirs of *R. aeschlimannii* (Matsumoto et al., 2004).

Rickettsia helvetica

Rickettsia helvetica has always been considered as non-pathogenic and never linked to any human diseases until 1999 when two young Swedish men died of sudden cardiac failure, showing perimyocarditis. Analysis revealed the presence of the bacterium in the two patient's pericardium (Nilsson et al., 1999). Recently human meningitis was associated with this pathogen in the same country (Elfving et al., 2010).

Rickettsia helvetica has been isolated from *Ixodes ricinus* in many European countries including Bulgaria, France, Italy, The Netherlands, Portugal, Slovenia and Sweden (Parola et al., 1998; Nilsson et al., 1999; Beninati et al., 2002; Christova et al., 2003; Sanogo et al., 2003; Nijhof et al., 2007) and also from Asian *Ixodes* species (Fournier et al., 2002). Because of the transstadial and transovarial transmission of *R. helvetica* by *Ixodes ricinus*, the ticks can act both as vector and reservoir of the bacterium.

3.2.7. Lyme borrelioses

Lyme borreliosis (LB) or Lyme disease is the most common tick-borne disease of humans in the Northern Hemisphere. It is a complex of several different zoonotic infections of which the etiological agents are transmitted by hard ticks.. At least 13 species or genomic groups of spirochetes in the *Borrelia burgdorferi* sensu lato complex have so far been described. Several are pathogenic to humans and domestic animals. They include *B. burgdorferi* (predominant in North America but also present in Eurasia), and *B. afzelii* and *B. garinii* (predominant in Eurasia). They are transmitted by tick species of the genus *Ixodes*, mainly *I. ricinus* in Europe, *I. persulcatus* in Eurasia, *I. pacificus* in western USA and *I. scapularis* in eastern USA. In Europe, another three *Borrelia* species, i.e., *B. valaisiana*, *B. spielmanii* and *B lusitaniae* sometimes infect humans and may cause human LB (Richter et al., 2004, Piesman and Gern, 2008). In Europe, three tick species are considered vectors of LB spirochetes, i.e., *Ixodes ricinus*, *I. hexagonus* and *I. uriae* (Piesman and Gern, 2008). Although the infection prevalence in the adult ticks is higher (mean 17.4%; range 3-58%) than in the nymphs (mean 10.8; range 2-43%) in European populations of *I. ricinus*, the nymphs are usually more important than the adult tick females for transmission of the pathogens to humans (Hubálek and Halouzka, 1998). Larvae are rarely infected (mean 1.9%; range 0-11%; Hubálek and Halouzka, 1998). However, in *I. persulcatus*, the nymphs rarely feed on humans, so in this case it is the adult female ticks which are responsible for nearly all human infections with LB spirochetes.

The enzootic cycle in general involves *Ixodes* spp. larvae and nymphs which become infected when feeding on infective wild bacteriemic mammals, particularly insectivores (shrews, hedgehog), rodents (mice, voles, rats and squirrels) or hares. Certain bird species also serve as vertebrate reservoirs to the spirochetes. Co-feeding transmission has been demonstrated to occur when sheep serve as *Borrelia* reservoir (Ogden et al., 1997).

It is important to distinguish between vertebrate hosts for the ticks and vertebrate reservoirs for the spirochetes. Cervids appear refractory to the infection and usually do not serve as *Borrelia* reservoirs but are extremely important hosts to *I. ricinus* females (Jaenson and Tälleklint 1992). Many species of *Borrelia* may circulate in the same ecosystem with the result that a single tick can be infected with two or more species of *Borrelia* – and with the TBE virus and other species of human-pathogenic bacteria. Throughout Europe, 13% of *Borrelia* infections in *I. ricinus* are mixed infections (Rauter and Hartung, 2005, Piesman and Gern, 2008). Multiple infection of a tick may occur because the host on which the tick was feeding had a multiple infection; or because the tick had fed two or more times on hosts infected with different *Borrelia* spp. In Europe, *B. garinii* and *B.valaisiana* are predominant of the mixed infections followed by mixed *B. garinii/B. afzelii* infection (Piesman and Gern, 2008). *B. afzelii* is mainly associated with rodents while some serotypes of *B. garinii* and all serotypes of *B. valaisiana* are associated with birds. *B. lusitaniae* is associated with lizards in the Mediterranean countries and often infect vector ticks more frequently than do the other genospecies in the complex (Richter and Matuschka 2006).

LB is prevalent in most parts of Europe (although the prevalence is low in southern Europe such as Portugal and Italy) throughout the former USSR to Japan, Mongolia and north-western China (Rauter and Hartung, 2005). The infection also occurs in some localities in North Africa. In North America nearly all human LB cases are confined to the north-eastern USA but the infection also occurs in other parts including California at a lower prevalence. LB is becoming increasingly prevalent in southern Canada and has also been reported from South America, including Mexico and Brazil. Climate change[6] and increasing abundance of deer could be associated with the spread of LB in North Europe (Gray et al., 2009).

Human LB infections sometimes cause clinical disease ranging from an influenza-like illness, often accompanied with excruciating (nocturnal) pain, to facial paresis, meningitis, severe arthritis and/or myocarditis. It has been estimated that in, for instance Sweden alone, about 10,000 people annually

[6] Climate change is not synonymous to global warming as per author's opinion. Climate change is a broad concept that include all potential changes in weather conditions

contract the infection resulting in clinical disease (Berglund, 2004). Among domesticated animals clinical symptoms associated with LB have been reported in dogs, cattle and horses. Antibody titres against *B. burgdorferi* s.l. in dogs, cats and livestock can be high but it is often difficult to establish a cause-and-effect relationship between exposure to the spirochetes and clinical signs and symptoms.

3.2.8. Recurrent (relapsing) Fever

Relapsing fever is an infection caused by several spirochaetes of the genus *Borrelia* (Cutler, 2006). Relapsing fever borrelioses are characterized by recurrent febrile episodes and spirochaetemia. Other than the louse-borne relapsing fever caused by *Borrelia recurrentis* and transmitted by the body louse *Pediculus humanus*, endemic tick-borne relapsing fever is a zoonotic disease transmitted worldwide by soft tick species of the genus *Ornithodoros*. Within each region, specific relationships usually exist between the *Ornithodoros* vector species, *Borrelia* species, and their distribution areas. Reservoir hosts are usually wild rodents. *Ornithodoros* ticks are included in the family Argasidae. They live close to their host, although the time spent on the host is relatively short. After each blood meal they are found in their habitats, typically cracks and crevices of rodent burrows, but also human shelters or just below the soil surface. Ticks become infected during a blood meal on a vertebrate with spirochaetemia. Spirochaetes then invade all tissues of the tick, including ovaries (responsible for transmission between generations), salivary glands and excretory organs. Vertebrates and humans become infected during a blood meal through contamination of the feeding site by salivary and/or coxal secretions of the tick (Parola and Raoult, 2001).

Borrelia hispanica is found in Spain, Portugal, Cyprus, Greece and North Africa. It has been isolated in *Ornithodoros erraticus*, a tick commonly found in south-western Europe. This tick species usually lives in the burrows of wild rodents, its natural host. In Spain and Portugal, however, it has adapted to bite domestic pigs that are kept in continuous grazing and sometimes overnight in large burrows or inside old buildings, and this tick species has adapted to live in these habitats (Estrada-Peña and Jongejan, 1999). Humans may be bitten, and hence relapsing fever was sporadically reported in countries such as Spain during the twentieth century, probably with an underestimated incidence (Sánchez-Yebra et al., 1997). The disease caused by *B. hispanica* is one of the less severe in the relapsing fever group, which presents with neurological signs in less than 5% of cases (Cadavid and Barbour, 1998). In 1996, a new *Borrelia* species was isolated in southern Spain from three patients with relapsing fever and from *Ornithodoros erraticus* ticks found in nearby areas (Anda et al., 1996). The reservoir of this bacterium is still unknown. Although this new *Borrelia* species has not yet been cultivated, molecular analyses have shown that it is closely related to *B. hispanica*, *B. duttoni* (an African species not preset in Europe) and *B. crocidurae*.

On the borders of Europe, several other relapsing borrelioses are present. *Borrelia persica*, the agent of Persian relapsing fever, is found in Israel, Syria, Egypt, Iran, and Central Asia. It is transmitted by *Ornithodoros tholozani* (Rodhain, 1998). This tick commonly lives in localities where livestock is housed, for example man-made shelters, caves, and rocky overhangs (Estrada-Peña and Jongejan, 1999). The disease is sometimes severe (Cadavid and Barbour, 1998). *Borrelia caucasica*, present in Caucasus and Iraq, is transmitted by *Ornithodoros verrucosus*, another argasid parasite of rodents. *Borrelia latyschevii* is transmitted by *Ornithodoros tartakovskyi* in Central Asia, the former USSR and Iran (Estrada-Peña and Jongejan, 1999; Rebaudet and Parola, 2006).

3.2.9. Babesioses

Babesiosis is caused by tick-transmitted intraerythrocytic protozoan parasites of the genus *Babesia* (Apicomplexa, Piroplasmida). Although they are capable of infecting a wide variety of vertebrate mammalian and some avian species babesial parasites require both a competent vertebrate and invertebrate host to maintain transmission cycles. Babesiae are the second most common blood-borne parasites of mammals after the trypanosomes. More than 100 species have been identified which are traditionally divided on the basis of their morphology into the small and large babesias. However, their phylogenetic situation has not been clarified. Molecular analysis suggests that the host-range of many

Babesia species is less restricted than believed previously and still unrecognised species may cause zoonotic infections in a variety of animals and humans.

To date, only ixodid ticks have been identified as vectors for *Babesia* spp. Some *Babesia* species can infect more than one genus of ticks; others can infect only ticks from the genus *Ixodes*. Several tick vectors can carry more than one *Babesia* species. The specific tick vector must feed on a vertebrate reservoir that is competent in maintaining the *Babesia* organisms in an infectious state. All species of *Babesia* are naturally transmitted by the bite of infected ticks. Animals and humans can also acquire the infection through transfusion of contaminated blood products. The vectors become infected when ingesting the infected blood cells. Certain species of *Babesia* are transmitted transovarially. The same species can persist over several tick generations. Infection is initiated by inoculation of the parasite stage with the saliva of the vector tick into the bloodstream of the host. The transmission only occurs often a few days after the tick has attached, because the sporoblasts first have to mature in the salivary glands of the vector before they are infective. Most *Babesia* spp directly invade red blood cells where their asexual multiplication most often results in two, sometimes four daughter cells which leave the host cell and each enters another red cell. There is extra-erythrocytic multiplication in the life cycle of *Babesia microti* which is one of the aetiological agents of human babesiosis. This species first invade lymphocytes where they develop into a motile form which then invades erythrocytes. Only transstadial transmission of *B. microti* from the larval to the nymphal stage of *Ixodes* spp. has been successful (Mehlhorn and Schein, 1984; Mehlhorn et al., 1986).

Babesiae can cause diseases in a wide range of wild and domestic animals in many regions of the world (Telford et al., 1993; Uilenberg, 2001, 2006). In endemic areas all or almost all individuals of the host population are infected when they are young, with no or minimal clinical disease. The introduction of susceptible animals in endemic regions could lead to recrudescence of babesiosis. To date, seven distinct *Babesia* species have been found to cause human babesiosis. Most infected patients share splenectomy as a risk factor for acquiring the disease. It seems that the number of symptomatic infection and more severe illness in humans is rising steadily due to higher medical awareness and the growing numbers of immunocompromised individuals. Zoonotic babesias are also being reported from geographical areas where babesiosis was not known to occur. Some recent papers have reviewed of human babesiosis providing new information on well known as well as recently discovered parasites with zoonotic potential (Telford et al., 1993; Kjemtrup and Conrad, 2000; Homer et al., 2000; Hunfeld et al., 2008).

The clinical features of babesiosis vary substantially from asymptomatic to life threatening, depending on the conditions of the host and the parasite involved. During the acute babesial infection, the host may become severely ill due to the host-mediated immunopathologic mechanisms and erythrocyte lysis. Typically, the infected host can suffer high fever, anemia, hyperbilirubinuria, possibly followed by alterations in the kidneys and other organs. All mammalian hosts examined have been able to develop immunity to *Babesia* species in which both humoral and cellular factors are involved (Telford et al., 1993; Kjemtrup and Conrad, 2000; Homer et al., 2000, Uilenberg, 2001; Hunfeld et al., 2008).

3.2.10. Theilerioses

Theileria spp. (Apicomplexa, Piroplasmida) are tick-borne intracellular protozoan hemoparasites causing infection, and often disease of veterinary and economic importance in livestock and wild animals in different regions of the world (Preston, 2001; Uilenberg, 2001). The genus *Theileria* differs from *Babesia* in that they first penetrate lymphocytes or macrophages in which they develop and after that enter red blood cells where they multiply, forming tetrads, often in the shape of a Maltese cross (Schein et al., 1981; Uilenberg, 2006).

Five species of *Theileria* have been recorded from cattle of which *T. parva* is the most pathogenic. It causes East Coast Fever (ECF), widespread in eastern, central, and southern Africa where *Rhipicephalus appendiculatus* and *Rh. zambesiensis* species are the vectors of *T. parva*. Apart from the cattle derived *T. parva*, Corridor disease is caused by buffalo-associated *T. parva*, which is mainly transmitted at the interface of cattle and African buffalo (*Syncerus caffer*). There is no cattle to cattle transmission of this parasite. Another milder disease of domestic cattle and the Asian domestic buffalo is called tropical or Mediterranean theileriosis, caused by *T. annulata*. This type of theileriosis is of greater importance than ECF because of its much wider distribution in many areas of the world, extending from southern Europe to southern Asia (Brown, 1990). Certain Ixodid ticks such as *Hyalomma marginatum*, *Hy. anatolicum*, *Hy. a. excavatum*, and *Hy. detritum detritum* are known to transmit *T. annulata*, and are found in large numbers in the Mediterranean region, especially in semi-arid areas (Viseras and Garcia-Fernandez, 1999). *T. sergenti*/*buffeli*/*orientalis* cause mild or asymptomatic disease in cattle known as bovine benign theileriosis (Uilenberg, 1981). *T. buffeli/orientalis* was detected in 2003 in Portugal using PCR-RLB in a survey conducted on local cattle (Brigido et al., 2003). *T. ovis*, *T. lestoquardi* (formerly *T. hirci*), *T. separata* and the recently described *Theileria* sp. China 1 are recognised as the species that can cause serious ovine theileriosis (Schnittger et al., 2000; Preston, 2001). There are also species of *Theileria* in deer in the United States, such as *Theileria cervi* (Reichard and Kocan, 2006)

The ticks can only transmit these hemoparasites transstadially. There is no transovarial transmission because theileriae do not passage the ovaries and the eggs of the vectors. The newly hatched larvae are never infected. Nymphs and adults become infective only if they were infected in the previous developmental stage. The transmission of parasites takes place by the injection of infected saliva of ticks but it only occurs often a few days after the tick has attached, the parasites first have to mature before they are infective (Mehlhorn and Schein, 1984).

The clinical signs of theileriosis differ from babesioses in the absence of hemoglobinuria and the less severe anaemia occurs in infected animals. *T. parva* is lethal to European (*Bos taurus*) cattle. Infected animals show enlarged lymph nodes, high fever and loss of appetite. This may be followed by diarrhoea, frequently by respiratory signs, due to oedema of the lungs. Mortality may exceed 90% in adult animals (Preston, 2001)

3.2.11. Equine piroplasmoses

Equine piroplasmosis (EP) is a tick-borne intra-erythrocytic protozoal disease of equids (horses, donkeys, mules, and zebras) caused by two species of apicomplexan protozoa, *Theileria* (syn. *Babesia) equi* (Mehlhorn and Schein, 1998) and *Babesia caballi* (Schein, 1988). *Babesia canis canis* of dogs has been reported in horses but no clinical signs attributable to this parasite species were described (Criado-Fornelio et al., 2003; Hornok et al., 2007). Equine piroplasmosis is thought to be indigenous to Asia but as a result of centuries of movement of horses both parasites have become distributed worldwide wherever competent vectors occur. This economically important protozoan disease of horses has been reported in many countries and continents thus making this disease a cause of great concern in the global horse industry. Equine piroplasmosis is endemic in many parts of Asia, Arabia, South and Central America and Africa (OIE, 2008). Within Europe, it is more prevalent in France (Leblong et al., 2005), Portugal (Bachiruddin et al., 1999), Spain (Camacho et al., 2005), Italy (Moretti et al., 2009) and Turkey (Karatepe et al., 2009). Equine piroplasmosis is a notifiable disease under OIE list within 72 h of diagnosis (OIE, 2008). For this reason, testing of horses for EP is mandatory for the international movement of horses either for participation in international events or for export. Only seronegative horses for both *T. equi* and *Ba, caballi* are qualified for importation to some countries like the United States, Canada, Australia and Japan (Friedhorff et al., 1990; Bruning, 1996; Knowles, 1996).

The disease agents are mainly spread by competent ticks. To date, up to 12 species of Ixodidae ticks belonging to the genera *Boophilus*, *Hyalomma*, *Dermacentor*, and *Rhipicephalus* have been identified as vectors of both *B. caballi* and *T. equi*) (Bruning, 1996; Massaro et al., 2003). *Babesia caballi* is passed transovarially from one tick generation to the next, whereas transmission of *T. equi* appears only to occur transstadially (de Waal, 1992). The parasites are also spread by the transfer of blood from infected to naïve equids through shared needles, improperly shared equipment, and blood or serum transfusions (de Waal and Van Heerden, 1994). Transplacental transmission of *T. equi* from carrier mares to asymptomatic foals was suspected (Phipps and Otter, 2004) and recently confirmed

(Allsopp et al., 2007). There is no reliable evidence that *B. caballi* can pass from mare to foal in this way.

Clinical signs of the infection are not pathognomonic, especially in endemic areas. *Theileria equi* appears to be the species more often involved in clinical cases. The clinical signs demonstrated by equids infected with the EP disease agents vary from mild to severe. Acute and subacute cases are the most commonly observed. The mild form of the disease can cause equids to appear weak or show lack of appetite, while more severe cases may have fever, anemia, jaundice, swollen abdomen haemoglobinuria, bilirubinuria and sometimes, death (de Waal and Van Heerden, 1994). In the chronic phase of the EP the horse can appear normal. In some cases of acute or chronic disease, mortality can reach up to 50% (de Waal, 1992). Infected animals that recover from acute or primary infection of *T. equi* remain life-long carriers since anti-theilerial drugs suppress but do not eliminate the parasite. Horses infected with *B. caballi* may remain carriers for up to 4 years (de Waal and Van Heerden, 1994). The detection of apparently healthy carrier horses has therefore remains a worldwide challenge for controlling the spread of the disease. Carrier mares may transmit the organism to their offspring and this may result in abortion or neonatal piroplasmosis. Some researchers suggest that foals may be born as carriers yet remain apparently healthy since colostral *T. equi* antibody may act to suppress parasitaemia in the newborn, reducing the incidence of clinical neonatal piroplasmosis **(**Allsopp et al., 2007**).**

The diagnosis of acute infection is made by microscopic examination of blood smears and observation of clinical symptoms. Although this method is simple, it is insufficient for the accurate identification of *B. caballi* and *T. equi* during mixed infections and low parasitemias (Krause, 2003). Therefore, a variety of serological tests such as indirect fluorescent antibody test (IFAT), enzyme-linked immunosorbent assay (ELISA), immunochromatographic tests and complement fixation test (CFT) have been used to detect specific antibodies (Hirata et al., 2002; Krause, 2003; Huang et al., 2004; Asgarali et al., 2007). The competitive ELISA (cELISA) using recombinant antigens was developed as a more specific method than CFT or IFAT for the serodiagnosis of piroplasmosis (Kappmeyer et al., 1999). The cELISA is currently the test of choice recommended by the World Organization for Animal Health (OIE, 2008). The specificity of the cELISA is 99.2 percent for *T. equi* and 99.5 percent for *B. caballi.* (OIE, 2008). Several PCR methods have been described recently including single round and multiplex PCR to allow simultaneous identification of both *B. caballi* and *T. equi* (Alhassan et al., 2005, 2007), and real-time PCR (Heim et al., 2007).

Both *B. caballi* and *T. equi* respond to the babesiacidal drugs but *T. equi* is more refractory to treatment than *B. caballi* (Schwint et al., 2009). No efficacious vaccine for equine babesiosis is available.

3.2.12. Hepatozoonosis

Hepatozoonosis is a tick-borne infection of increasing importance in dogs, in regions that have previously been considered free of the infection (Holland, 2001). It is caused by apicomplexan protozoa from the family *Hepatozoidae*. *Hepatozoon canis* and *H. americanum* are known to infect canids. *H. canis* has been reported from the mediterranean region (Spain, Portugal, Italy, Greece and France), Africa, the Middle East, the Far East and South America, where its main vector, the brown dog tick *Rhipicephalus sanguineus* is enzootic (Vincent-Johnson et al., 1997b). *H. canis* is regularly introduced into northwest Europe by dogs after ingestion of infected *R. sanguineus* during visits to endemic regions (Holland, 2001). *H. americanum* was initially considered a virulent strain of *H. canis* until it was described in 1997 as a separate species causing an emerging disease in the USA (Vincent-Johnson et al., 1997b). Its vector is Gulf Coast tick *Amblyomma maculatum*.

The tick, which serves as the definitive host, becomes infected when feeding on the blood of a parasitemic dog. Both *Hepatozoon* species are only transmitted transstadially from the nymph to the adult stage in their tick vectors. Vertical transmission of *H. canis* in the dog was reported in puppies born from an infected dam and raised in a tick-free environment (Murata et al., 1993). Transmission of *Hepatozoon* species to dogs takes place by ingestion of a tick containing the parasite. No salivary transfer of these parasites has been documented. In this respect, *Hepatozoon* differs from many other tick-borne protozoal and bacterial pathogens. When the infected vector is ingested by the dog, *H. canis* penetrates the gut wall, invades mononuclear cells and disseminates hematogenously to the hemolymphatic organs, liver, lung and kidney.

Canine hepatozoonosis caused by *H. canis* varies from being apparently a sub-clinical infection to a severe and life-threatening disease with lethargy, fever, cachexia and anaemia. It occurs mostly in young animals or in dogs suffering from a concurrent infection or immunosupressive conditions. *H. americanum* infects primarily muscular tissues and induces severe myositis. It is a systemic chronic and severe disease with fever, hind limb paresis, and ataxia, often leading to death (Vincent-Johnson et al., 1997a; Ewing et al., 2001).

3.2.13. Other potentially tick-borne infections

The following infections are associated or suspected to be associated with ticks as one of the potential modes of transmission but it is not the only one.

African Horse Sickness

African Horse Sickness (AHS) is a vector borne viral disease affecting equids (horse, donkey, zebra, mule). Camel and dog may be infected but they do not show signs of disease. It is caused by an orbivirus, *African Horse Sickness virus* (AHSV), which is endemic in tropical and sub-tropical areas of Africa south of the Sahara occupying a broad band stretching from Senegal in the west to Ethiopia and Somalia in the east, and extending to northern South Africa. AHS has also been sporadically reported in northern Africa, and in the Arabian Peninsula (Saudi Arabia and Yemen) in 1997. It was reported in Spain in 1990, from where it spread to Portugal. (Mellor and Hamblin, 2004; OIE 2010).

AHSV is transmitted primarily by the bites of females of *Culicoides* spp. (Diptera: Ceratopogonidae), which feed on blood to provide a protein source for egg production. Approximately 30 of the over 1500 identified species of *Culicoides* are believed to be natural vectors able to transmit orbiviruses (Wilson et al., 2009). Although the main role in the transmission of AHSV is played by *Culicoides*, it is to be noted that experimental demonstration of infection, replication, and transmission of AHSV have been described in some other species of mosquitoes. Nevertheless, they are generally considered to be of minor (if any) epidemiological significance as vectors in the field.

The role of ticks in the epidemiology of AHS is still uncertain, as demonstrated by the limited literature data. Following the isolation of AHSV from street dogs in Egypt (Salama 1981), an experimental study was performed on the brown dog tick *Rhipicephalus sanguineus* that has been demonstrated capable of transmitting the virus in laboratory conditions (Hess, 1988). In Egypt AHSV was also isolated in camels and in field samples of the camel-associated tick species *Hyalomma dromedarii* (Hess, 1988). Following this finding the possible vector competence of *Hy. dromedarii* has been investigated experimentally: transmission of AHSV to a susceptible host, transstadial transmission and AHSV active replication have been demonstrated in *Hy. dromedarii* (Awad et al., 1981).

Since ticks have a relatively long lifespan compared to mosquitoes and *Culicoides*, it is possible that they could provide an effective reservoir for AHSV and possibly play a role in overwintering survival of the virus in the environment. However, as these experiments have not been repeated or confirmed, the role of ticks in the epidemiology of AHS remains uncertain, although most scientific opinion suggests that any role is likely to be small (Hess, 1988; Mellor and Hamblin, 2004),

Bartonelloses

Bartonella infections are widespread in wild and domesticated mammals and several new species have been described during the last few decades. These alpha-proteobacteria infect erythrocytes and endothelial cells leading to persistent infections of their mammalian hosts. Since *Bartonella* spp. tend to infect the blood of their vertebrate hosts chronically these microparasites can be ingested, and potentially be transmitted by blood-feeding arthropods. Confirmed vectors of *B. henselae* (aetiological agent of catch-scratch disease), *B. bacilliformis, B. quintana, B. grahamii* and *B. taylorii* are *Ctenocephalides felis, Lutzomyia verrucarum, Pediculus humanus humanus,* and *Ctenophthalmus nobilis,* respectively (Billeter et al. 2008). *Bartonella* bacteria have been detected – based mainly on PCR - in several tick species, including *I. ricinus, I. scapularis, I. persulcatus, Dermacentor reticulatus, Rhipicephalus sanguineus* and *Carios kelleyi* (Billeter et al. 2008). Some of the reasons that *Bartonella* species might be transmitted by ticks have been listed by Telford and Wormser (2010): other arthropods can transmit *Bartonella* spp.; DNA of *Bartonella* spp. is often detected in ticks; human cases of bartonellosis preceded by tick bites are on record; and *Bartonella* spp. are commonly present in important hosts of *Ixodes* ticks, i.e., deer and rodents.

The mere detection of *Bartonella* DNA by PCR in blood-feeding arthropods is certainly no evidence that these bacteria are viable and infective, or that these arthropods are competent vectors of *Bartonella* spp. In fact, there is no conclusive evidence that any *Bartonella* species under natural circumstances can infect a vertebrate via tick bite, although a recent laboratory investigation using a membrane feeding technique suggested that *I. ricinus* is a competent vector for *B. henselae* (Cotté et al., 2008): transstadial transmission of the bacteria, their multiplication within the tick's salivary glands after a second blood meal, and transmission of viable and infective *B. henselae* from ticks to blood was recorded. However, this study may not be relevant to establishing vector competence of ticks for bartonellae since certain parameters were unnatural: the ticks were fed continuously on blood containing exceedingly high numbers of bacteria and the strain of *B. henselae* used is highly adapted to laboratory conditions and grows easily in vitro. As suggested by Telford and Wormser (2010) a more reliable proof of vector competence would be to feed an uninfected *Ixodes* sp. on a *B. henselae*-infected cat and then, after the tick has hatched, determine whether the nymph can transmit *B. henselae* by bite to an uninfected cat. However, additional (epidemiological) data would be necessary to conclusively prove that ticks are of importance as natural vectors of bartonellae.

Tularemia

Tularemia, caused by *Francisella tularensis*, a Gram-negative facultative intracellular bacterium, is a zoonotic disease of the northern hemisphere. Human cases are typically sporadic, but outbreaks do occur (Matyas et al., 2007). Endemic areas existed during the last century and still exist in the former USSR and the Nordic countries. Cases of tularemia have also been reported from Japan (Ohara et al., 1998) and northern regions of China (Pang, 1987). In the USA there have been 200 cases per year from 1990 to 2000 (Feldman et al., 2001). Currently, the highest incidences in the world occur in confined geographical areas of Finland and Sweden (Eliasson et al., 2002). Humans acquire infection by inadvertent exposure to infected arthropod vector, or by handling, ingesting, or inhaling infectious materials. *Francisella tularensis* has been isolated from over 250 animal species, including fish, birds, amphibians, rabbits, squirrels, hares, voles, ticks, mites, mosquitoes and flies (Oyston et al., 2004; Santic et al., 2006). Maintenance in nature is primarily associated with rodents and lagomorphs (rabbits and hares) although amoebae are a potential reservoir (Oyston et al., 2004; Santic et al., 2006). *Francisella tularensis* can be recovered from contaminated water, soil, and vegetation. Arthropods play an important role in maintaining the infection in natural conditions. Deer and horse flies, non-specified species of ticks, and mosquitoes are common arthropod vectors of *F. tularensis* between mammals (Petersen et al., 2009). A variety of small mammals, including voles, mice, water rats, squirrels, rabbits, and hares, are natural susceptible species for the infection and its spread. These hosts can acquire infection through bites by ticks, tabanids, and mosquitoes, and by contact with contaminated environments.

Four closely related subspecies of *F. tularensis* have been identified: *F. tularensis tularensis, F. tularensis holarctica, F. tularensis mediasiatica* and *F. tularensis novicida* (Forsman et al., 1994). Subspecies *F. tularensis tularensis* and subspecies *F. tularensis holarctica* cause most human illness. The subspecies *F. tularensis tularensis* has been divided into two clades A.I and A.II (Johansson et al., 2004), which differ in geographical distribution, transmission routes and manifestation of disease

(Staples et al., 2006). Subspecies *F. tularensis tularensis* is confined to North America, whereas subspecies *F. tularensis holarctica* is found in many countries of the Northern Hemisphere, and subspecies *F. tularensis novicida* has a strong association with water and it is the oldest in evolutionary terms (Oyston et al., 2004; Santic et al., 2006).

Host-seeking adult *Dermacentor reticulatus* ticks were examined for the prevalence of *Francisella tularensis* in an active natural focus of tularemia along the lower reaches of the Dyje (Thaya) river in South Moravia (Czech Republic) and adjacent Lower Austria, in four localities of the flood plain forest-meadow ecosystem during the spring of 1996. Twenty-five isolates of *F. tularenis* were recovered from pooled *D. reticulatus* (Hubalek et al. 1998).

In China, 1670 ticks from 2 endemic areas (Inner Mongolia Autonomous Region and Heilongjiang Province) and 2 non-endemic areas (Jilin and Fujian Provinces) were collected and tested for evidence of *F. tularensis* by nested PCR. The prevalence of *F. tularensis* in ticks averaged 1.98%. The positive rates were significantly different between *Dermacentor silvarum* and *Ixodes persulatus*, the tick species responsible for all positive cases. All *F. tularensis* that were detected in ticks belonged to *F. tularensis* subsp. *holarctica* and MLVA disclosed genetic diversity. The study concluded that *D. silvarum* and *I. persulatus* might have a role in tularemia existence in China (Fang Zhang et al., 2008).

Q fever

Q fever is an infectious disease caused by the bacterium *Coxiella burnetii* that affects both animals and humans. It has been reported to be present in a wide range of animal species, including cattle, sheep and goats, in most areas in the world.

It was first recognised as an infection transmissible from animals to humans in abattoir workers in 1935 in Australia. In recent years, there has been an increasing number of confirmed cases of Q fever in humans in The Netherlands.

Coxiella burnetii does not usually cause clinical disease in animals, although abortion in goats and sheep has been linked to infection with this bacterium. The Animal Health and Animal Welfare Unit of EFSA published a scientific opinion on Q fever (EFSA 2010d). In humans, Q fever may cause flu-like symptoms, including fever and headache, diarrhea and vomiting. In some cases it can cause pneumonia and hepatitis. The chronic form of Q fever is uncommon but a much more serious disease with complications such as inflammation of the inner lining of the heart (endocarditis).

Most human infections result from close contact with infected animals, particularly through inhalation of dust contaminated with bacteria from the placenta and birth fluids. Ticks are one of broad range of reservoirs for *C. burnetii* that have been identified, including mammals and birds.

4. Emerging tick-borne infections and dissemination of ticks

Among arthropods, ticks are highly efficient vectors of many pathogens of viral, bacterial and protozoan nature that cause diseases now considered emerging based on the increased reported cases in both animals and humans. Many factors are capable of causing or influencing the emergence or re-emergence of pathogens as well as the introduction of exotic tick species or tick-borne pathogens in new areas. Globalisation and climate changes are two such factors posing a threat to the introduction and spread of vectors and vector-transmitted pathogens in Europe and elsewhere in the world. The medical and veterinary impact of ticks, however, is closely linked to the biology of each tick species as well as to the ecology of vectors and pathogens considered.

4.1. Factors influencing the spread and distribution of ticks

4.1.1. Climate changes

Long historical data related to geographic distribution of ticks and tick-borne pathogens are required to link to climate factors in order to determine the impact of climate changes on the spread of these infections. To our knowledge no such attempt has been done. In general, it is possible to affirm that despite some evidence it is difficult to implicate climate change as the main cause increasing of tick-borne diseases. Climate change models are required that take account of the dynamic biological processes involved in vector abundance and pathogen transmission affecting the complex ecology and epidemiology of tick-borne diseases such CCHF, tick-borne encephalitis and Lyme borreliosis in order to predict future tick-borne scenarios. According to Gray et al. (2009), climate changes have influenced the survival of the ticks (direct effect). Climate changes can indirectly change the ticks' survival by modifying the type of vegetation (indirect effect) and the host abundance.

Changes in climate and the length of the different seasons will directly affect tick survival, activity, and development, but there is no strong evidence that rising temperature results in a greater abundance of ticks simply by increasing rates of development; rather changes in development rates will make tick cohorts available to different diapause windows (largely determined by day length), thus changing patterns of seasonal activity and significantly altering generation length.

More complicated are indirect effects of climate change. For instance, climate will affect the vegetation, which in many ways will influence the number of infected ticks. For instance, dense humid vegetation will, in general, be beneficial to tick survival. Such vegetation may also be beneficial to pathogen-reservoir hosts such as rodents and shrews, and to the survival and abundance of tick-maintenance hosts, such as deer. All these factors may increase the density of infected ticks.

The influence of mast years on rodent abundance and consequently on tick density is one example of how vegetation indirectly will affect the density of *Borrelia*-infected *Ixodes* ticks (Ogden et al., 2005).

Climate change may also influence the risk of infection by affecting human activities: for example the long-term use of land e.g. for agriculture or tourism, could be affected by climate change, while weather patterns have an effect by influencing short-term human behaviour so that tick-bite risk may be linked to the seasonality of certain human activities, e.g. hiking, hunting, and berry and mushroom picking. Generally climate effects are more easily noticeable close to the geographical distribution limits of both vector and pathogen, but the magnitude of the effects of climate change in an endemic area is the result of the interaction of many other parameters associated with the socioeconomics, human migration and settlement, ecosystems and biodiversity, bird migrations, land-use and land cover, human culture and behaviour, and immunity in the human and animal populations (Gray et al., 2008).

4.1.2. Migratory birds

Introduction and spread of tick species by migratory birds are documented for those tick species which are ornithophilic in the larval and nymphal stages. *Hyalomma marginatum* and *Hy. Rufipes*, and to a lesser extent some species of *Amblyomma* spp. belong to this group of ticks. Their potential spread northwards and establishment of permanent populations in the north are therefore of great importance, in particular since the immature stages of *Hyalomma* are frequently found on migratory birds flying northwards to temperate Europe (e.g., Jaenson et al., 1994). The dispersal of ticks by birds may be restricted to a short distance during local post-breeding flights, or extremely long distance during migration flights. In studies conducted on birds migrating through Egypt between 1955 and 1973, it was discovered that birds migrating from Eurasia to Africa carried tick species that were characteristic of the fauna of Europe and Asia (Hoogstraal, 1963). In contrast, *Hy. rufipes* is the most common tick found on birds migrating northwards from sub-Saharan Africa to Eurasia in the spring (Hoogstraal, 1963, Linthicum and Bailey, 1994). In the same way, the risk of diffusion of CCHFV into areas where the virus does not occur is linked to the possibility of *Hyalomma* infected ticks to reach and to become established in such "uninfected areas". This probability is greater for tick associated with migratory birds (Manilla, 1998c). Hoogstraal (1979) reported that many bird species are responsible for the intra- and intercontinental dissemination of ticks associated with CCHFV. However, this fact is not the important factor in introduction of CCHFV to Europe. In 2002, nevertheless, it has been hypothesized that the outbreak of CCHF in Turkey could have been caused by birds carrying CCHFV infected ticks from the Balkans (Karti et al., 2004). This disease occurrence in Turkey is under discussion, considering the epidemiological available data. It seems currently impossible that some migrating birds from Balkans could introduce the disease in Turkey and spread in an interval of weeks. The current opinion is that the virus has been there since many years, and that some changes favoured its contact with humans and hence the increased disease incidence (Ozdarendeli et al., 2010). The introduction of *Am. variegatum* in Italy and Greece by migratory birds is sporadically reported.

4.1.3. Animal husbandry and production systems

The introduction of *Am. variegatum* into the Caribbean area is an example of the role of movement of domestic animals as a way of spread of exotic ticks. The initial introduction of *Am. variegatum* in Guadeloupe and probably also in most of the West Indies islands was due to the importation of infested N'Dama cattle in the 1800s, or of the tick-infested litter used during cattle transportation by ships from Senegal to the West Indies (Barré et al., 1987), or from East Africa onto the Indian Ocean islands. Cattle transportation between islands also explains the introduction of the tick at least in Marie-Galante, Antigua and Martinique. But from the late 1960s, the rapid increase in the number of infested islands in the Caribbean area was linked to the presence and spreading of the cattle egret in the West Indies, a cattle-associated African bird species also introduced in the Caribbean area (Corn et al., 1993; Barré et al., 1995). The re-infestation of some countries, like Puerto Rico, after a successful eradication campaign, might also be due to movement of this bird (Bokma and Shaw, 1993). *Am. variegatum* is thus the only African vector of cowdriosis that has established itself successfully outside the continent (Walker and Olwage, 1987). It remains a threat in areas where the climatic conditions are suitable for its establishment, as it already succeeded to colonize new territories through movement of migratory birds, which cannot be controlled.

Rhipicephalus (Bo.) microplus, the pantropical blue tick, is without any doubt one of the most important vectors of livestock pathogens in the world, mainly because of its large geographical distribution, and its ability to transmit both Asiatic and African redwater babesiosis, caused by *Babesia bovis* and *B. bigemina* (Coetzer and Tustin, 2004).

This tick species originates from Asia but during the latter half of the 19th century it, and the babesiae it transmits, were spread by cattle transported to Australia, Madagascar, South Africa, Latin America, Mexico and the United States (Hoogstraal, 1956, Temeyer et al., 2004). *Rh. microplus* was eradicated from the United States in 1943 through the costly Cattle Fever Tick Eradication Program, which started in 1906. The most resistant strain studied to date has been shown to survive the dipping procedure used at the US-Mexico border as part of an importation barrier to prevent the re-entry of *Rh. microplus* into the United States (Temeyer et al., 2004).

Until recently *Rh. microplus* was not present in West Africa, but this tick species has unfortunately been introduced into Ivory Coast (Madder et al., 2002) and Benin as a result of uncontrolled cattle imports for cattle improvement programmes. Because of the high adaptability of ticks and more specifically of *Rh. microplus*, the risk of introducing this species in the Mediterranean area and the establishment of local populations seems possible.

Dermacentor reticulatus could be seen as a tick species that is expanding its range in North-Western Europe. In Germany its distribution and abundance has increased on deer and on the vegetation after a study performed in 2003 and 2004 (Dautel et al., 2006). In The Netherlands and Belgium populations have also been found the last years (Nijhof et al., 2007; Madder pers. comm.). In The Netherlands, its several populations have been established in freshwater tidal marshes mainly in the south of the country and most likely after having introduced southern European cattle breeds. Ponies used as management mesure to control vegetation were exported to Belgium. These ponies then introduced this tick species to Belgium. In Belgium, *D. reticulatus* has been found by tick-cloth dragging in different nature reserves and peri-urban areas, and on dogs. Most of the other areas are frequently visited by dogs, explaining a possible further spread of *D. reticulatus*, as no large mammals are present there.

4.1.4. Exotic and wildlife species

There are many example of exotic ticks introduced in countries by import of exotic animals. Some reptile-associated African *Amblyomma* tick species were found on the American mainland through animal movements, mainly due to the importation of tick-infested reptiles from Africa (i.e. infested by *Am. marmoreum* or *Am. sparsum*). Similarly, importation of livestock from the Caribbean islands infested with *Am. variegatum* ticks, but also through the introduction of lightly infested wild ungulates from Africa (Burridge et al., 2002). In addition, in The Netherlands, *Am. flavomaculatum* was collected from an African Savannah monitor (Nijhof et al., 2007), and other tick species like *Am. marmoreum, Am. dissimile* and *Hy. rufipes* have occasionally been collected from imported tortoises and snakes (Bronswijk et al., 1979; Jongejan, 2001).

4.1.5. Movement of people

Similarly ticks associated with pets are able to reach and to establish themselves in areas far from their origins. One of the most typical examples is *Rhipicephalus sanguineus* universally known as "the kennel tick" (Manilla 1998b, Walker et al. 2000, Estrada-Peña et al. 2004), is a monotropic three-host tick strictly associated with the domestic dog. *Rhipicephalus sanguineus* is probably one of the most widely distributed tick species in the world. Travelling with dogs has brought this important vector species permanently to the latitudes approximately between 50°N and 30°S (Walker et al. 2000). Furthermore, the ornate dog tick, marsh tick or cattle tick, *D. reticulatus*, may have been introduced in North-Western Europe in a similar way, apart from the routes described previously.Tick species with proven involvement in the transmission of pathogens causing animal infections and zoonoses

This table depicts a general overview of the association of tick vectors with the most common pathogens. The list is not exhaustive and under local conditions (other countries or continents), some other vectors may be involved in the transmission of these pathogens.

Table 5: Tick vector competence in relation to pathogen transmission in Europe.

Pathogen	Tick vectors	Vertebrate hosts	Reference
Viruses			
Bunyaviridae, *Nairovirus* (CCHF virus)	*Hyalomma marginatum., Rhipicephalus bursa*	Human	22
Flaviviridae, *Flavivirus* (TBE)	*I. ricinus, I. persulcatus*	Human	22
Flaviviridae, *Flavivirus* (Louping ill)	*I. ricinus*	Sheep	23
Asfaviridae, *Asfavirus* (African Swine Fever)	*Ornithodoros erraticus complex*	Pig	24
Protozoa			
Babesia* and *Theileria			
B. bigemina	*Rhipicephalus bursa*	Cattle	1
B. bovis	*Rh. (Bo.) annulatus*	Cattle	1
B. major	*Haemaphysalis punctata*	Cattle	1

Pathogen	Tick vectors	Vertebrate hosts	Reference
B. divergens	*Ixodes ricinus*	Cattle	1
B. canis canis *B. canis vogeli*	*Dermacentor reticulatus* *Rh. sanguineus*	Dog	1, 2, 3
Babesia gibsoni	*Rh. sanguineus*	Dog	1, 2, 3
B. ovis	*Rh. bursa, Rh. turanicus*	Sheep	1
B. motasi	*Ha. punctata*	Sheep	1
B. caballi	*Rh. bursa, D. marginatus*	Horses	1, 3
B. venatorum (EU1)	*I. ricinus*	Deer	25, 26, 27
Theileria annulata	*Hy. scupense, Hy. marginatum*	Cattle	4
T. lestoquardi	*Hyalomma spp.*	Sheep	5
T. (Babesia) equi	*Hy. marginatum, Dermacentor marginatus, Rh. bursa*	Horse, Donkey, Mule	3, 5
T. buffeli/orientalis	*Ha. punctata*	Cattle	28,
Hepatozoon			
Hepatozoon canis	*Rh. sanguineus*	Dog	6
Bacteria			
Anaplasma			
A. (Aegyptianella) pullorum	*Argas spp.*	Domestic poultry	3, 7
A. phagocytophilum	*I. ricinus*	Human and various mammals	10, 16, 17
A. marginale	*I. ricinus, I. persulcatus, Rh. sanguineus, Rh. bursa, Rh. annualtus*	Cattle, sheep, wild ruminants	18
A. centrale	*Am. Variegatum, Rh. appendiculatus, Hy excavatum, Rh sanguineous, Rh. turanicus*	Cattle	18, 29, 30
A. ovis	*Rh. bursa*	Sheep	18
Anaplasma platys	*Rh. sanguineus*	Dog	19
Ehrlichia			
E. canis	*Rh. sanguineus*	Dog	2
Rickettsia* (Spotted fever group)			

Pathogen	Tick vectors	Vertebrate hosts	Reference
R. conorii	*Rh. sanguineus*	Dog, Human	8, 9, 10
R. slovaca	*D. reticulatus*	Human	8, 9, 10
R. helvetica	*I. ricinus*	Rodents, human	11
R. aeschlimanii	*Hy.* marginatum, *Dermacentor* spp., *Rhipicephalus* spp.	Human	8, 9, 10
R. massiliae	*Rh. sanguineus*	Human	9, 12, 13, 14
R. monacensis	*I. ricinus*	Human	9, 15
Borrelia			
B. burgdorferi sensu stricto	*Ixodes ricinus, I. persulcatus, I. scapularis*	Rodents, human	16
B. garinii	*I. ricinus, I. persulcatus, I. uriae*	Birds, rodents, human	16
B. afzelii	*I. ricinus*	Rodents, human	
B. valaisiana	*I. ricinus*	Birds, human	8, 16
B. lusitaniae	*I. ricinus*	Lizards, human	16
Borrelia spielmanii	*I. ricinus*	Vole mice, human	20
B. crocidurae	*Ornithodoros erraticus*	Rodents, human	21
B. hispanica	*O. erraticus*	Rodents, human	21
B. anserina	*Argas spp.*	Birds	21
Francisella			
F. tularensis	*D. reticulates, I. persulcatus*	Human and various mammals	18
Coxiella			
C. burnetii	Several, among which *Rh. sanguineus*	Human and various mammals	18, 31

Bo: *Boophilus*; *Rh*: *Rhipicephalus*; *Ha*: *Haemaphysalis*; *D*: *Dermacentor*; *Hy*: *Hyalomma*; *I*: *Ixodes*.
(*)In the case of *Rickettsia* currently several research and studies are ongoing thus it is expected changes in the roles of the ticks, and the reservoirs,
In most of these cases, human is an incidental host

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4.2. Genus *Argas*

Argasid ticks (family Argasidae) are leathery or "soft" ticks that hide in soil or in crevices, come out to feed for a short while, and then retreat to their hiding place. Two of the several argasid genera, *Argas* and *Ornithodoros*, are common in Africa. The term argasid should not be construed to refer to the genus *Argas* alone. A variety of argasids occur throughout most of the tropics and subtropics of the world. Fewer species live in temperate areas and very few inhabit arctic climates. Two species presently are distributed widely as a result of transport of domestic fowls.

Argasid eggs, deposited at intervals in small batches and totalling only a few hundred, are laid in cracks and crevices where females seek shelter. Chances that hatching larvae will find a favourable host near by are reasonably good. Nymphs and adults of both genera feed for only a few minutes to a few hour's at most, in marked contrast to the longer attachment time of most nymphal and adult ticks of the family Ixodidae. There are at least two and sometimes as many as six or more nymphal instars. Argasid adults take several blood meals, each of which is usually followed by a rest for digestion and, in the female, for oviposition.

Argasid ticks have a considerable economic and medical impact in many parts of the world. However, at the present time they are apparently of less importance in Europe than the ixodid ones. It should be noted that argasid ticks in general are xerophilic arthropods. Although in localities of extremely low relative humidity argasids may seek a somewhat more humid microhabitat, these cracks and crevices are seldom those with a significantly high relative humidity. Within this range, individual species have varying degrees of tolerance.

Examination of bird nests, caves, animal lairs, burrows, rodent nests, and big game resting and rolling areas will undoubtedly reveal unrecorded argasid species. Although of considerable medical importance and zoological interest, these ticks are not frequently collected because specialized efforts and techniques are necessary to obtain them. Examination of rock interstices and searching under stones is also important in some situations. Investigation of bird nests, especially those of larger birds, should yield much interesting data.

Argasid ticks are vectors of a high number of poorly known viruses (Hoogstraal, 1985), which seems of little economic interest for domestic animals. A few studies exist about those pathogens. However, perhaps the most prominent pathogen transmitted by a soft tick in the Mediterranean basin is the African swine fever virus, which produced several epidemics in Spain and Portugal, transmitted by *Ornithodoros erraticus*.

Three species of *Argas* have been commonly reported in Europe, namely *Ar. persicus*, *Ar. reflexus* and *Ar. polonicus*.

Argas persicus

Argas persicus, the fowl tick, is now established in most parts of the world between 40ºN and 40ºS as a result of transportation of poultry. In Siberia, this species occurs even farther north than 55ºN. (Olenev, 1926, 1927). In Argentina, 38ºS is its southern limit (Roveda, 1940). As an example of the fowl tick's long range spread, it is said to have been introduced into New Zealand from America. Its initial appearance in many parts of the world is believed to have been during early Persian conquests though the species did not necessarily originate in Persia (Robinson and Davidson, 1913).

Once introduced, the fowl tick often spreads quickly and widely, as it has done in Argentina where it became a common pest within sixteen years after first reported (Lahille and Joan, 1931; Roveda, 1940). In the United States, after having first been collected in 1872 in southwestern Texas, its dispersion has been "gradual and orderly" (Parman, 1926). In other areas it occurs only sporadically. For instance, in Madagascar, *Ar. persicus* is said to be restricted to the western coastal lowlands and absent from the central uplands. *Ar. persicus* in all stages is chiefly a parasite of chickens. Ducks, geese, turkeys, and infrequently pigeons, are also attacked. This parasite often becomes so numerous in fowl houses that the birds die from exsanguination.

Wild birds may be infested when they construct large, numerous, or fairly permanent nests in the vicinity of human activities. The question of infestation of other wild birds and of mammals is a most uncertain one. Although the fowl argas does parasitize man on occasion, the frequency and fierceness of these attacks have been exaggerated and enhanced. Identification of larvae from wild birds that construct isolated nests and that do not live close to human habitations should be regarded with suspicion if these larvae have not been identified by a contemporary expert in argasids. Larvae of related species closely resemble those of *Ar. persicus*. Wild bird parasites are so poorly known that the presence of argasid larvae on them should be a hint to consider rare or poorly known tick species before concluding definitely that those found are *Ar. persicus*. The mouthparts of larvae pulled from birds are usually broken unless extreme caution is exercised and the body characters are frequently obscured by engorgement so that it is difficult to identify the material.

All stages congregate on walls, in crevices, or between boards of poultry houses. Trees in which chickens roost are frequently reported as hiding places for *Ar. persicus*. Fifty-nine observations of nymphs and adults in temperature gradients ranging from 2 C to 47 C failed to exhibit a significant response to changing temperature stimuli. While the vital optimum of the egg stage is 20 C and 80% relative humidity, the tolerance to fluctuating climatic factors is remarkably great. Even at 20% relative humidity, mortality is only slightly greater than at optimum conditions of environmental moisture. The thermal constant for the egg stage is 316 day-degrees. At temperatures of 33 C to 18 C, eggs hatch from 10.5 days to 33.3 days (from highest to lowest temperature). Temperatures of 15 C and below inhibit egg hatching. At high temperature (33 C.), a relative humidity of at least 60% is necessary for hatching. At moderate temperature (18 C to 27 C), there is little difference in numbers of larvae hatching from eggs maintained at various percentages of relative humidity ranging from twenty to a hundred.

Argas reflexus

Argas reflexus appears to be a Near or Middle Eastern tick that has spread northward through Europe and Southwestern Russian Federation, and eastward to India and elsewhere in Asia (the status of related species or subspecies in Asia requires further study). It may have been accidentally introduced into a few localities in the Ethiopian Faunal Region north of the Equator and to parts of the Americas. Domestic pigeons are the chief host of *Ar. reflexus* and are mentioned by all authors. Man is frequently attacked, especially in the vicinity of long unoccupied pigeon sites. In the laboratory, any usually available mammal may serve as host. The literature contains numerous reports of *Ar. reflexus* biting man and the painful sequelae of these attacks. Although the pigeon argas is nearly always associated with pigeons, the exigencies of its domestic existence drive it to attack persons, possibly more frequently than does *Ar. persicus*. The pigeon tick may remain unfed in or near pigeon houses for many months, or even for several years. Feeding is much like that of *Ar. persicus*, which attacks poultry, and is accomplished at night. Domestic chickens are apparently considerably less liable to attack by *Ar. reflexus* than are pigeons. Hiding places of these ticks are easily found in the cracks and crevices of pigeon cotes. The life cycle appears to be much like that of *Ar. persicus*. Restrictive and optimum biological and climatic factors have not yet been reported in literature. Females feed prior to oviposition, but according to Schuize (1943), males require only a single blood meal annually.

Argas polonicus

Argas polonicus is a poorly known species, which seems to be restricted to domestic and wild pigeons. It has been largely confused with a related species, *Ar. vulgaris*. However, phenotypic (involving the use of cuticular hydrocarbons) and genetic analysis (Estrada-Peña and Dusbabek, 1992) showed that both species are different.

4.3. Genus *Ornithodoros*

EFSA 2010a scientific report on the role of tick vectors in the epidemiology of Crimean-Congo haemorrhagic fever and African swine fever in Eurasia, describes the characteristics of this genus (Section 3.1)

4.4. Genus *Ixodes*

This is the largest genus of the family Ixodidae (hard ticks). Barker and Murrell (2004) listed 899 names of ticks regarded as valid genus and species name, 249 of which belong to the genus *Ixodes*. The ticks in this genus are so-called prostriate hard ticks, characterized by the anal groove encircling the anus anteriorly. The genus is represented on all continents including Antarctica. The medically and veterinary most important species are *I. scapularis* and *I. pacificus* in North America, *I. ricinus* in Europe, western Asia and the Mediterranean coast of North Africa, and *I. persulcatus* in northwestern Europe and northern Asia. In Eurasia, *I. hexagonus* (present in Europe only), *I. caledonicus*, *I. frontalis*, *I. trianguliceps* and *I. uriae* may also be considered as medically-epidemiologically important vectors of zoonotic pathogens. Among all *Ixodes* species approximately 20% parasitize birds and 80% parasitize mammals (Kolonin, 2009).

Ixodes ricinus

In Europe the most well-known tick species is *I. ricinus* often called the common tick, castor bean tick or sheep tick. It is the most commonly encountered tick species in most parts of central, western and northern Europe. The distribution of this species ranges from Ireland, Britain and Scandinavia, Finland and western Russia across continental Europe southwards to the Mediterranean area into northern Africa and eastwards to Iran. *I. ricinus* is a three-host (telotropic) tick with a very wide host-range: lizards, many species of birds and small, medium-sized and large mammals. Jaenson et al. (1994) listed two lizard species, 56 bird species and 29 mammal species as hosts recorded for *I. ricinus* in Sweden alone.

Ixodes ricinus is the vector in Europe of the agents of several zoonoses including Lyme borreliosis (seven *Borrelia* genospecies have been recorded from *I. ricinus*), tick-borne encephalitis (TBE), anaplasmosis (granulocytic ehrlichiosis, tick-bite fever) due to *Anaplasma phagocytophilum*, and *Rickettsia helvetica*. *I. ricinus* also transmits *Babesia divergens*, i.e. the causative agent of babesiosis in cattle and a life-threatening infection in splenectomised humans, tularemia due to *Francisella tularensis*, and the *Louping ill virus*.

Ixodes persulcatus

The Taiga tick, is an extremely important vector of the TBE virus, Lyme borreliosis spirochetes and other pathogens in Finland, The Baltic States and Russia, and eatwards to Japan. In the Baltic region and north-western Russia *I. persulcatus* overlaps with the range of *I. ricinus* and "replaces" *I. ricinus* eastwards through Siberia. *I. persulcatus* transmits, in general, the same pathogens as *I. ricinus*, i.e., the TBE virus, Lyme borreliosis spirochetes, *A. phagocytophilum* and *B. divergens*. Both tick species are occasionally also vectors, and possibly long-term reservoirs, of *F. tularensis*.

Ixodes canisuga

Ixodes canisuga Johnston 1849 [=*Ixodes crenulatus* Koch 1844 (according to Kolonin 2009)] is often confused with *I. hexagonus* which is usually more commonly encountered. *I. canisuga* is distributed from western, northern and southern Europe through Russia into Iran, Afghanistan, India and China (Hillyard, 1996; Kolonin, 2009). All stages are parasitic on rodents and carnivores including badger, fox, mustelids, dogs and cats, i. e., hosts which regularly return to a burrow or lair (Hillyard, 1996).

Ixodes gibbosus

The main hosts of larvae, nymphs and adults of this species are sheep and goats but the larvae and nymphs also feed on small mammals and birds. It is distributed from former Yugoslavia through Turkey to Israel (Kolonin 2009).

Ixodes hexagonus

This tick ranges through Western, Central and Southern Europe including Ireland, U.K., Norway, Sweden and Poland to Portugal, Spain, Italy, Greece, Romania and Ukraine (Kolonin, 2009). The main hosts are carnivorous mammals (Canidae, Felidae and Mustelidae), and the hedgehog, i.e. mammals having a permanent dwelling (Arthur, 1963; Jaenson et al., 1994; Kolonin, 2009). It is often found on dogs but rarely on sheep, cattle, horses and birds (Hillyard, 1996). This tick bites man occasionally and was a pest in underground shelters in the London area during wartime (Browning, 1944). *I. hexagonus* is a competent vector of *B. burgdorferi* s.l. and transfers the spirochete both transstadially and transovarially (Gern et al., 1991) and is possibly a competent vector of TBEV, *Babesia microti* and *Rickettsia conorii*.

Ixodes uriae

This is the seabird tick that inhabits islands and mainland coasts in the subarctic and temperate regions of the northern and southern hemispheres. *I. uriae* parasitizes colony-nesting marine birds. This tick will occasionally bite people visiting sea-bird colonies. It is a vector of the human Lyme disease spirochete *Borrelia garinii* (Olsen et al., 1993).

Ixodes frontalis

Several arboviruses (Bahig, Kemerovo, TBEV) have been isolated from this bird-parasitizing tick. This is an ornithophagous ectoparasite that does not bite humans but is presumably indirectly of enzootic and epidemiological importance of TBEV.

Ixodes trianguliceps

It is a nidiculous ectoparasite of small mammals. It is distributed throughout most of Europe eastwards through Ukraine to Georgia, Armenia, and Azerbaijan (Kolonin 2009). Although this tick does not bite humans it may indirectly be of medical and veterinary importance in view of its presumed role as a maintenance vector of TBEV, *Borrelia afzelii* and *Babesia microti* among its natural small mammalian hosts (rodents and insectivores)

4.5. Genus *Haemaphysalis*

Few of the about 160 species of *Haemaphysalis* parasitize livestock, but those that do are economically important in Eurasia, Africa, Australia, and New Zealand. Some species of the genus *Haemaphysalis*, parasites of wild deer and antelope, have adapted to domestic cattle and, to a lesser extent, to sheep and goats. Others, originally specific for various wild sheep and goats, have adapted chiefly to the domestic breeds of these animals. A few African species that evolved together with carnivores now parasitize domestic dogs. Immatures of species that parasitize livestock generally feed on small vertebrates, but there are a few notable exceptions (Merck, 2010). All *Haemaphysalis* species have a 3-host life cycle.

The *Haemaphysalis* species with the largest distribution range in Eurasia is *Ha. punctata*. It is associated with wild and domestic ruminants (Manilla, 1998). It is frequent where sheep, goats, and cattle feed in certain open forests and shrubby pastures from southwestern Asia (Iran and former USSR) to the great part of Europe, including southern Scandinavia and Britain. Immatures infest birds, hedgehogs, rodents, and reptiles. It is a good vector of *Anaplasma*, *Babesia* and *Theileria* species. *Ha. punctata* is also able to transmit *Francisella tularensis*, *Coxiella burnetii*. Populations of this species have been found infected by tick borne encephalitis virus, Tribec virus, Bhanja virus, and Crimean-Congo haemorrhagic fever virus.

Haemaphysalis sulcata adults parasitize livestock (chiefly sheep and goats) from northwestern India and southern former USSR to Arabia, Sinai, and southern Europe. Immature *Ha. sulcata* are especially common on lizards, but the range of hosts of larvae and nymphs of both species is similar to that of *Ha. punctata*. Probably because of misidentification in the past, the role in the transmission of pathogens of this species is not yet clearly defined, it is suspected to transmit *Theileria annulata* and *Anaplasma ovis*. The Bhanja virus has also been isolated in *Ha. sulcata* during a survey performed in Bulgaria (Pavlov, 1978).

4.6. Genus *Hyalomma*

The genus *Hyalomma* of the hard ticks is a complex of a few species exhibiting an almost endless variation. Its original centre of dispersal was probably Iran or southern Russia. Genetic instability may in part account for the wide morphological differences found in many specimens (Hoogstraal 1956).

Hyalomma ticks are large ticks with pale rings on most segments of their legs. They also have long mouthparts with project to the anterior of the body, and anal plate in males (Manilla, 1998; Estrada-Peña et al., 2004).

Environmental changes are undoubtedly important additional factors in modifying size, colour, and overall appearance in this genus. These are tough, hardy ticks that survive under conditions in which all other species are uncommon or entirely absent; they may even thrive in such environment. They inhabit country where humidity is frequently low, seasonal climatic conditions are extreme, favourable niches for development away from the host are rare, smaller animals for immature-stage feeding are sparse, and larger-size hosts are frequently poorly nourished and wander widely amongst inhospitable situations (Hoogstraal, 1956).

Hyalomma ticks are often the most abundant tick parasites of livestock, including camels, in warm, arid, and semiarid, generally harsh lowland and middle altitude biotopes, and those with long dry seasons, from central and southwest Asia to southern Europe and southern Africa. Extraordinary survival factors play a large part in permitting these ticks to exist and even thrive where few or none others live.

The duration of the life cycle of *Hyalomma* species can be substantially prolonged in unfavourable climatic conditions, or shortened under optimum conditions. It has been observed that adult specimens can remain alive without food for approximately two years and after this period of starvation they are able to copulate and feed.

A greater capacity for regeneration of lost appendages and injured mouthparts than other ticks was also described for *Hyalomma* ticks (Hoogstraal, 1956).

Of the 30 known *Hyalomma* spp, many are important vectors of infectious agents to livestock and humans. The three-host life cycle predominates in this genus, but some species have either a two- or three-host cycle. Some three-host species can develop in one- or two-host cycles, a facultative ability unique to this ixodid genus (Merck, 2010).

Hyalomma ticks are the main vectors of Crimean Congo haemorrhagic fever, the known distribution of the virus broadly coincides with the global distribution of these ticks (Turrell, 2007).

Hyalomma spp. are also the main vectors of *Theileria annulata* agent of Tropical Theileriosis, that occurs in northern Africa, including the Sub-Saharan territories, Sudan and Eritrea, southern Europe, the Near and Middle East, Central Asia, India and northern China. Its distribution reaches the Far East, where it overlaps with *Theileria sergenti* infection (Pipano and Shkap, 2004). *Hyalomma marginatum marginatum and Hy. m. rufipes* are now regarded as separate species

4.7. Genus *Amblyomma*

Species of the genus *Amblyomma* are characterised as being large ornated ticks with banded legs, with very long mouth parts and presence of eyes. Males lack ventral plates all the stages present festoons.

All *Amblyomma* species have a three host life cycle. They are present in Sub-Sahara Africa and the Americas. Only imported cases of *Amblyomma* have been identified in EU until now, basically associated with migratory birds and imported exotic pets including reptiles. Amongst the pathogens they can transmit there are, *Ehrlichia ruminantum* (causal agent of cowdriosis or heartwater) in Sub-Sahara Africa and in the Caribbean; *Rickettsia africae* (African tick bite fever); and they are also a predisposing factor for *Dermatophilus congolensis*.

4.8. Genus *Rhipicephalus*

The genus *Rhipicephalus* is one of the largest of the family Ixodidae. Species in this genus have some features in common: short hypostome and palps, basis capituli usually hexagonal, presence of eyes and festoons and anal plate in the males. With the exception of few species, they are inornate hence the common name of “the brown ticks”. It is mainly an African genus (Walker et al., 2000).

Adults of most species parasitize wild and domestic artiodactyls, perissodactyls, or carnivores. Immatures feed mostly on smaller mammals; however, of those that parasitize rodents or hyraxes, and of those that parasitize artiodactyls, a few feed on the same host as the adults. The life cycle is typically three-host, but in the Mediterranean climatic zone (long, warm summer with low rainfall), *Rh. bursa* is a two-host species (Merck, 2010).

Many *Rhipicephalus* spp have long been difficult to identify or have been incorrectly identified. Current concepts of tick phylogeny, taxonomy, and nomenclature are being revised and expanded based on molecular analyses. This ongoing work is likely to expand and alter the current understanding of the phylogeny and evolution of the subfamily Rhipicephalinae. On the basis of those study the genus *Boophilus* has been, recently, included in the genus *Rhipicephalus.* Eventhough they belong to the same genus, the morphology and biology of the species of *Boophilus* spp are significantly different.

The genus *Rhipicephalus* comprises 79 species, including the five species that were in the genus *Boophilus.*

The best known African *Rhipicephalus, Rh, sanguineus*, the “kennel tick”, or “brown dog tick”, has travelled worldwide with domestic dogs. It is now established in buildings as far north as Canada and Scandinavia and as far south as Australia. It that can be found almost worldwide, mainly within latitudes 35°S and 50°N (Dantas Torres, 2008).

Although this species feeds primarily on dogs, it can be found on a diverse range of wild and domestic animals, including human (Dantas Torres, 2008). In urban situations everywhere, dogs are virtually the only hosts of immatures and adults. 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, 2010).

Rhipicephalus ticks are recognized worldwide as vectors of many important diseases of animals and of humans such as: Mediterranean spotted fever and other rickettsioses, Q fever, monocytic ehrlichiosis, canine babesiosis, hepatozoonosis, Nairobi sheep disease, East coast fever.

Furthermore, some African *Rhipicephalus* can produce neurotropic toxins that may cause tick paralysis (Norval and Horak, 2004).

4.9. *Rhipicephalus* (previously known as *Boophilus*)

Riphicephalus (Boophilus) ticks are unique in that their entire life cycle from larva to engorged, mated adult is confined to a single host. Females drop to the ground to oviposit. This single-host type of life cycle has numerous biological advantages. It also allows for particularly easy control by dipping infested animals. The boophilid type of life cycle eliminates danger-ridden periods between two or three different kinds of hosts, possibly in inhospitable areas and for indefinite periods. The predilection of these ticks for large domestic animals particularly favors widespread dispersal and survival, not only within a continent but also from continent to continent on imported hosts. Cattle are the chief hosts throughout the world, horses, other domestic stock, and wild antelopes and deer are less frequently attacked. Other wild animals are uncommonly infested. The veterinary importance of those ticks is considerable and they are vectors of important pathogens of livestock. The only species present in the Mediterranean basin is *Rh*. (*Bo) annulatus*. It is an important pest of domestic cattle in every kind of Mediterranean environment. Most interesting is that this tick is well adapted to xerophilic areas, with periodic rains. Temperature seems to be the only restrictive factor in the dissemination of the tick towards northern latitudes. Therefore, it is widespread at scattered points across the Mediterranean basin. It is the vector of some prominent pathogens, like several species of the genus *Babesia*, most importantly *B. bovis*, which is a potentially dangerous pathogen of cattle. Records about the parasitism of wildlife by *Boophilus* ticks have been reported, but this seems not to be the rule.

4.10. Genus *Dermacentor*

The genus *Dermacentor* of hard ticks is small with about 30 species, most of which are found in the New World. *Dermacentor* resembles *Rhipicephalus* in having eyes and 11 festoons, but the basis capituli is rectangular and the scutum is ornamented. The adults are medium-sized to large, usually with ornate patterning. The palps and mouthparts are short. The coxa of the first pair of legs is divided into two sections in both sexes. The males lack ventral plates and, in the adult male, the coxa of the fourth pair of legs is greatly enlarged. The size of nymphs when unfed is about 1.4-1.8 mm. They resemble those of *Hyalomma*. Most species of *Dermacentor* are three-host ticks, but a few are one-host ticks. Two species, *D. marginatus* and *D. reticulatus* occur in Europe (Hillyard, 1996).

Dermacentor marginatus also known as “the ornate sheep tick” has an ornate scutum. It is distinguished from *D. reticulatus* by its palp which lacks a prominent rear-facing spur. The length of unfed adults is 4.6-5.8 mm; engorged female measures up to 1.5 cm. The unfed nymph is 1.4-1.8 mm in length. It is a widely distributed three-host species in many areas from West European countries to

Central Asia (Nosek, 1972). The ticks inhabit pastures, temperate forest and grassland having preference for xerophilic vegetation (Estrada-Peña et al., 1992). The activity of the species varies considerably according to region. Adults are active during the spring, early summer and autumn. In colder areas the seasonal activity of adults may begin earlier in the year. The larvae appear in June and the nymphs in July. A complete generation usually develops within one year. Adults feed on large mammals such domesticated and wild ruminants but also on dog, hare, hedgehog and man. The larvae and nymphs feed mostly on small mammals like rodents and birds (Nosek 1972; Hillyard, 1996). *Dermacentor marginatus* is the vector of *Coxiella burnetii, Rickettsia conori, R. slovaca*, *R. sibirica sibirica. Francisella tularensis* may also be transmitted by this tick species (Nosek, 1972; Hillyard, 1996; Raoult et al., 2002).

Dermacentor reticulatus (syn. *D. pictus*) also known as ”the ornate dog tick” is ornately-marked. This species has been confused with others in the genus because it has considerable morphological variability (Estrada-Peña and Estrada-Peña, 1991a,b). The length of unfed adults is 3.8-4.8 mm; engorged female measures up to 1.0 cm. The unfed nymph is 1.4-1.8 mm in length. Copulation takes place on the host. The distribution area of the species extends from France and south-western England in the west to Central Asia in the east (Gilot et al., 1989). In western and Central Europe, it does not occur north to 53–54ºN latitude, for example in Scandinavia, nor in the Mediterranean climate zone. In East Europe, however, it may occur as far north as St. Petersburg (60ºN) (Dautel et al., 2006). Most important for the survival and activity of *D. reticulatus* are the foci of adequate microclimate (Estrada-Peña, 2008). Therefore it is abundant in open, unused habitats both in the middle and in the periphery of villages, unused gardens, abandoned prairies, as well as grazing pastures and woodlands. It is absent from mountain regions, but very abundant in low altitude hills. Favourable landscapes for its survival are found where different forms of cultivation overlap and urbanization modifies landscape structures such as periurban colonies. It has a one or two year life cycle depending on the environmental conditions. It prefers cold regions with an adequate amount of air relative humidity, therefore it is absent in the Mediterranean region where relative humidity is not a constraint for survival. The main activity period of adults is in spring with a secondary peak in autumn but it varies considerably according to region (Szymanski, 1987). The immature stages are generally active from midsummer to late autumn. Adults parasitize larger domestic and wild mammals, cattle, horses, sheep, goats and pigs. It is the most common tick species on dogs and wild canids wherever it exists (Gilot et al., 1989; Földvári and Farkas, 2005). The immature stages feed on a variety of small mammals, such as small rodents and carnivores, and occasionally birds (Nosek 1972; Hillyard, 1996). *Dermacentor reticulatus* is known to be vector of *Babesia* spp. (*B. canis, B. divergens, B. caballi*), *Theileria equi, Rickettsia conori, R. raoultii* (formerly *Rickettsia* sp. strain RpA4) and *Francisella tularensis* (Nosek 1972; Martinod and Gilot, 1991; Hillyard, 1996; Zahler and Gothe, 2001; Dautel et al., 2006).

4.11. Generic morphological features of the different genera of hard ticks

Identification of ticks can be based on different criteria. Morphology, which can be some times the only criterian, but also in a more holistic approach it may be based on host species, predilection sites, geographical occurrence, seasonality, and others. Morphological identification is based on presence / absence of eyes; the presence of anal plates; ornamentation on the legs and scutum; shape, size and the patterns of the scutum, and other unique characteristics.

The taxonomy of ticks is not exempt of complications. There are problems of morphological identification and sympatric tick speciation. Identification of tick species requires for many species lots of expertise. Molecular biology has reshuffled many names at both species and genus level but it must be stressed that the “old” identification was in many cases able to identify the different tick entities. For instance, when *Boophilus microplus* changed to *Rh. microplus* or *Hyalomma marginatum marginatum* to *Hy. marginatum,* it was only the name that changed, not the identification. In several other situations also the identification changed (i.e. *Rh. microplus* in Australia to *Rh. australis*: or when *Ha. leachi* changed to *Ha. elliptica* in South Africa).

Appendix S contains photographs of some hard and soft tick species involved in the transmission of animal diseases and zoonoses.

Table 6 Generical distinguishing morphological features of different genera of hard ticks

Feature	*Hyalomma*	*Rhipicephalus*	*Rh. (Boophilus)*	*Ixodes*	*Dermacentor*	*Haemaphysalis*	*Amblyomma*	*Rhipicentor**	*Aponomma**	*Margaropus**
Size (unfed adults, total length)	large (0.5-0.8cm)	medium (0.3-0.6cm)	small (0.1-0.3cm)	small (0.2-0.3)	medium-large (0.4-0.9cm)	small (0.1-0.3cm)	very large (0.5-1.0cm)	medium (0.3-0.5)	large (0.5-0.6cm)	small (0.1-0.3cm)
Mouthparts	long	Short to medium	very short	long	medium	short	very long	medium	long	very short
Basis captuli		hexagonal	hexagonal	with ventral auriculae	rectangular	rectangular		hexagonal		
Ornate	no	no, except for 4 spp.	no	no	yes	no	yes	no	some species	no
Eyes	yes	yes	yes	no	yes	no	yes	yes	no	yes
Festoons	yes	yes	no	no	yes	yes	yes	yes	yes	no
Adanal plates	yes	yes	yes	no	no	no	none, or very small	no	no	yes
Sub-anal plates	yes	no	no	no	no	no	no	no	no	no
Anal groove	posterior, chalice-shaped	posterior, chalice-shaped	posterior, vertical line	anterior, semicircular or u-shaped	posterior, chalice-shaped	posterior, chalice-shaped	posterior, semicircular	posterior, chalice-shaped	posterior, chalice-shaped	absent
Caudal process	no	present in some species	yes on some	no	no	no	no	no	no	yes, pilose posterior margin
Coxae I	bifid	bifid			large, bifid			large, bifid		
Coxae IV					very large			very large, with spurs		
Legs	banded			grouped anteriorly	banded		banded			banded, enlarged segments in males

(*) These genera are currently not present in European member states, but they may be imported in the future

4.12. Generic morphological features of the different genera of soft ticks

Appendix Q contains photographs of some of the soft ticks involved in the transmission of animal diseases and zoonoses.

Table 7: Generic distinguishing morphological features of different genera of soft ticks

Feature	***Argas***	***Ornithodoros***
Body	Flattened	Thick
Presence of suture (differentiated tegumental tissue between dorsal and ventral surface)	No	Yes
Presence of cuticle extensions rounded hook-like cones shaped	No	Yes
Eyes	No	Yes
Tegument	Granular	Squamous
Discs of tegument	Usually in radial rows	Not in radial rows

5. Geographic distribution of tick genus and tick-borne pathogens

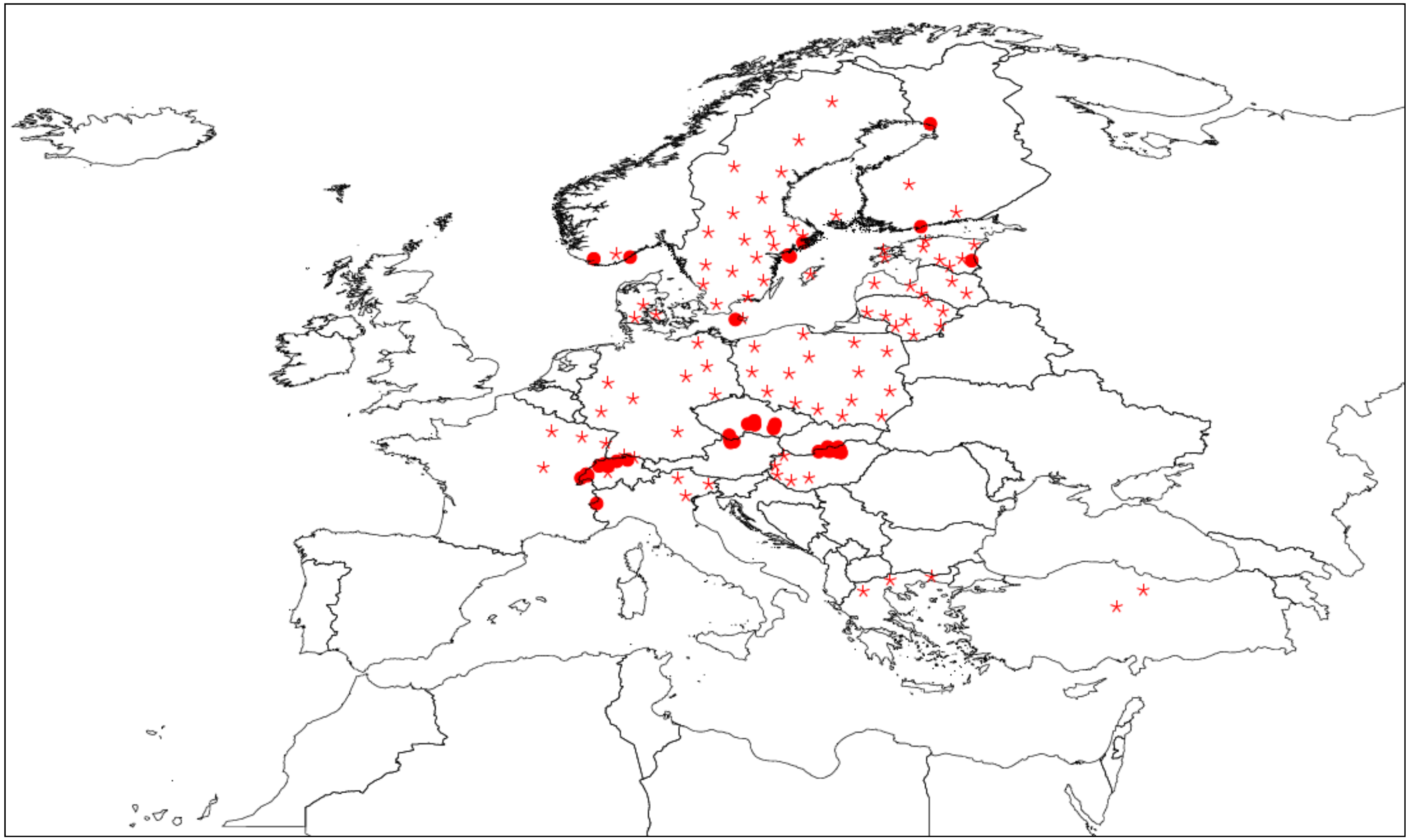
The following maps have been made up using three sources of data: (1) A systematic literature review (see appendix G of EFSA 2010a scientific opinion [EFSA Journal, 8(8): 1703]) based on scientific papers retrieved from the databases integrated in ISI web of knowledge and Pubmed in the last 10 years (Jan 2000 to March 2010), (2) as well as on a pool of scientific papers considered relevant by the WG experts, coming from their private collections regardless of the time frame; and (3) published historical data (approximately from years 1970 - 2000) of the integrated consortium on ticks and tick-borne diseases (ICTTD3 European project). Such historical data was not available for tick-borne pathogens. The signs in red colour indicate cases extracted from the systematic literature review (last 10 years). The green colour indicates historical cases (older than 2000). Dots correspond to coordinates (latitude/longitude). Stars correspond to cases where coordinates were not indicated and even could not be found because the name of the location given in the corresponding paper was equivocal (several toponyms existed with the same name). Stars are placed either in the middle of the smallest administrative region described in the scientific paper (for the countries that do not have official NUTS); or in the middle of the NUTS containing the specified location. Countries or areas that are not showing cases of presence of this tick are not necessarily free of it. Rather the species may not be presented in available literature for this report.

The maps corresponding to CCHFV, ASFV, *Hyalomma marginatum*, *Dermacentor marginatus*, *Rhipicephalus bursa*, and *Ornithodoros* spp. have been published in the scientific opinion EFSA 2010a (EFSA Journal, 8(8): 1703.)

Due to the lack of reported data in the area of concern, no maps were produced for the following: Recurrent fevers, Hepatozoon, African horse sickness, *Argas* and *Amblyomma*.

The presence of the pathogens presented in the maps is based on confirmed tests of the detection of the antigen. Serological evidence was not included, thus these maps may underestimate of the real distribution of the pathogens.

5.1. Tick-borne Encephalistis group viruses



* Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years
● Coordinate (latitude/longitude), data from last 10 years

Figure 1: Reported occurrence of tick-borne encephalitis group viruses for the last 10 years

This map displays the records of the tick-borne encephalitis group viruses that we found in the available literature of the last ten years. The dots indicate the coordinates (latitude/longitude). The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick-borne pathogen are not necessarily free of it. Rather the species may not be presented in available literature for this report.

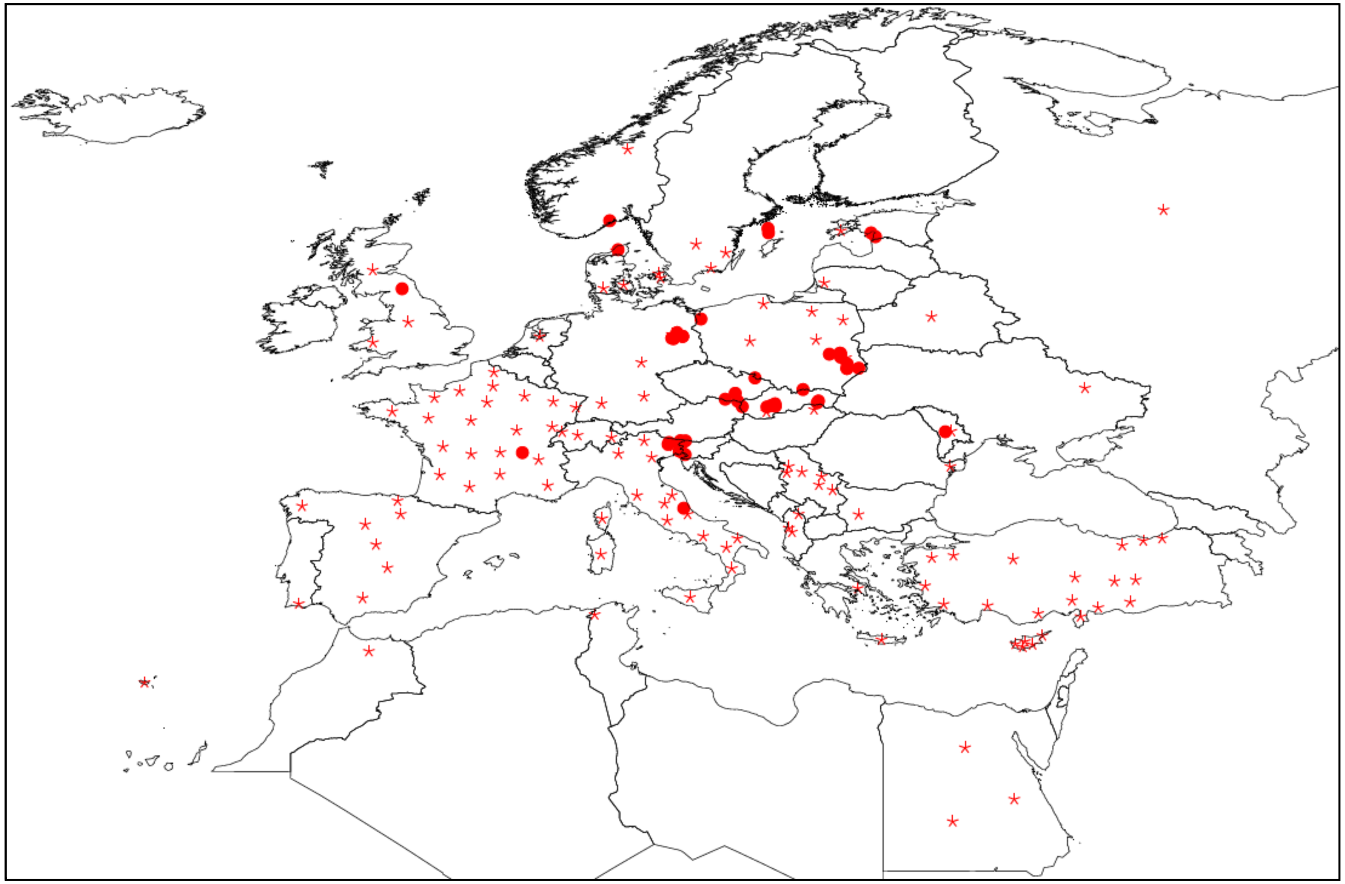
Records of *TBE Group Viruses* published during the last 10 years shown on the map originate from the following countries: Czech Republic, Denmark, Estonia, Finland (including Åland Island), Germany, Greece, Hungary, Italy, Latvia, Liechtenstein, Lithuania, Norway, Poland, Russia, Sweden, Switzerland and Turkey. The map (Fig. 1) does not include records published prior to 2000. “Countries with increased risk of TBE include Austria, Slovakia, Hungary, the Czech Republic, the Baltic States, southern Germany and southern and eastern Sweden” (ECDC 2010). TBE is prevalent in Russia all the way from the western border with Europe to its eastern border. The TBE virus strain in Russia, vectored by *I. persulcatus* causes more severe disease than the central European strain and fatalities are not uncommon.

Grard et al. (2007) assigned the Tick-borne encephalitis and Louping ill viruses to a unique species, *Tick-Borne Encephalitis Virus*, including the four viral subtypes, i.e. *Western TBEV*, *Eastern TBEV*, *Turkish sheep TBEV* and *Louping ill TBEV*. All subtypes are generally vectored by *Ixodes ricinus* (and in Eastern Europe and Asia also by *I. persulcatus*). Regarding the subtype *Western TBEV* the main vector species is *I. ricinus*. However, several other species including *I. hexagonus*, *I. arboricola, Haemaphysalis concinna, Ha. inermis* and *Ha. punctata* are competent but secondary vectors (Labuda and Nuttall, 2008).

Although the map does not show the presence of *Louping ill TBEV*, this virus is considered endemic in in sheep farming areas of Northern Ireland, Scotland, Cornwall and Wales, and Norway. This discrepancy may be related to bias in reporting cases, or in the time frame of the review. The geographical range of the closely related *Turkish sheep TBEV* was reported not only from Turkey, but also from Bulgaria and northern Spain. Experimental and transstadial transmission have been reported in *Rh. appendiculatus* and *Hy. anatolicum*, but there is no evidence that they are natural vectors or that any other tick species except *I. ricinus* play any significant role in the epidemiology of Louping ill (Reid 1988).

The geographical distribution of TBE infected ticks within regions and countries is such that the risk of infection can change dramatically from one area to another within short distances. TBE incidence fluctuates from year to year but the number of reported human TBE cases has increased in Europe in the last two decades. “The mean number of TBE infections in Europe excluding Russia between 1990 and 2007 was 2805 cases per year, up 193% from a mean of 1452 cases per year (1976–1989)” (ECDC 2010). An increase in TBE incidence has been noted in some northern countries and new TBE foci have appeared, especially in the last decade in many areas, e.g. Denmark, Norway, Sweden and Finland (Jääskeläinen et al., 2006; Formsgaard et al., 2009). The main determinants for such changes in TBE incidence may vary from one time to another and from one region to another region. Also, the determining factors are often many and they interact – often in complex manners. Among main determinants should be mentioned the changing climate affecting the vector directly as well as the plant and host communities, socio-political changes which may increase or decrease human activities in TBEV foci, and technological factors, e.g. better diagnostic methods and increased awareness (Telford III and Goethert, 2008; Donoso Mantke et al., 2008; Randolph, 2010).

5.2. *Anaplasma* spp. and *Ehrlichia* spp.



* Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years

● Coordinate (latitude/longitude), data from last 10 years

Figure 2: Reported occurrence of *Anaplasma* spp. and *Ehrlichia* spp. for the last 10 years.

This map displays the records of *Anaplasma* spp. and *Ehrlichia* spp. that we found in the available literature of the last ten years. The dots indicate the coordinates (latitude/longitude). The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick-borne pathogen are not necessarily free of it. Rather the species may not be presented in available literature for this report.

Ehrlichia canis is transmitted by the kennel tick *Rhipicephalus sanguineus* transstadially and is widespread in tropical and temperate areas of the world. Its distribution has expanded with the distribution of its vector, *Rh. sanguineus*. For *E. ruminantium* no records were found yet in Europe as the vectors are still absent from this continent, except for some inportations of immature stages on birds.

For anaplasmoses, *Anaplasma phagocytophilum* has been recorded in most European countries. *A. marginale*, normally recorded from tropical and sub-tropical regions, has a more limited distribution in Europe with records from Sicily, Hungary and Spain. *A. ovis* has been found in the same countries as *A. marginale* so far. In Italy, *A. centrale*, a similar parasite as *A. marginale*, was first recorded in 2008. Similarly, *A. bovis* has also been recorded in Italy although it is most commonly present in other continents like South America, Africa and the Indian subcontinent.

Anaplasma platys has been detected worldwide and in Europe cases have been reported from Spain, France, Greece and Italy.

5.3. *Rickettsia* spp.

* Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years

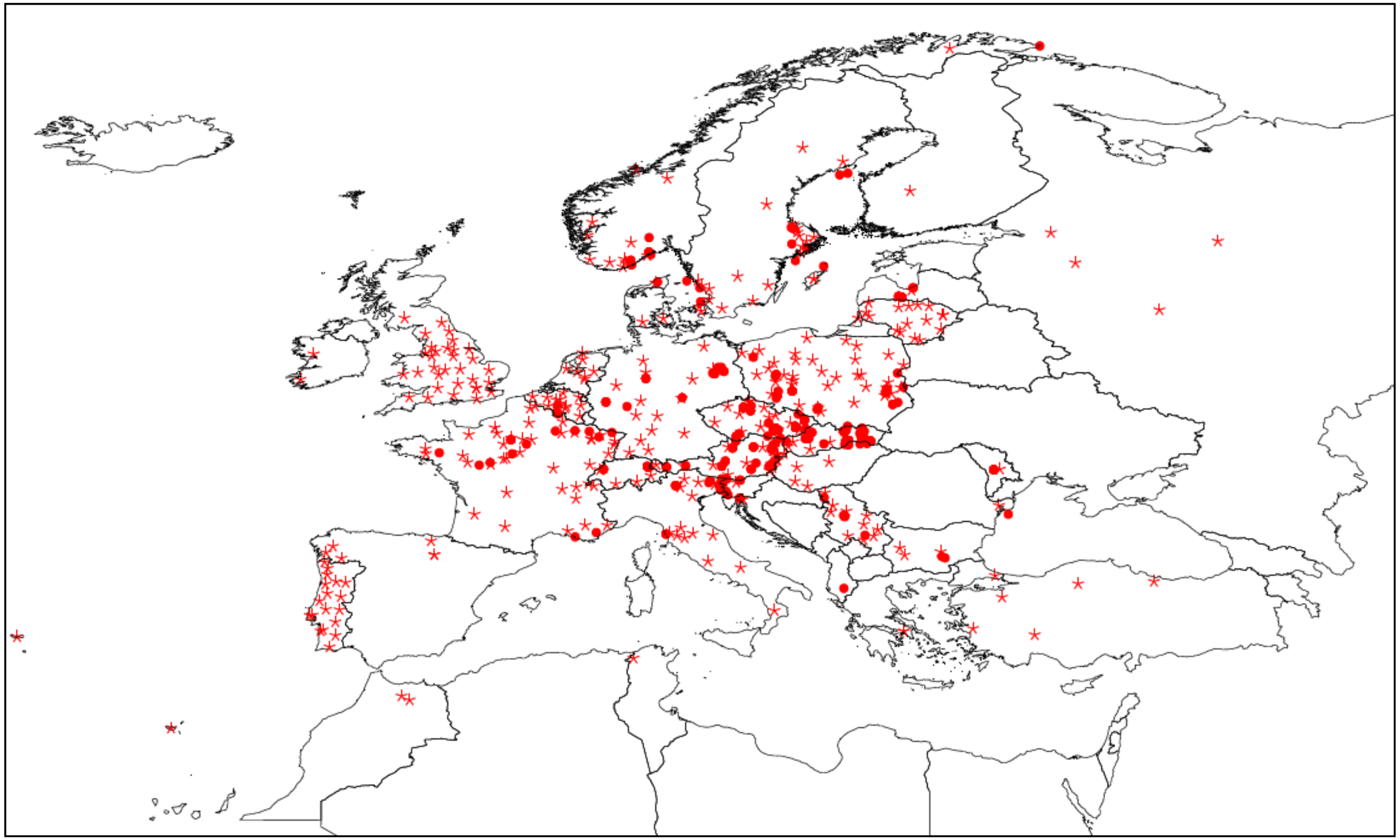
Figure 3: Reported occurrence of *Rickettsia* spp. for the last 10 years.

This map displays the records of *Rickettsia* spp. that we found in the available literature of the last ten years. The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick-borne pathogen are not necessarily free of it. Rather the species may not be presented in available literature for this report.

The map represents records of all the tick-transmitted *Rickettsiae* recorded in Europe, irrespective of the species or subspecies. Each of the species has a specific area of distribution, *R. conorii* subsp. *conorii* causing Mediterranean Spotted Fever (MSF) mainly being present in the Mediterranean where *Rhipicephalus sanguineus*, the vector, is present. The subspecies *R. c.* subsp. *israelensis* has first been reported from Israel but later also detected in Portugal. As most of the *Rickettsia* spp. are transmitted by different ticks species, of which the distribution is not always overlapping, these pathogens are found is areas determined by their vector.

Although no detailed information is available about the presence and absence of the different *Rickettiae*, it must be said that more and more recent studies, especially molecular studies, reveal the presence of the *Rickettsia* spp. in new member states of the EU, and not necessarily in adjacent countries from which the parasite was described originally.

5.4. *Borrelia* spp.



⋆ Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years
● Coordinate (latitude/longitude), data from last 10 years

Figure 4: Reported occurrence of *Borrelia* spp. for the last 10 years.

This map displays the records of *Borrelia* spp. that we found in the available literature of the last ten years (January 2000 to early March 2010). The dots indicate the coordinates (latitude/longitude). The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick-borne pathogen are not necessarily free of it. Rather the species may not be presented in available literature for this report.

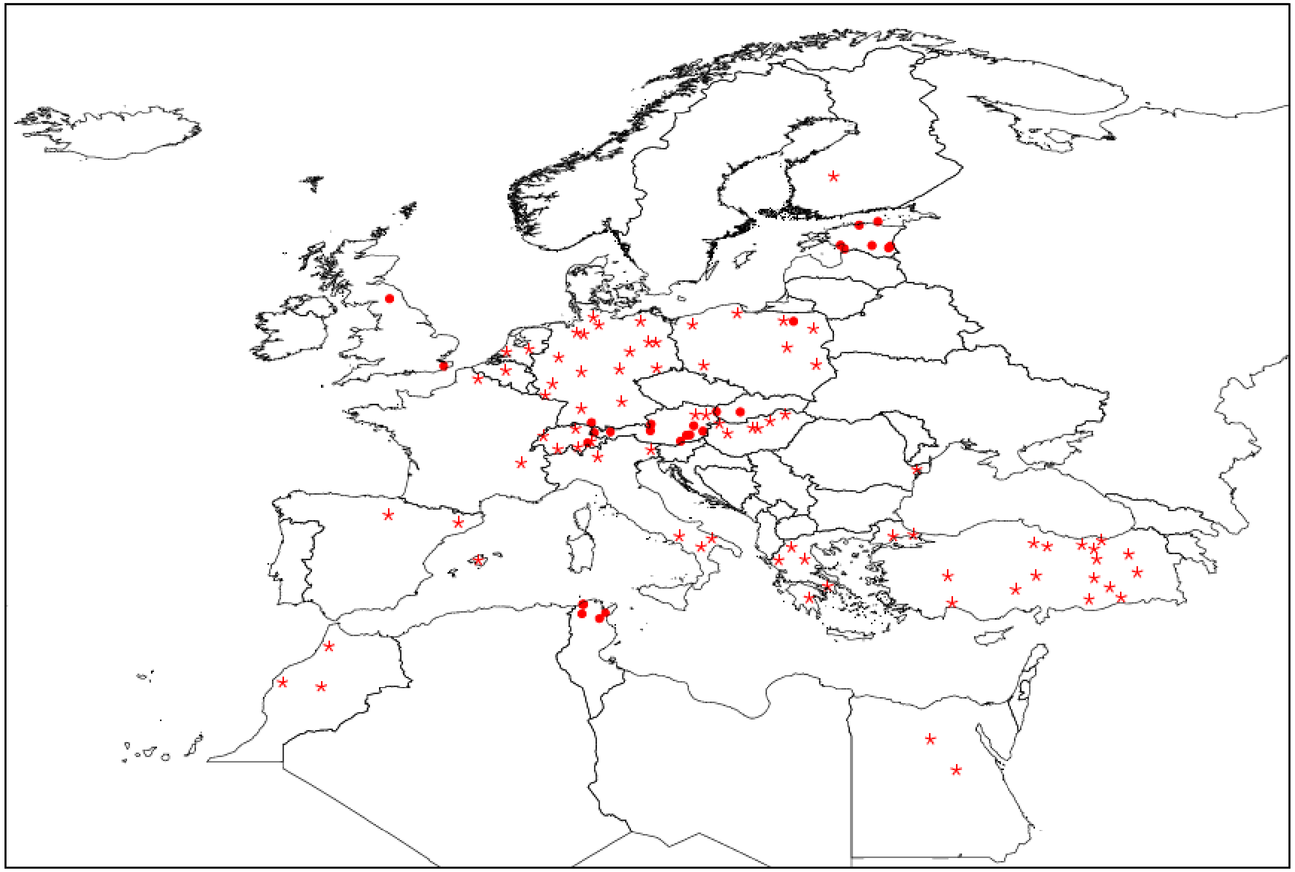
As described above, this map shows the more recent records of *Borrelia afzelii*, *B. burgdorferi* sensu stricto, *B. garinii*, *B. lusitaniae*, *B. miaymotoi*, *B. spielmanii*, *B. valaisiana* and "*B. burgdorferi* sensu lato". *B. burgdorferi* s.l. is considered to consist of at least 15 genospecies, 8 of which occur in Europe, namely: *B. burgdorferi* sensu stricto (s.s.), present in Europe and in the USA, but rare in Russia and apparently absent from Asia; *B. afzelii*, *B. bavariensis* (formerly the *B. garinii* OspA serotype 4), *B. garinii*, *B. valaisiana*, *B. spielmanii*, *B. lusitaniae* and *B. bissettii* in Eurasia; *B. japonica, B. tanukii and B. turdae* restricted to Japan, *B. sinica* in China, and *B. andersonii*, *B. bissettii*, *B. californiensi* and *B. carolinensis* in the USA (EUCALB 2010). *B. garinii* and *B. afzelii* are the most commonly encountered and most widely distributed of the "European" Lyme disease genospecies. In Portugal, Tunisia and Morocco *B. lusitaniae* is common and predominates over the other genospecies in *I. ricinus* populations (Piesman and Gern 2008).

Although *I. ricinus* and *I. persulcatus* are apparently mainly responsible for infecting humans with the Lyme disease spirochaetes in Europe and Asia, *B. burgdorferi* s.l. has been found in several other tick species (EUCALB 2010). These "carrier species" are not considered to be competent natural vectors of *B. burgdorferi* s.l.

There are indications from Northern Europe about an increasing incidence of Lyme borrelioses and TBE as a result of increased abundance of the vector, *I. ricinus* and expansion of its range, likely due to an extended vegetation period caused by climate change (Tälleklint and Jaenson 1998; Lindgren et al., 2000; Gray et al., 2009). Thus, the ranges of at least some of the Lyme disease genospecies is likely to change significantly in the near future.

Please note that the present map is based solely on records published after 1 January 2000. Therefore, many earlier records of *B. burgdorferi* s.l. and some genospecies, especially *B. afzelii*, *B. garinii* and *B. burgdorferi* s.s. from large areas of Europe are not shown on the map. Thus, while not revealed by this map it should be noted that *B. burgdorferi* s.l. is common in most or all *I. ricinus* populations in southern and central Sweden, southern and central Finland, Estonia, Latvia, Russia, Byelorussia, Kirghizia, Moldavia, Ukraine and Ireland.

5.5. *Babesia* spp.



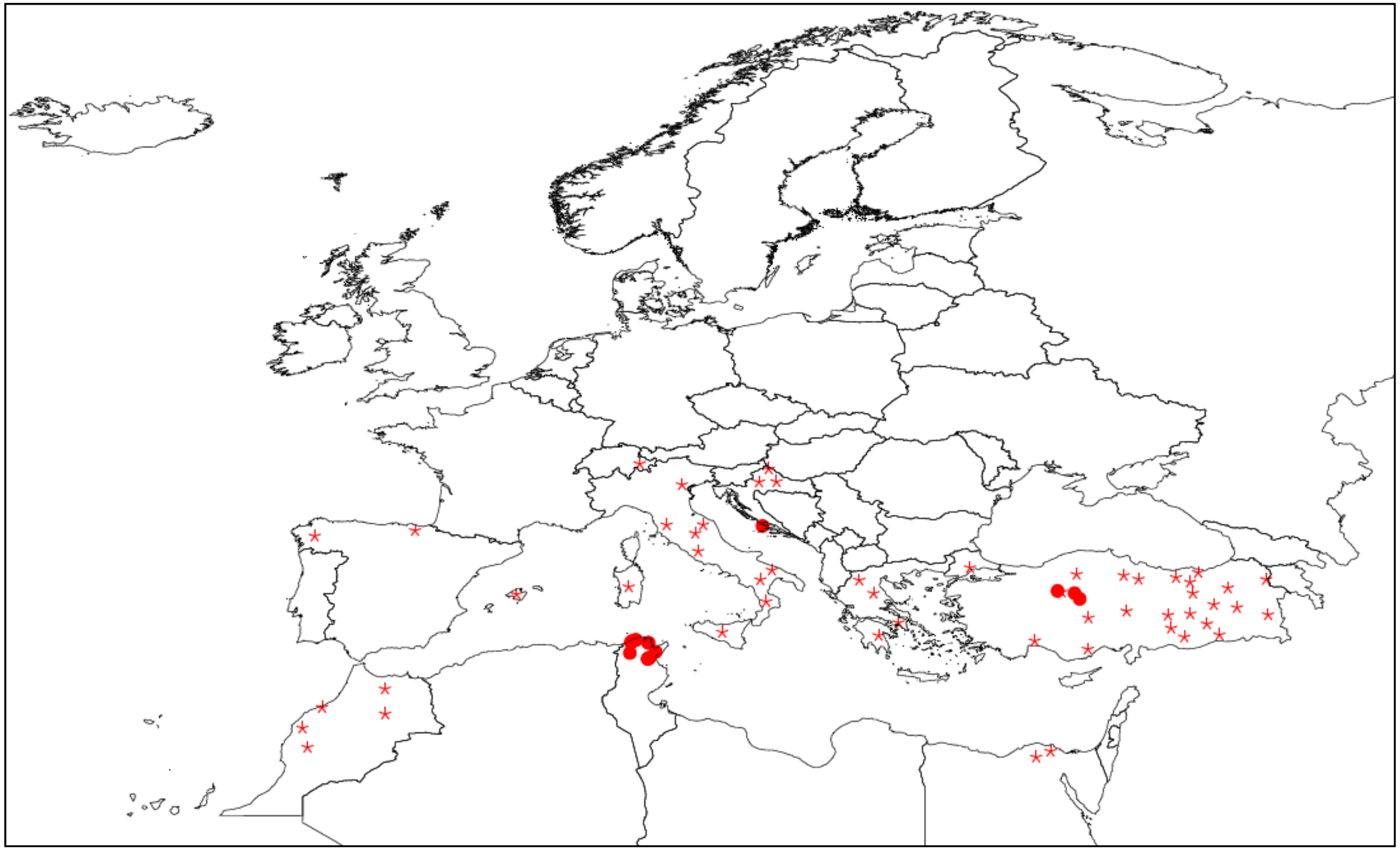
* Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years
● Coordinate (latitude/longitude), data from last 10 years

Figure 5: Reported occurrence of *Babesia* spp. for the last 10 years.

This map displays the records of *Babesia* spp that we found in the available literature of the last ten years. The dots indicate the coordinates (latitude/longitude). The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick-borne pathogen are not necessarily free of it. Rather the species may not be presented in available literature for this report.

The occurrence of *Babesia* spp. has been reported from many European countries. Several tick vectors can carry more than one *Babesia* species. Some *Babesia* species can infect more than one genus of ticks, others can only infect ticks from the genus *Ixodes*. Most common species is *Babesia canis* canis which exists in several foci of wide areas in Europe, from France to Poland where its known vector species, *Dermacentor reticulatus* is present. Recently new zoonotic *Babesia* species (Babesia EU-1, its proposed name is *B. venatorum*) has been detected in roe deer, *Ixodes ricinus* identified as its vector and in humans. In endemic areas all or almost all individuals of the host population are infected when they are young, with no or minimal clinical disease. The introduction of susceptible animals in endemic regions could lead to recrudescence of babesiosis.

5.6. *Theileria* spp.



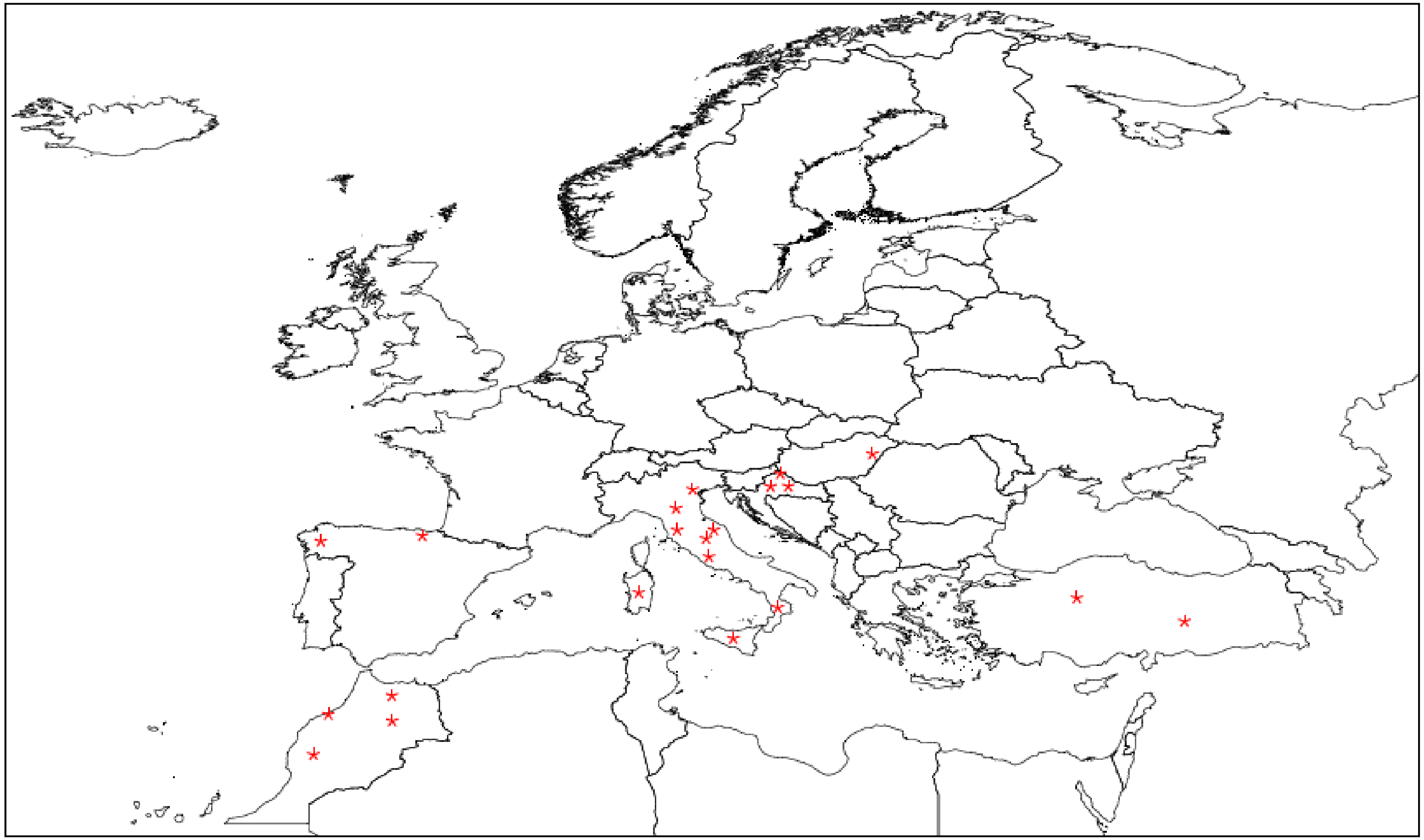
⋆ Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years
● Coordinate (latitude/longitude), data from last 10 years

Figure 6: Reported occurrence of *Theileria* spp. for the last 10 years.

This map displays the records of *Theileria* spp. that we found in the available literature of the last ten years. The dots indicate the coordinates (latitude/longitude). The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick-borne pathogen are not necessarily free of it. Rather the species may not be presented in available literature for this report.

There have been very few reports on theileriosis of domesticated ruminants from the European countries. Mediterranean theileriosis, caused by *T. annulata* is known to occur in southern Europe, north Africa and Turkey. However, no published reports exist for its incidence and distribution in the Balkans and Iberian Peninsula where Ixodid ticks such as *Hyalomma anatolicum anatolicum*, *Hy. marginatum marginatum* and *Hy. a. excavatum,* known to transmit *T. annulata*, are found in large numbers, especially in semi-arid areas. Most papers published in the last 10 years reported the occurrence of horse theileriosis caused by *Theileria* (*Babesia*) *equi* in Morocco, Turkey, Italy, Croatia and Slovenia (See figure 7, equine piroplasmoses). Based on these reports the exact geographaphical distribution and the incidence of theileriosis in domesticated and wild animals cannot be mapped properly in Europe.

5.7. Equine piroplasmoses



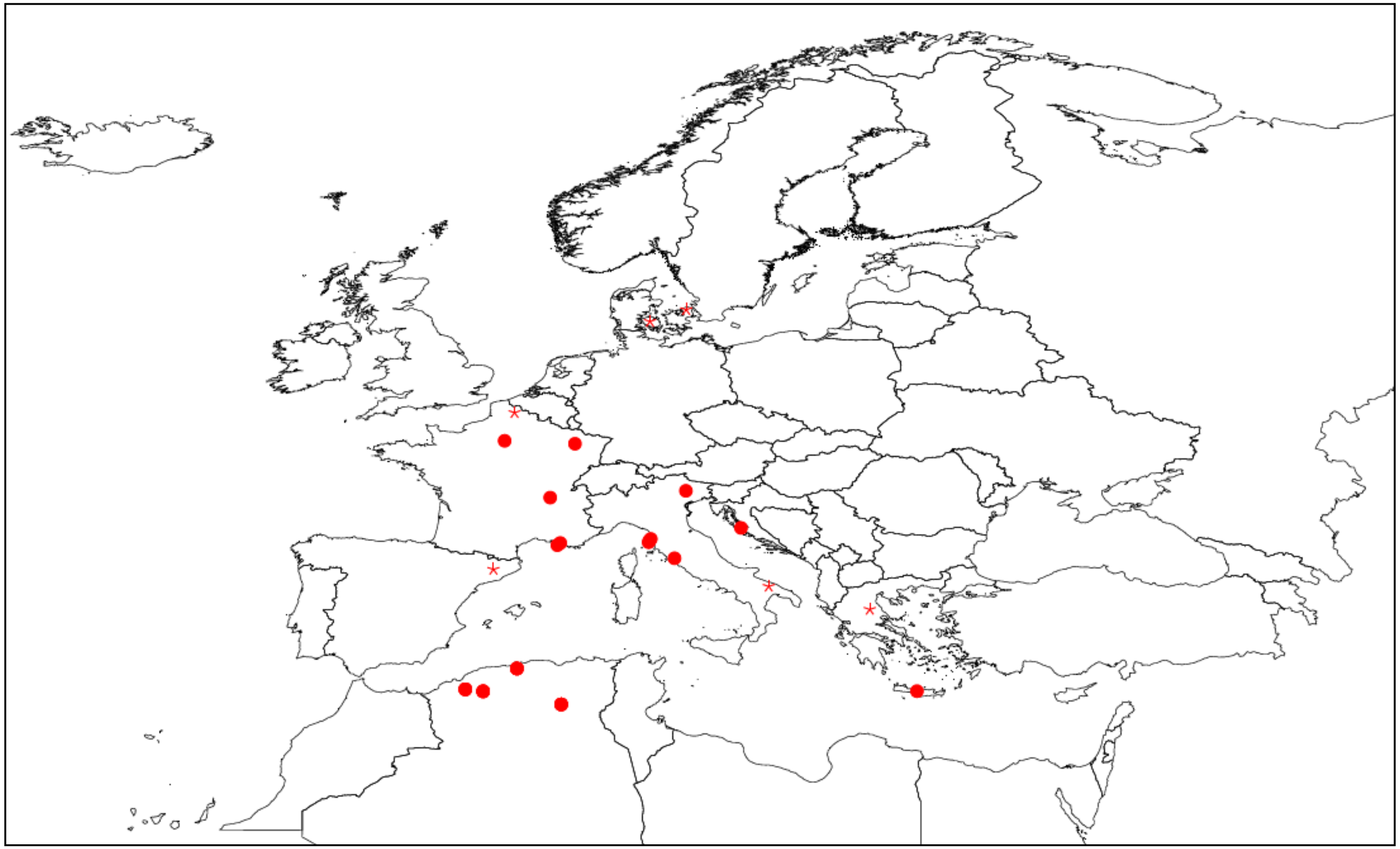
* Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years

Figure 7: Reported occurrence of equine piroplasmoses for the last 10 years.

This map displays the records of equine piroplasmoses that we found in the available literature of the last ten years. The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick-borne pathogen are not necessarily free of it. Rather the species may not be presented in available literature for this report.

The distribution and incidence of equine piroplasmoses caused by two species of apicomplexan protozoa, *Theileria* (syn. *Babesia) equi* and *Babesia caballi* have been reported from a few European countries. It seems to be more prevalent in France, Italy and Turkey than in other countries. Piroplasmosis may occur in other countries because several species of Ixodid ticks belonging to the genera *Hyalomma*, *Dermacentor* and *Rhipicephalus* have been identified as vectors of both *B. caballi* and *T. equi* in a wide area in Europe. Besides infected tick vectors both parasite species can be spread by infected horses without clinical signs, by the transfer of blood from infected to naïve equids through shared needles, improperly shared equipment, and blood or serum transfusions.

5.8. *Bartonella* spp.



* Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years
● Coordinate (latitude/longitude), data from last 10 years

Figure 8: Reported occurrence of *Bartonella* spp. for the last 10 years.

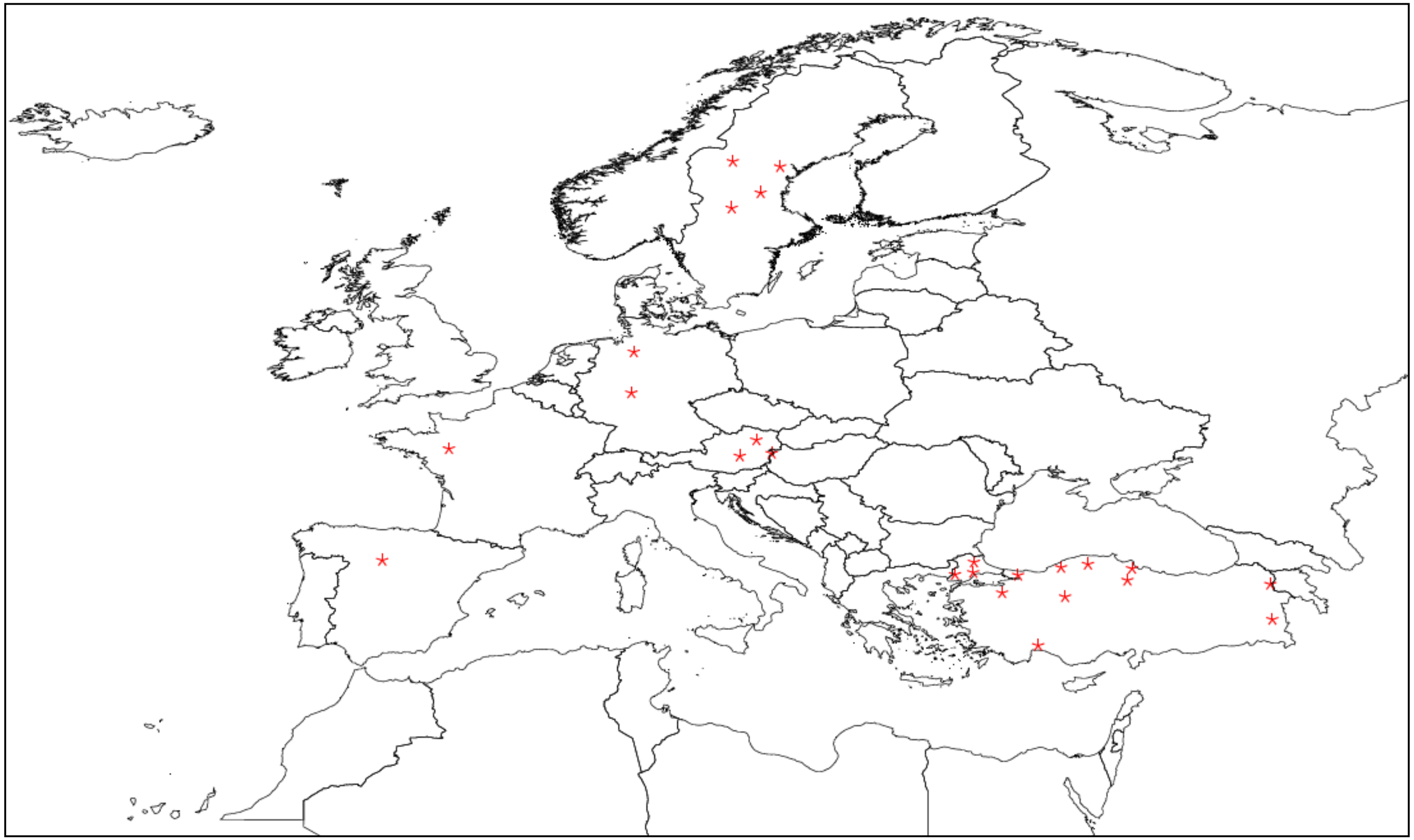
This map displays the records of *Bartonella* spp. that we found in the available literature of the last ten years. The dots indicate the coordinates (latitude/longitude). The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick-borne pathogen are not necessarily free of it. Rather the species may not be presented in available literature for this report.

This map shows the geographical locations only of recent (2000-2010) records of *Bartonella henselae*, *B. quintana*, *B. vinsonii* and unidentified "*Bartonella* spp.". The genus comprises at present 28 species and subspecies (DSMZ, 2010). Thus, the map does not give a complete picture of the geographical distribution in Europe of the genus *Bartonella*.

Since *Bartonella* spp. usually infect their vertebrate hosts chronically these microparasites can be ingested, and potentially be transmitted by blood-feeding arthropods. Confirmed vectors of *B. henselae* (aetiological agent of the cat-scratch disease), *B. bacilliformis, B. quintana*, *B. grahamii* and *B. taylorii* are *Ctenocephalides felis*, *Lutzomyia verrucarum, Pediculus humanus humanus*, and *Ctenophthalmus nobilis*, respectively (Billeter et al., 2008). *Bartonella* bacteria have been detected - based mainly on PCR - in several tick species, including *I. ricinus, I. scapularis, I. persulcatus, Dermacentor reticulatus, Rhipicephalus sanguineus* and *Carios kelleyi* (Billeter et al., 2008). Some of the reasons that *Bartonella* species might be transmitted by ticks have been listed by Telford and Wormser (2010): other arthropods can transmit *Bartonella* spp.; DNA of *Bartonella* spp. is often detected in ticks; human cases of bartonellosis preceded by tick bites are on record; and *Bartonella* spp. are commonly present in important hosts of *Ixodes* ticks, i.e. deer and rodents.

Although many researchers have indicated that ticks might be vectors of bartoneloses, it should be clear that there is, so far, no evidence that any tick species is a natural, competent vector of any *Bartonella* species (Telford and Wormser, 2010).

5.9. *Francisella tularensis*



⋆ Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years

Figure 9: Reported occurrence of *Francisella tularensis* for the last 10 years

This map displays the records of *Francisella tularensis* in in humans or animals that we found in the available literature of the last ten years. The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick-borne pathogen are not necessarily free of it. Rather the species may not be presented in available literature for this report.

Not all these cases are necessary related to tick transmission. Although vector-borne transmission of tularemia to mammalian hosts has an important role in pathogenesis of the disease (Petersen et al., 2009), there are several vectors in addition to ticks that are related to this transmission and maintenance of this pathogen. The map indicated the sporadic reported cases by locations mainly due to low percentage of compliance with reporting of this disease and the link of clinical signs of the related disease (i.e. tularemia) to several similar diseases.

5.10. *Coxiella burnetii*

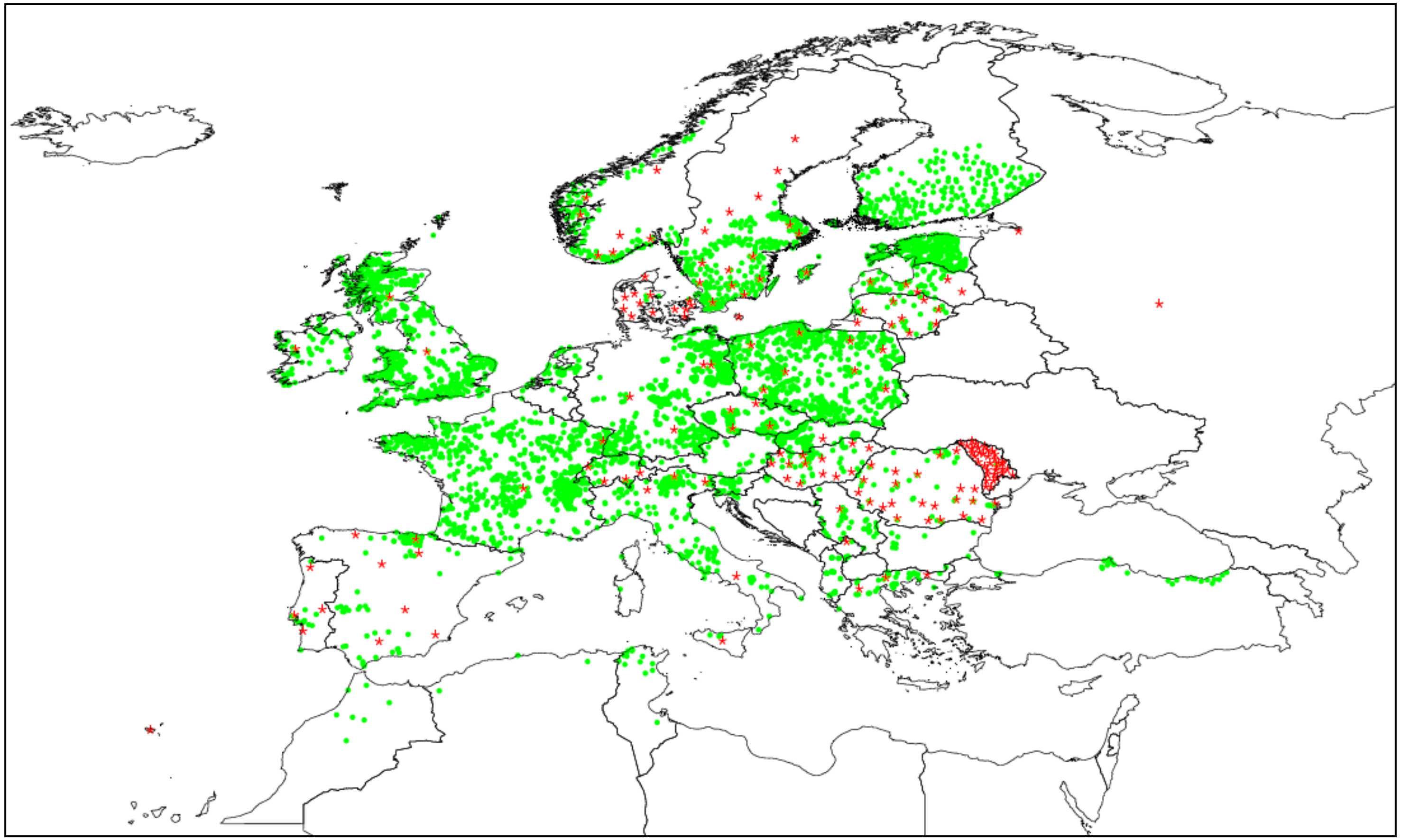
* Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years

Figure 10: Reported occurrence of *Coxiella burnetii* for the last 10 years.

This map displays the records of *Coxiella burnetii* infection in animals and Q fever disease in humans or animals that were reported in the available literature of the last ten years. The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick-borne pathogen are not necessarily free of it. Rather the species may not be presented in available literature for this report.

In domestic animals, *Coxiella burnetii* is endemic in most European member states with a limited impact on human and animal health. Most countries have a long history of infection in domestic animals, with sporadic human cases. In the Netherlands, a Q fever outbreak in humans first emerged in 2007 and is considered the largest community outbreak ever recorded (EFSA Journal 2010; 8 (5):1595).

5.11. *Ixodes ricinus*



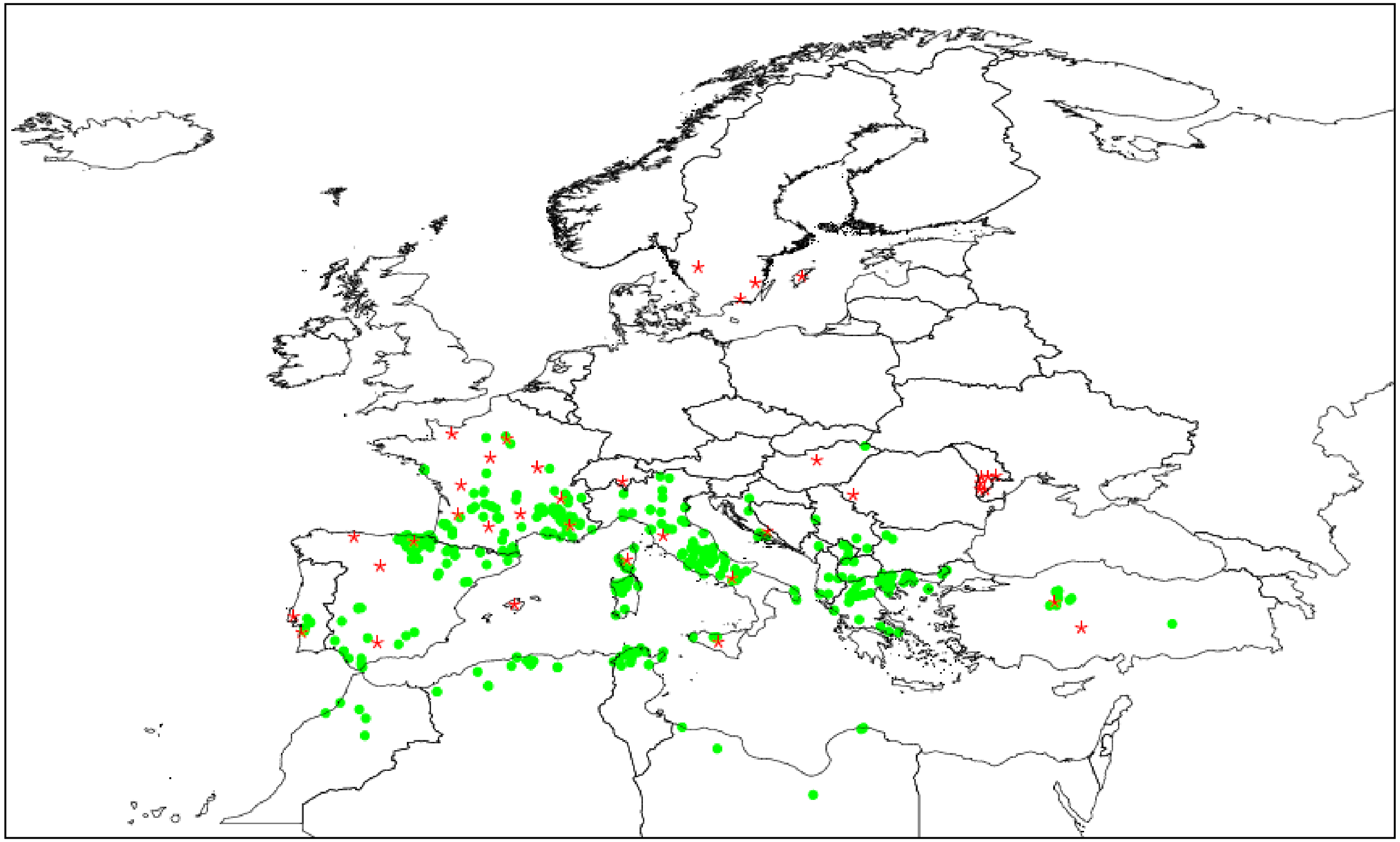
* Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years
● Coordinate (latitude/longitude), historical data (before 2000)

Figure 11: Reported occurrence of *Ixodes ricinus*

This map displays the records of *Ixodes ricinus* ticks that we found in the available literature of the last ten years (in red); and from historical data older than 2000 (in green). The dots indicate the coordinates (latitude/longitude). The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick are not necessarily free of it. Rather the species may not be presented in available literature for this report.

Ixodes ricinus is "the common tick of Europe" and is widely distributed in north-western Europe through much of the Palaearctic, from Iceland and Ireland through central and southern Europe eastwards to Central Asia (Iran) and southwards to North Africa. It is present in relatively dry Mediterranean habitats in Northern Africa and the Iberian Peninsula, in damp sheep pastures of Ireland, Scotland, Wales and England, and in relatively humid, mixed coniferous/deciduous woodland biotopes throughout most of Europe including Scandinavia, Finland and western Russia. In Europe, changes in climate during the last decades appear to cause an expanding range, to higher altitudes (Materna et al., 2005) and latitudes (Tälleklint and Jaenson, 1998; Lindgren et al., 2000; Lindgren and Jaenson, 2006), as well as affecting the population density of the tick. Moreover, with a changing range of *I. ricinus* its role as an important vector of infections of humans and/or domesticated mammals, e.g. tick-borne encephalitis viruses (TBEV) including louping ill of sheep, Lyme borrelioses due to *Borrelia burgdorferi* s.l., anaplasmosis (*Anaplasma phagocytophilum*), babesiosis (*Babesia divergens*), ricketsiosis (*Rickettsia helvetica*), tularemia (*Francisella tularensis*), needs to be monitored in the future.

5.12. *Haemaphysalis punctata*



* Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years
● Coordinate (latitude/longitude), historical data (before 2000)

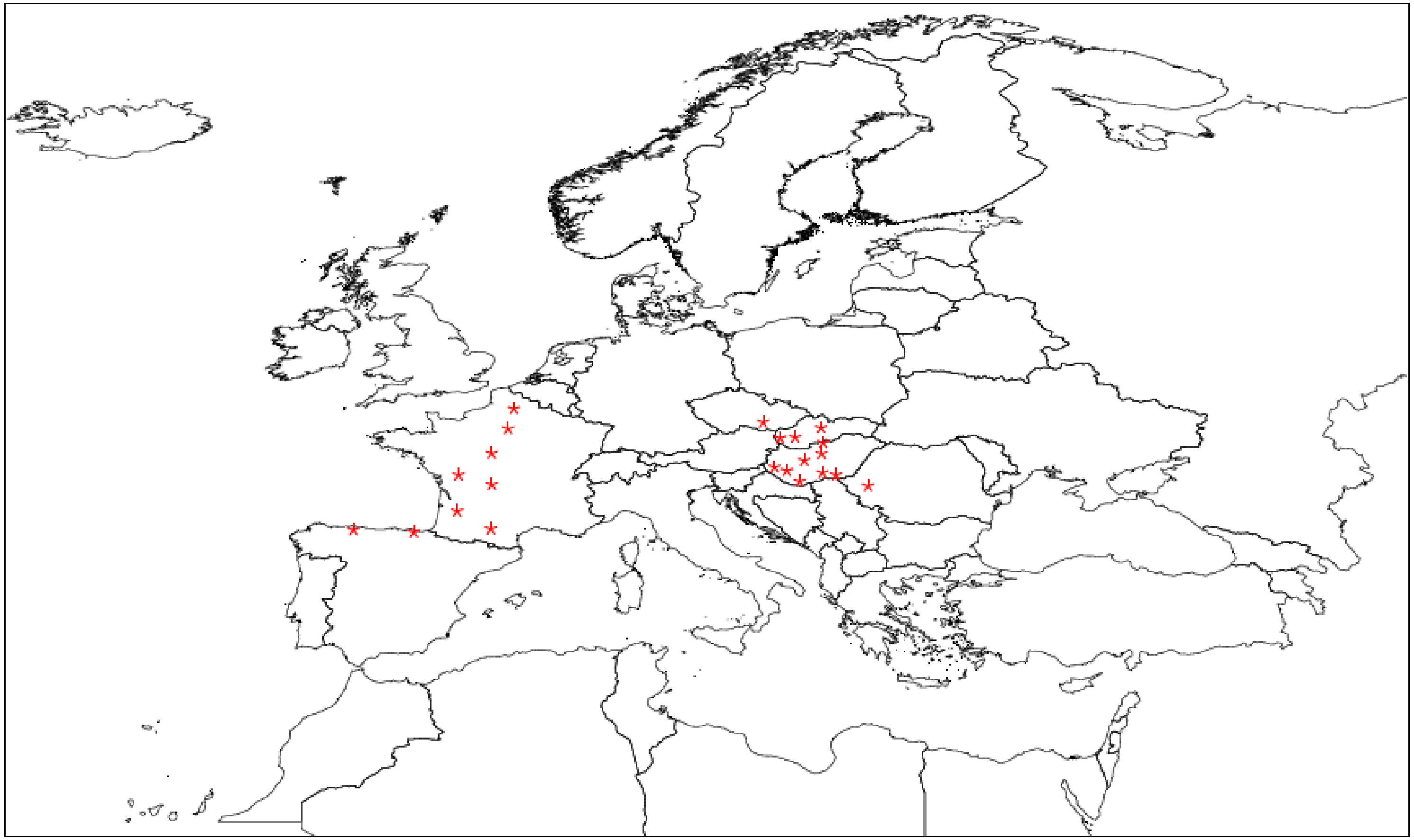
Figure 12: Reported occurrence of *Haemaphysalis punctata*

This map displays the records of *Haemaphysalis punctata* ticks that we found in the available literature of the last ten years (red signs); and from historical data older than 2000 (green signs). The dots indicate the coordinates (latitude/longitude). The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick are not necessarily free of it. Rather the species may not be presented in available literature for this report.

Haemaphysalis punctata is widely present in Europe and in the whole Mediterranean area. It is mainly present in dense forest environment. Adults feed on domestic and wild ungulates; immatures, besides small mammals, can feed on birds, including migratory birds.

Migratory birds are carriers of immature ticks and could potentially introduce them into free areas. Nevertheless, most part of reports is concentrated in southern-central Europe while northern Africa appears to be the southern limit of its distribution.

5.13. *Haemaphysalis concinna*



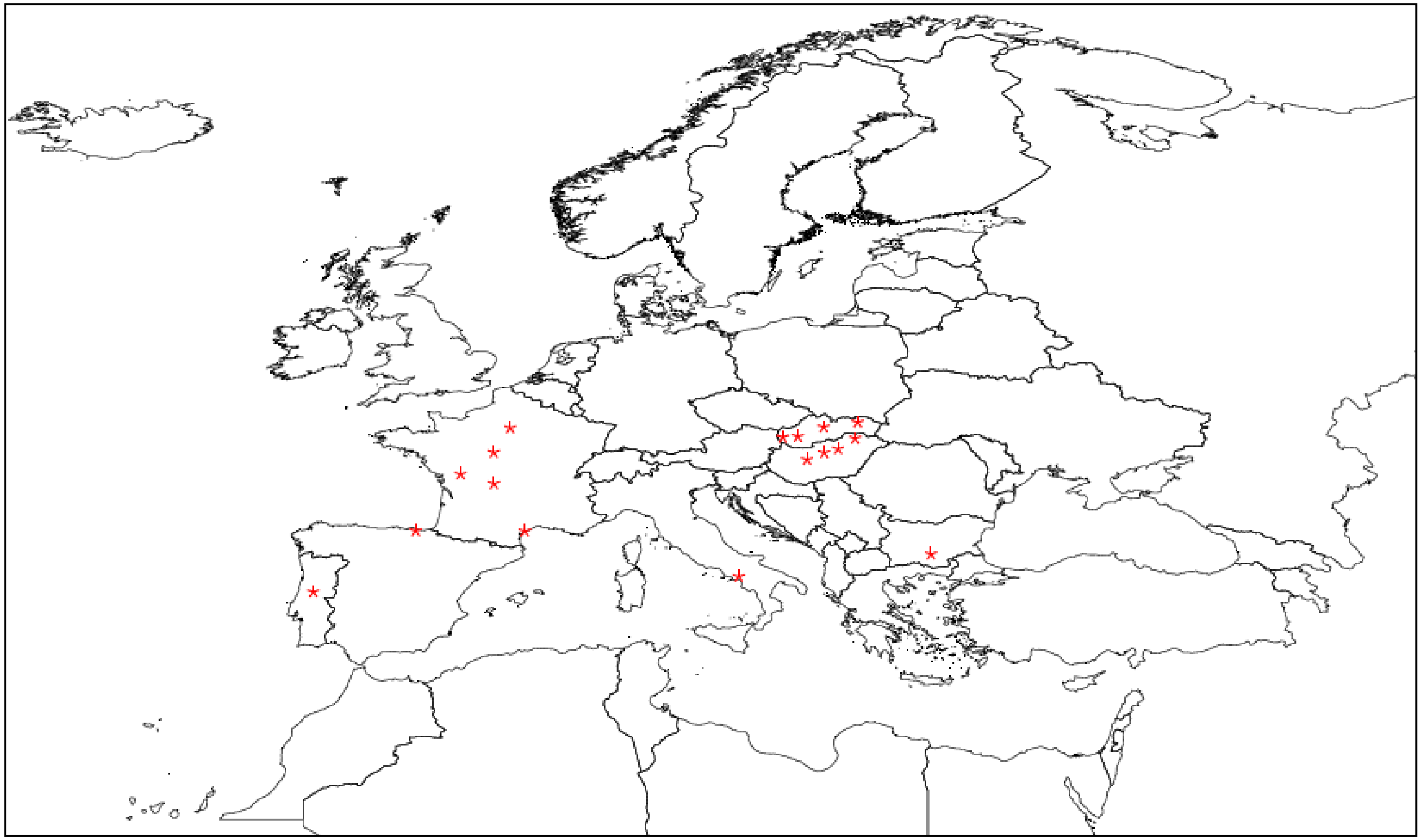
★ Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years

Figure 13: Reported occurrence of *Haemaphysalis concinna*

This map displays the records of *Haemaphysalis concinna* ticks that we found in the available literature of the last ten years. The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick are not necessarily free of it. Rather the species may not be presented in available literature for this report.

Ha. concinna is a palaearctic species scattered in the Eurasian region from the Atlantic coast to Japan. It is mainly present in temperate climate and well adapted to different biotopes. Adults feed on domestic and wild ungulates, immature, besides small mammals, can feed on birds, including migratory birds.

5.14. *Haemaphysalis inermis*



* Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years

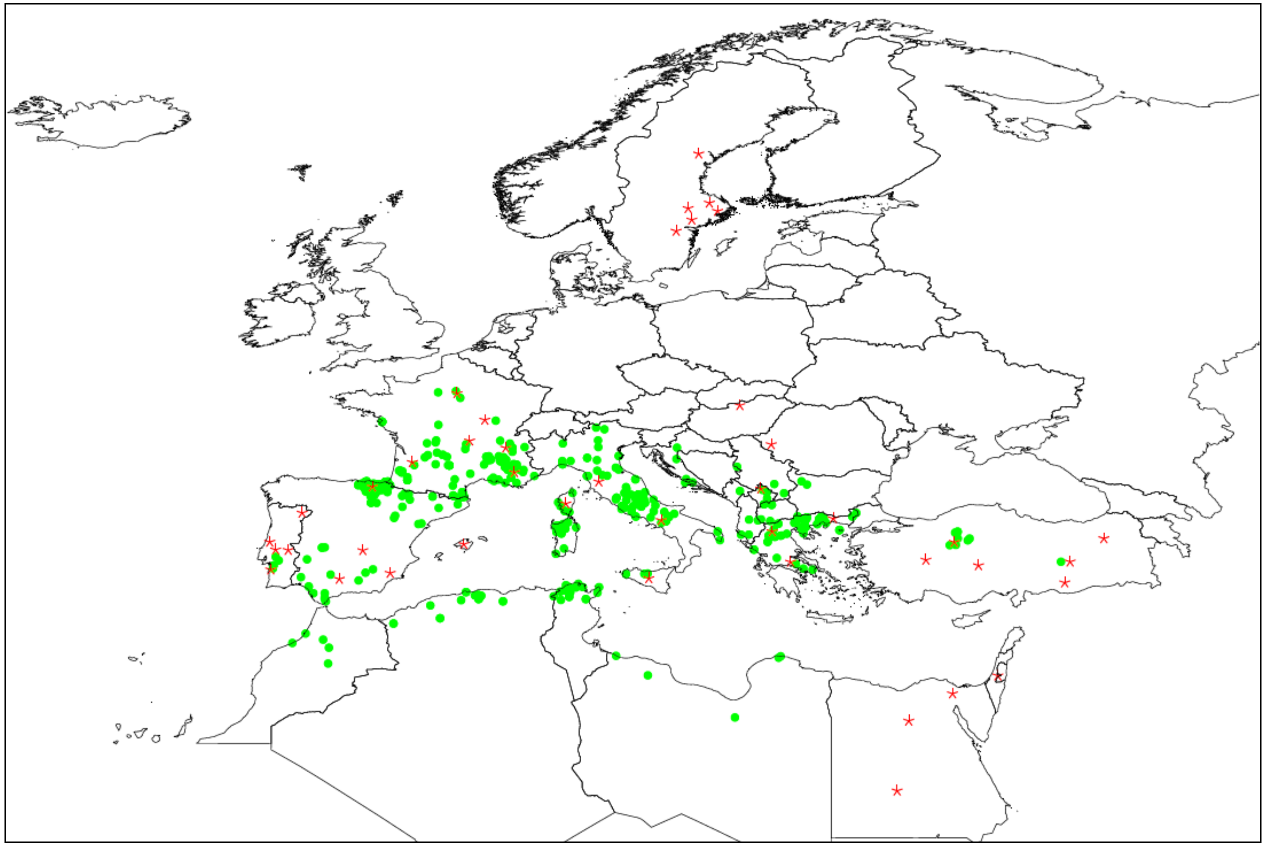
Figure 14: Reported occurrence of *Haemaphysalis inermis.*

This map displays the records of *Haemaphysalis inermis* ticks that we found in the available literature of the last ten years.). The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick are not necessarily free of it. Rather the species may not be presented in available literature for this report

Ha. inermis is present in the Southern-central Eurasian region. It is an ancient species and the geographic origin has been identified in the Caucasus

It is well adapted to different biotope. Adults feed on domestic and wild ungulates, but also on canids and lagomorphs. Immature, besides small mammals, can feed on lizards, ground feeding birds, including migratory ones.

5.15. *Rhipicephalus sanguineus* group *(Rh. sanguineus, Rh. turanicus)*



★ Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years
● Coordinate (latitude/longitude), historical data (before 2000)

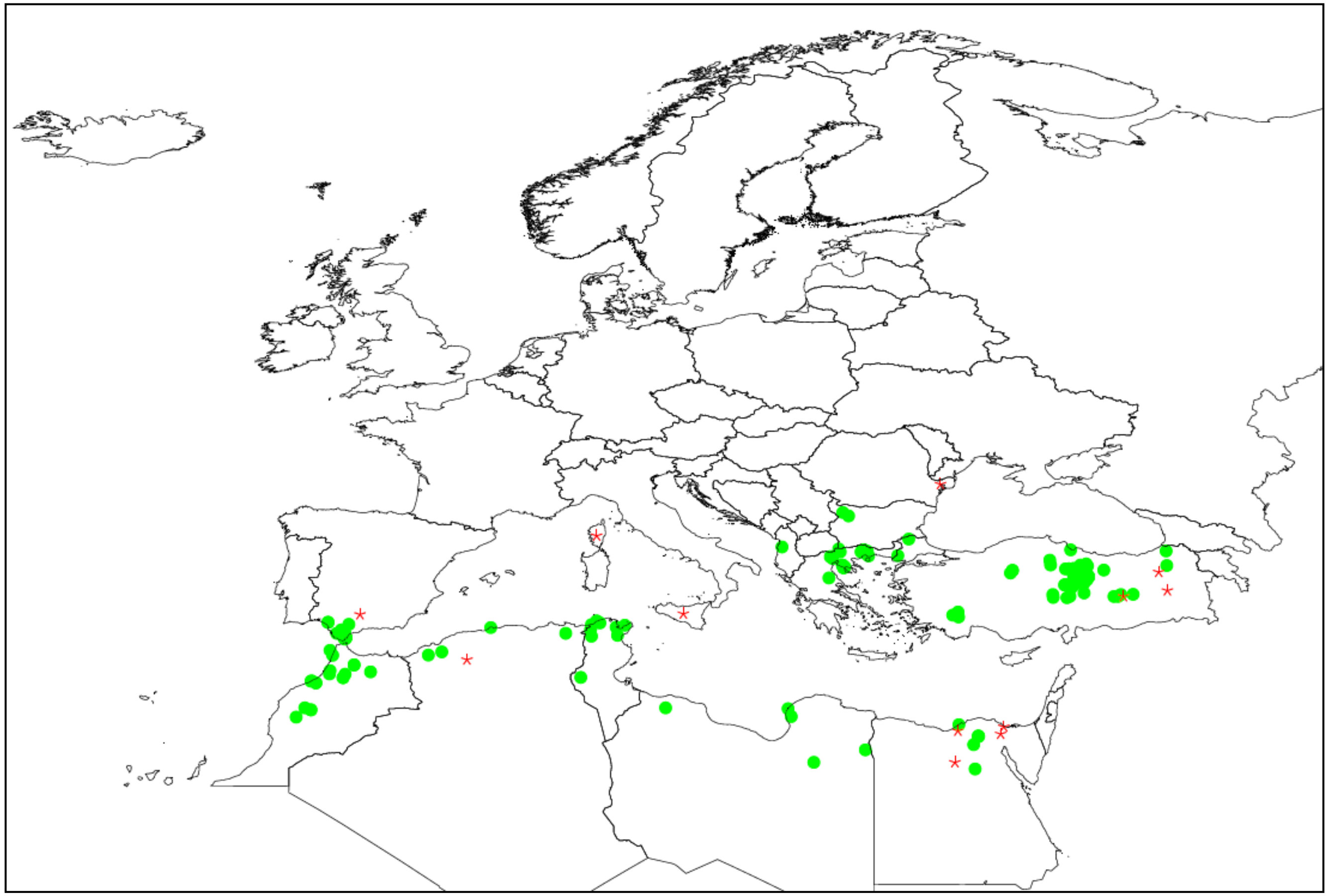
Figure 15: Reported occurrence of *Rhipicephalus sanguineus* group *(Rh. sanguineus and Rh. turanicus)*

This map displays the records of *Rhipicephalus sanguineus* group ticks that we found in the available literature of the last ten years (red signs); and from historical data older than 2000 (green signs). The dots indicate the coordinates (latitude/longitude). The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick are not necessarily free of it. Rather the species may not be presented in available literature for this report.

Due to the difficulties of the identification, the map is referred to the *Rh. sanguineus* group that comprises several tick species. The biosystematics status of the majority of these species has been confused leading to a misidentification. Two of these species, *Rh. turanicus* and *Rh. camicasi*, closely resemble to *Rh. sanguineus* sensu stricto. The latter it is reported in the north-eastern horn of Africa (to Egypt) and in Arabian Peninsula, while *R. turanicus* is widely present in Africa but it also spreads in Europe, in the whole Mediterranean area, in Russia and India.

In both cases the geographic distribution overlaps with *Rh. sanguineus* sensu stricto that spreads worldwide, mainly within latitudes 35°S and 50°N, associated with dogs, leading to risk of misidentification.

5.16. *Rhipicephalus (Boophilus) annulatus*



* Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years

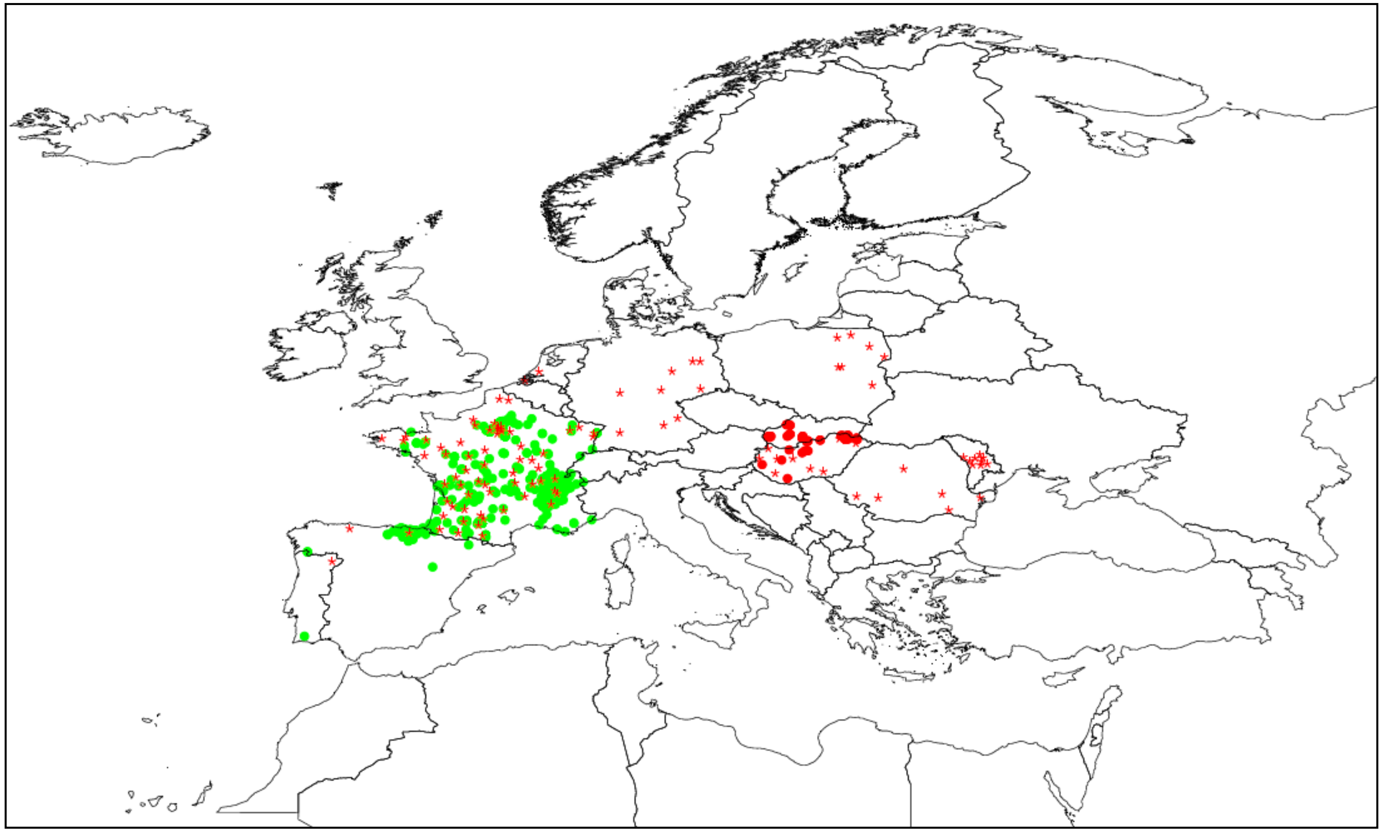
● Coordinate (latitude/longitude), historical data (before 2000)

Figure 16: Reported occurrence of *Rhipicephalus (Boophilus) annulatus*

This map displays the records of *Rhipicephalus (Boophilus) annulatus* ticks that we found in the available literature of the last ten years (red signs); and from historical data older than 2000 (green signs). The dots indicate the coordinates (latitude/longitude). The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick are not necessarily free of it. Rather the species may not be presented in available literature for this report.

Rhipicephalus (Boophilus) annulatus is a circum-Mediterranean species which prefer the dog as main host. However, its presence has been pointed out on wild deer. The species needs a Mediterranean climate, with mild winters and hot summers, where humidity does not seems to be a limiting factor. It prefers areas of xeric vegetation and scrublands, and is absent from cold forests, open and cold grasses. However, local observations suggest that the tick prefer open areas where some water courses (permanent or seasonal) are available. This feature will undoubtedly improve the reproductive performance of the tick. The species has been never recorded northern than latitude 44ºN. It is interesting to note that the tick has been recorded in many areas of northern Africa, southern Spain, Greece and neighbouring countries in Balkans, and Turkey. Reliable samplings in southern France have never found this tick species. We ignore if the absence of the tick in continental Italy is a result of its actual absence or a lack of reports over the area.

5.17. *Dermacentor reticulatus*



- ★ Smallest administrative region or territorial unit for statistics (NUTS), data from last 10 years
- ● Coordinate (latitude/longitude), data from last 10 years
- ● Coordinate (latitude/longitude), historical data (before 2000)

Figure 17: Reported occurrence of *Dermacentor reticulatus*

This map displays the records of *Dermacentor reticulatus* ticks that we found in the available literature of the last ten years (red signs); and from historical data older than 2000 (green signs). The dots indicate the coordinates (latitude/longitude). The stars indicate records in which the coordinates were not provided, just the name of the location. Stars are placed in the centroid of the corresponding NUTS. Countries or areas that are not showing cases of presence of this tick are not necessarily free of it. Rather the species may not be presented in available literature for this report.

Accurate records of *Dermacentor reticulatus* (syn. *D. pictus*) also known as ”the ornate dog tick” exist in wide areas in Europe, from France to Moldavia. The area of distribution of this tick species overlaps in many parts of Europe with that of *D. marginatus* and it has been wrongly reported as the later species. It seems to be widespread in France, Germany, Hungary and eastern part of Poland. It prefers cold regions with an adequate amount of air relative humidity, therefore it is absent in the Mediterranean region where relative humidity is not a constraint for survival. It is absent from mountain regions, but very abundant in low altitude hills. The actual geographical distribution and northern limits of this species are not well known. Concerns exist about the probable spread of *D. reticulatus* into other areas of the infested countries (e.g. in Germany) and into new counties where the tick is currently absent.

6. Surveillance and control measures

There is a lack of reliable consistent surveillance to provide sufficient information to confirm or refute whether these tick species are endemic or not in a specific areas. The majority of the above data and information were collected using srveys and specific studies without systematic collection of samples and intervention strategies. Nevertheless, the available data are significant indicators of the distribution of the TBD and their ticks.

6.1. Control options for hard ticks

Tick control has stimulated intense interest for more than a century. There is a variety of strategies for control of ticks and tick-borne diseases (Willadsen, 2006; Sonenshine et al., 2006). Treatment with synthetic chemicals known as acaricides including ixodicides still provides the most widely used means to control or prevent hard tick attacks with the aim to prevent pathogen transmission (Polar et al., 2005). Control of ticks with acaricides can either be directed against the ticks on the host or against the free-living stages of ticks in the environment. Acaricides include several groups of pesticides: organophosphates (e.g. coumaphos, diazinon), carbamates (e.g. propoxur), pyrethroids (e.g. permethrin, deltamethrin, flumethrin), formamidines (e.g. amitraz), two classes (avermectins and milbemycins) of macrocyclic lactones (e.g. ivermectin, moxidectin, eprinomectin), phenyl-pyrazoles (e.g. fipronil) and natural acaricides such as botanical materials (e.g. extract of the neem tree containing azadirachtin).

6.1.1. Chemical Control of Ticks on Animals

There are several application methods of acaricides on animals such as dips, sprays using manual or motorized high-pressure sprayers, dusts, pour-ons, spot-ons, intraruminal bolus and injections. Dipping vats have been used extensively for tick control on livestock including cattle and sheep. With these methods livestock are run through the vat full of acaricide-treated solution to entirely expose the animal from head to hoofs. Dipping vats need to be maintained with proper solution levels and percentage of active ingredient when used for several animals over extended periods of times. Retreatment may be needed several times during a season when using sprays and dips. To achieve long-lasting efficacy, acaricides can be incorporated into plastic or other suitable matrices that provide a slow release of the toxicant over a period of weeks or months. Acaricide-impregnated plastic ear tags are widely used for control of ear-infesting ticks on cattle and other large domestic animals. Systemic acaricides offer another means of providing long-lasting and effective tick control. These preparations can be divided into injectable, oral and topically applied products, all of which are delivered to the tick during its feeding activity on the skin. Most acaricides are too toxic to administer to animals systemically except for the macrocyclic lactones that are active systemically in very low doses for the control of ticks and other parasites.

Each application method has its advantages and disadvantages. Spray races are often used due to their advantage of limiting the amount of acaricide used; the cattle pass through a heavy low pressure spray and become soaked with acaricidal fluid, but body parts such as ears and groin may not be effectively treated by this method (Latif and Walker, 2004). Small numbers of livestock can be treated with hand-held sprayers but manual spraying depends on the person applying it. Pour-on formulations of acaricides contain high quality oil which spreads through the greasy hair coat of livestock and these products can also be used with applicators to treat wild ungulates in game reserves (Latif and Walker, 2004). Pour-on formulations are relatively expensive, but there is little wastage of acaricide and they may be cheaper in the long term.

Regarding wildlife, in recent years, an important concept called host-targeted tick control was introduced as a way to destroy ticks without harming their hosts. Several devices have been developed to attract deer or small mammals to 'feeding stations' where they are treated. One of the most promising of these devices, the ‘four-poster’, is now available for controlling ticks on white-tailed deer (Pound et al., 2000). The device includes a central bin, containing bait to attract deer, with a bait dispenser and applicator station on either side. Deer attracted to the bait source contaminate their fur with acaricide from the applicators as they insert their heads to feed. Four-poster devices have the advantage of well-targeted applications allowing far lower amounts of pesticide to be applied than in broadcast applications. The effectiveness of the approach taken tends to depend on ecological conditions at the application site. These methods can be important tools in integrated pest management programmes, especially when integrated with other management techniques appropriate for local conditions of tick dis¬tribution and transmission dynamics. Another novel host-targeted method is the use of rodent-targeted bait boxes containing fipronil, which has proven effective in eliminating immature ticks on mice and thereby reducing the subsequent population of questing I. scapularis nymphs and adults, in addition to reducing the proportion of these ticks infected with the Lyme disease spirochete Borrelia burgdorferi (Dolan et al., 2004).

There are several formulations of different acaricides for treating pets against ticks. Both cats and dogs can be sprayed with approved products. Topical spot-on treatments containing e.g. fipronil or selamectin can be used on cats and dogs. Permethrin as a spot-on topical treatment can be used on dogs. Insecticide-impregnated pet collars are available for dogs and cats of which contains amitraz is available for dogs. These collars offer at least partial protection but may not provide total tick protection (Elfassy et al., 2001; Spencer et al., 2003).

Chemical control of ticks poses several problems. Besides leaving residues in meat and milk, the use of many acaricides (e.g. organophosphates, carbamates) is associated with risks of side-effects or poisoning resulting from overdose on specific species or breed sensitivity (de Oliveira Monteiroa et al., 2010). Environmental contamination and effects on non-target animals have been also well documented in the case of the organochlorines, organophosphates, carbamates and pyrethroids (Kunz and Kemp, 1994). The development of acaricide resistance by some tick species is an increasing and continuing concern in tropical and subtropical areas where the tick species have been found to be resistant to chlorinated hydrocarbons, organophosphorus insecti-cides, pyrethroids and formamidines (Kunz and Kemp, 1994). Acaricide resistance in tick species occurring in Europe has not been reported yet but to avoid the onset of this problem there are certain rules to follow:

- when acaricides are used they should be stored as recommended and be used as soon as possible to be of full strength as specified by the manufacturer;
- all ticks on treated animals should be destroyed or eliminated;
- the acaricide type recommended by the official veterinary authorities should be used until official veterinary advice is to change to another type; and
- novel acaricides should be used preferably only when the older types of acaricides have become ineffective (Latif and Walker, 2004).

For the above-mentioned reasons major alternatives to conventional acaricide treatments have been developed in recent years that can be used in programs for integrated management of hard ticks to minimize the environmental impacts, acaricide resistance and to reduce production costs (Samish et al., 2000). The following promising alternative methods are being investigated.

6.1.2. Pheromone-Assisted Control

Pheromone-assisted tick control is one of the novel strategies. Research with tick pheromones suggests that combinations of pheromones and acaricides can be significantly more effective for controlling ticks than the acaricide alone, because ticks are unlikely to develop resistance to their own pheromones. A pheromone-acaricide combination applied to a single spot on cattle can be effective in killing ticks. Another promising device is the "tick decoy" in which the sex pheromone 2,6-

dichlorophenol and an acaricide are impregnated into plastic beads on the surface of which "mounting" sex pheromone is smeared. Male ticks are attracted to decoys on the animal's hair coat and killed. This also disrupts mating activity, so that any surviving females cannot lay viable eggs. For the livestock-parasitizing bont ticks (*Amblyomma hebraeum, Am. variegatum*) a tail-tag decoy was developed that uses a mixture of tick-specific phenols to attract ticks to specific sites on cattle and kill them when they attach nearby. Field trials with tail-tag decoy have demonstrated promising efficacy for up to three months (Norval et al., 1996). A novel technology for killing *I. scapularis* ticks in their natural habitats was developed by impregnating the components of the tick arrestment pheromone (guanine, xanthine, and haematin) along with permethrin in an oily matrix for dispersal on vegetation. These paste-like droplets attracted and killed ticks before they can infest humans or animals (Sonenshine et al., 2003, 2006; Sonenshine, 2008).

6.1.3. Hormone-Assisted Control:

Hormones and insect growth regulators (IGRs) such as methoprene also have been used to disrupt tick development in laboratory experiments. Analogues or mimics of ecdysteroids and juvenile hormone are effective in killing ticks by delaying their development, disrupting oviposition, or killing the larvae when they hatch from eggs deposited by treated females. However, these compounds do not appear to be uniformly effective against all types of ticks.

6.1.4. Biological Control

Biological control of ticks seems an appropriate alternative that may reduce the frequency of chemical acaricide use and the need for treatment for tick-borne diseases. Biological control agents are in principle highly desirable but their narrow host-specificity, often relatively low efficacy, costs of manufacture, certain application problems and sometimes low stability present serious challenges. Numerous pathogens attack ticks, including bacteria, fungi, and nematodes (Samish et al., 2004). Several papers have reported about testing of entomopathogens for control of ticks in laboratories and using these novel biocontrol techniques on animals (Alonso-Díaz et al., 2007) or spaying vegetation (Kaaya, 2000). Among potential biocontrol agents, entomopathogenic fungi, nematodes and parasitic wasps are the most promising candidates (Samish and Rehacek, 1999).

Entomopathogenic fungi have been studied mainly in laboratory assays as control agents of ticks (Kaaya, 2000; Samish and Glazer, 2001; Samish et al., 2004; Polar et al., 2005). These fungi invade their host by direct penetration of the cuticle. After germination of the attached spore, appressoria are formed which then secrete histolytic enzymes and produce a penetration hypha. After successful penetration, yeast-like blastospores are formed and propagate. After the death of the host, the fungus grows out of the cadaver and sporulates (Kleespies, 1993). The comparative ease by which the spores of these fungi can be produced and artificially disseminated makes them promising potential agents for the control of ticks (Norval and Horak, 2004). Studies of fungal effects on ticks under field conditions are scarce (Benjamin et al., 2002; Alonso-Díaz et al., 2007). It was reported that temperature and host secretions (e.g. sweat) may affect the virulence of entomopathogenic fungi on animals treated with biopesticides to control ticks (Polar et al., 2005). Blanket spray of the vegetation may also affect nontarget organisms (Hajek and Geottel, 2000; Brownbridge and Glare, 2007) and are expensive requiring significant quantities of materials to treat large areas. Alternative, target methods of applying fungal pathogens to the environment to control ticks are needed. There are opportunities to use autodissemination device to deliver pathogens to ticks (Maniania et al., 2007). Such devices use visual cues, pheromones and kairomones to attract host pests to a pathogen source (Vega et al., 2000). Maranga et al. (2006) was able to attract and infect *Am. variegatum* under field conditions with a fungus-treated pheromone-baited trap. Ticks attracted to the trap were infected and killed by the fungus, with a subsequent reduction in the tick population.

A promising alternative is biological control through the use of entomopathogenic nematodes (EPNs) (Samish and Glazer, 2001). The third-stage infective larvae of EPNs of the families Heterorhabditidae and Steinernematidae are living freely in the soil. They enter their hosts through natural body openings like the genital pore and release symbiotic bacteria carried in their intestine (Kocan et al., 1998). The bacteria proliferate in the haemolymph and produce toxins and other metabolites. The tick dies from septicaemia and the bacteria produce suitable conditions for the development of the nematodes to complete their life cycle (Ehlers, 2001).

Arthropods can also be used for biological control of ticks: chalcid wasps of the genus Ixodiphagus are obligatory parasitoids of ixodid ticks and most species will oviposit and develop only in the nymphal stage of the tick. Several wasp larvae can successfully develop in a single engorged nymph, which is killed during this process. Two of the seven described species of these wasps occur in Africa, namely *I. hookeri* and *I. theilerae* (Mwangi et al.,1997; Hu et al., 1998; Norval and Horak, 2004).

Domestic chickens are opportunistic predators of ticks and can be used in rural areas. In particular, the indigenous breeds of Galliformes, if allowed to scavenge amongst cattle, can consume considerable numbers of ticks (Latif and Walker, 2004).

6.1.5. Genetic Resistance

In general, tick tolerance or tick resistance exhibited by certain livestock breeds might vary with the species of infesting tick; heterospecific resistance appears to be low or even absent among different genera of ticks, while a certain degree of cross-resistance is expressed to tick species belonging to the same genus (de Castro and Newson, 1993). Genetic resistance has been described in West African N'Dama cattle. This breed has a higher degree of natural resistance against ticks with a long hypostome, such as some *Amblyomma* and *Hyalomma* species, than to tick genera with a short hypostome. In *Bos indicus* breeds, the evidence for a genetic resistance trait to multihost ticks, such as *Rh. appendiculatus*, is not as strong as for the one-host ticks, i.e., *Rhipicephalus microplus* (Mattioli et al., 2000).

6.1.6. Vaccine

In Australia, a commercial recombinant antigen vaccine has been developed for the control of the cattle tick *Rhipicephalus (Boophilus) microplus*, based on a so-called concealed antigen (Bm86) in cells of the tick gut. A similar recom¬binant vaccine has been developed in Cuba. Recent reports suggest that the recombinant Bm86 can reduce tick fecundity by as much as 90%. (Willadsen, 2006, 2008). Although it is possible that antigen-resistant strains of cattle ticks may appear, large-scale vaccination of cattle herds with these recombinant vaccines offers a promising alternative or supplement to acaricides. Although it uses an antigen from *Rh. (Bo.) microplus*, it is even more efficacious against *Rh. (Bo.) annulatus* than against the homologous species (Fragoso et al., 1998). Such effects appear not to correlate with the degree of sequence conservation of the antigen across tick species (Willadsen, 2006). Because vaccines are expensive and involve considerable risk, a high level of efficacy is required to offset these negatives. Research on other antigens and other tick species is in progress. Many more potential antigens have been proposed than have been tested. Tick antigen targets studied to date are from a restricted range of functional classes. They include structural proteins, particularly from salivary glands, hydrolytic enzymes and their inhibitors, particularly those involved in haemostatic processes and a range of membrane-associated proteins of unknown function (Willadsen, 2006, 2008). Of special interest is the development of novel combinations using RNAi to silence subolesin and a tick- protective antigen, Rs86 (similar to Bm86) against *Rh. sanguineus*; the synergistic effect of silencing both genes causes a much greater reduction of tick feeding and oviposition than targeting either one alone (de la Fuente and Kocan, 2006). Other promising vaccine targets tick-cement protein, disrupting attachment success, as well as midgut injury and the tick's ability to transmit pathogens (Labuda et al., 2006), the ability to disrupt the male engorgement factor or the administration of combined anti-tick and anti-pathogen vaccines (Sonenshine et al., 2006, Willadsen, 2008).

6.1.7. Vegetation Management

Tick control primarily involves treatment of animals. However, habitat modifications of the infested land can aid in reducing tick abundance in an area. Several acaricides, including organic phosphorus and synthethic pyrethroid can be applied directly to vegetation in gardens, parks, and picnic areas which are suitable harborage sites for ticks. Using acaricides off the host in tick-infested areas is of limited value because ticks commonly occur in microhabitats covered by vegetation, leaf litter, soil, and other natural materials, or in the nests, burrows, and other cavities used by their hosts; they often do not come in direct contact with these toxicants. Therefore, to be effective, the acaricides must reach the ticks as vapors or by contact when the ticks move about while seeking hosts. However, public opposition to treatment of natural habitats with pesticides has made it unpopular to use this form of tick control. In the European Union it is prohibited to use any acaricides in the environment.

Selective grazing and pasture rotations often reduce cattle exposure to tick populations. By keeping animals out of certain pastures (e.g. removal of deer by hunting and deer-exclusion fences), the number of fed ticks that would serve to build-up a population is reduced. An extreme case of pasture management is zero-grazing of dairy cattle, but there is a risk of unexpected reintroduction of ticks on cut fodder, on wild mammals or birds, or on newly introduced animals. This has often been referred to as pasture "spelling" (Ginsberg and Stafford, 2005).

Burning of pasture grasses may sometimes, but not always, kill many ticks. For controlling ticks off the pet in outdoor areas, efforts should first be made to keep overgrown and heavy vegetation cleared and cut in potential tick-infested areas. Prevention of unwanted wildlife, rodents, and stray dogs and cats from entering a property that could transport ticks is also important. Indoor tick control, as well as in and around kennels, with cleaning or changing pet bedding to prevent or remove ticks is directed primarily at the brown dog tick, *Rh. sanguineus*. Chemical treatments, when needed, can be applied in and around pet where ticks may be found when not feeding on a host animal.

6.1.8. Personal Protection

Ticks can be avoided by refraining from exposure to fields, forests and other hard tick-infested habitats, especially in known disease foci (Ginsberg and Stafford, 2005). Specific habitats to be avoided depend on tick distribution, which can differ for different species and for different stages of the same species. Maintaining a short-clipped lawn in the gardens and parks and establishing barriers to prevent access to the woods can minimize human exposure to ticks in this environment. Use of clearly defined paths can help avoid contact with tick-infested vegetation. Preventive measures are the most effective means for protecting from ticks. People should wear boots, socks, long trousers, and light-colored clothing. Trousers should be tucked into the boots, socks drawn over trousers, and the socks taped to form a tight seal. The clothing should be treated with a repellent or acaricide. Permethrin is effective when applied to clothing before entering tick-infested habitats. However, permethrin should not be applied to bare skin. It is now possible to obtain clothing permanently impregnated with permethrin that remains efficacious for the life of the garment, despite repeated washings (Vásquez et al., 2008). Exposed skin also should be treated with repellents or acaricides suitable for use on humans. The most widely used personal protectant is the repellent diethyl toluamide (DEET), available as a lotion or a spray. Applications should be repeated as needed to maintain maximum protection, but should be longer than a few hours, because of absorption or abrasion. Each person should conduct self-examinations for ticks during and after exposure to tick-infested areas. Early removal of attached ticks is important in minimizing the risk of contracting tick-borne diseases (Whitehouse, 2004).

6.1.9. Integrated Tick Management

There is no single, ideal solution to the control of ticks. Integrated control scenarios representing increased scientific and practical complexity can be developed and recommended. The integrated control approach is probably the most effective way to control ticks (Jongejan and Uilenberg, 1994;

Willadsen, 2006). Integrated Pest Management is an approach to the management of arthropod pests that fosters the integration of various pest control methods, so as to minimize reliance on individual environmentally damaging approaches and to provide sustained management of pest populations. Given the many tick control techniques currently available and the numerous novel techniques being developed, it is important to develop the theory and practice of efficient integration of methods, so that these techniques can be applied in such a manner as to most effectively prevent human and animal disease.

In conclusion, controlling hard ticks can be effective way to break the cycle of the tick-borne pathogens and subsequently to control the disease spread. There are numerous conventional and relatively new approaches to control ticks and their spread. Several factors should be considered in determining the most effective options for hard tick controls. These factors can be summarized as: ticks species involved, animal species, environmental and ecological conditions, animal managements, and feasibility of the measures. Integrations of these factors are required in order to be efficient in controlling ticks and their potential pathogens.

6.2. Control possibilities of soft ticks

Control of soft ticks is a difficult task due to long life, cycle, and maintaining off food for long period of time. These ticks can also alternate hosts and the possibility of hiding deeply in the fissures of the buildings where it is difficult to spray with chemicals to destroy them. Thus the eradication effort from the old buildings has generally been unsuccessful. Suggestions for control include inoculation of the host to be protected with avermectins or chlorpyrifos, use of fumigation with methylene bromide associated with a spray application of a product type carbaryl (Endris et al., 1992). As contrary to hard ticks, no vaccine against soft ticks exists yet, but studies have been undertaken to evaluate several salivary glands extracts and "concealed" gut antigenic extracts (Astigarraga et al., 1995; Arrastiaga et al., 1997; Manzano-Roman et al., 2006; Manzano-Roman et al., 2007).

From the observations made in the field, no effective method for the long-term control of ticks exists and the various alternatives need further investigation. At present the only practical measure is to avoid housing domestic animals in old, infested, buildings and prevent animals’ access to this type of building when located within the area of free ranging of a herd.

LIMITATONS

This report addresses the ticks' distribution and TBDs in Eurasia region that were retrieved from existing literature and technical reports. The report's findings, however, are limited due to the following issues:

- The presence of pathogens was based on antigen or genomic detection assays in ticks and receptive hosts without considering serological evidence in the host.
- Cases were only reported from the literature without considering other sources that may be available through other means of searching.
- Literature were retrieved mainly in English language, with limited other languages.
- Although the intention to be comprehensive in the literature strings, the search may have missed some publications.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

This report presents the actual existing data related to ticks presence and TBDs in the Eurasia. The report, however, may underestimate the presence of ticks and TBDs due to the limitations specified above.

Reports of the presence of ticks and TBDs can be obtained directly from literature without further predication by using weather and other environmental factors associated with the survivability of the ticks. This approach can be used as baseline for determining the existing risk areas to assess potential risk of these diseases.

Animal and human movement play a significant impact on the spread of the ticks and TBDs. Climate changes and flight pattern of migratory birds can also influence the presence and spread of the ticks and TBDs. These two factors acting by themselves have not been determined to be responsible for the widespread distribution of ticks.

Specific ecological and biological factors should be considered prior to implementation of control strategies for ticks and TBDs. Control measures should be assessed for their impact on the environment prior to the implementation.

RECOMMENDATIONS

- Studies are needed to evaluate the vector roles of the different tick species as well the various factors that might affect pathogen transmission. For example the role of ticks in the epidemiology of ASF in the Caucasus needs to be elucidated.
- It is important – in view of the changing incidence patterns and epidemiological differences among geographical regions - to have an effective surveillance of TBEV-infected I. ricinus and I. persulcatus ticks
- With a changing range of I. ricinus its role as an important vector of infections of humans and/or domesticated mammals, e.g. tick-borne encephalitis viruses (TBEV) including louping ill of sheep, Lyme borrelioses due to Borrelia burgdorferi s.l., anaplasmosis (Anaplasma phagocytophilum), babesiosis (Babesia divergens), ricketsiosis (Rickettsia helvetica), tularaemia (Francisella tularensis), needs to be monitored in the future.

- Risk factors associated with the exposure of Ornithodoros tick vectors in their specific biotopes should be investigated in reported human cases.

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GLOSSARY

Argasid ticks: soft ticks

Co-feeding. A phenomenum in which ticks become infected with a pathogen during feeding adjacent to infectious ticks on the same vertebrate host, even when the vertebrate host has not developed a systemic infection.

Competence: the ability of a vector to transmit a pathogen to a susceptible host, in a way that the host becomes infected.

Conscutum: The hard, sclerotized protective shield (plate) which covers most of the dorsal surface of Ixodidae males

Diapause: A neurohormonally mediated, dynamic state of low metabolic activity. Associated with this are reduced morphogenesis, increased resistance to environmental extremes, and altered or reduced behavioural activity. Diapause occurs during a genetically determined stage(s) of metamorphosis, and its full expression develops in a species-specific manner, usually in response to a number of environmental stimuli that precede unfavourable conditions. Once diapause has begun, metabolic activity is suppressed even if conditions favourable for development prevail.

Ditropic: When adult ticks feed on a different type of host, e.g. ruminants, compared to the host of immature ticks, e.g., rodents.

Enamel is often called ornamentation. It is most conspicuous on the conscutum, of males. The colour is mainly pink, orange or red; the enamel looks like paint on the surface of the integument.

Endophilic and Exophilic. When not feeding, endophilic (=nidiculous) ticks live in the nest, burrow or den of the host. Exophilic ticks live in the open environment away from the host's nest or burrow.

Hunting. Host-seeking ticks, e.g., adult Hyalomma ticks which actively and rapidly run towards and onto a host.

Ixodid ticks: hard ticks

Kairomone: A kairomone is a compound emanating from a potential host, e.g. carbon dioxide in ox breath that may induce appetitive behaviour in blood feeding arthropods (ticks, mosquitoes, etc.)

Monotropic: ticks, which as immatures feed on the same type of host, e.g., ruminants as the adult ticks.

Nidiculous. Endophilic and nidiculous mean the same.

Questing. Many exophilic ticks cling to plant stems or similar substrates and await passing animals with the tick's front legs, having chemosensillae, held out. Such questing ticks may be collected by flagging or dragging a cloth onto which questing ticks try to attach.

Reservoir: an animate or inanimate object on or in which an infectious agent usually lives, and which therefore is often a source of infection by the agent.

Scutum. The scutum is the hard plate on the anterior dorsal surface of the larva, nymph and adult female ixodid tick. Soft ticks (Argasidae) do not have a scutum

Semiochemical: Information-carrying compounds. Semiochemicals are defined by the type of behaviour they initiate, not the specific compound(s) affecting that behaviour. In ticks as in most animals, chemical stimuli guide behaviour. These chemical compounds are secreted external to the animal body, and when recognized by, for instance by a tick, direct a specific behavioural response such as host location or mate location.

Sympatric speciation: new species arise without geographic isolation

Telotropic. When the immature stages of a tick are able to feed on both different types of hosts and the same types of host as the adult ticks. For instance, both rodents and ruminants can support feeding immature stages of a certain telotropic tick.

Transovarial transmission. The transmission of microorganisms including viruses from mother to offspring, via the ovaries

Transstadial transmission. The passage of microorganisms and viruses in arthropods from one stage (stadium or instar) to the next.

ABBREVIATIONS

A.: Anaplasma

Am.: Amblyomma

Ar.: Argas

ASF: African swine fever

B.: Borrelia, or *Babesia*

Bo.: Boophilus

CAHP: Community Animal Health Policy

CCHF(V): Crimean-Congo haemorrhagic fever (virus)

D.: Dermacentor

DEET: dietil toluamide

E.: Ehrlichia

EPNs: Entomopathogenic nematodes

H.: Hepatozoon

Ha.: Haemaphysalis

Hy.: Hyalomma

I.: Ixodes

ICTTD: Integrated Consortium on Ticks and Tick-borne Diseases (European project)

MSF: Mediterranean spotted fever

NUTS: Statistical territorial units

O.: Ornithodoros

R.: Rickettsia

RF: Russian Federation

Rh.: Rhipicephalus

T.: Theileria

TBD: Tick-borne disease

TCC: Trans Caucasic Countries

APPENDICES

Appendix A: Table of geographic data of tick-borne encephalitis group

Table 8: Tick-borne encephalitis group, geographic distribution data.
See appendix R for the related complete reference.

Country	Admin 1	Admin 2	Reference ID	Number of entries*
Åland			1329	
Czech Republic	Jihocesk		1045	
Czech Republic	Jihocesk		226	8
Czech Republic	Jihocesk		525	
Czech Republic	Jihomoravsky		1338	
Czech Republic	Jihomoravsky		227	
Czech Republic	Jihomoravsky		525	
Czech Republic	Kraj Vysocina		227	4
Czech Republic	Královéhradeck		225	
Czech Republic	Královéhradeck		230	
Czech Republic	Plzensk		230	
Denmark	Århus		888	
Denmark	Bornholm		1290	
Denmark	Bornholm		345	2
Denmark	Bornholm	Hasle	1325	
Denmark	Fyn	Otterup	582	
Denmark	Ringkøbing	Ringkøbing	582	
Denmark	South Jutland		888	
Denmark	Storstrøm		888	
Denmark	Storstrøm	Fakse	582	
Denmark	Vejle		888	
Denmark	Vejle	Vejle	582	
Estonia	Harju		1317	
Estonia	Harju		377	2
Estonia	Hiiu		1317	
Estonia	Ida-Viru		1317	
Estonia	Ida-Viru		376	
Estonia	Ida-Viru		377	
Estonia	Järva		1317	
Estonia	Jõgeva		1317	
Estonia	Lääne		1317	
Estonia	Lääne		377	2
Estonia	Lääne-Viru		1317	
Estonia	Pärnu		1317	
Estonia	Põlva		1317	
Estonia	Rapla		1317	
Estonia	Saare		1317	
Estonia	Tartu		1317	
Estonia	Tartu		1348	2
Estonia	Tartu		376	
Estonia	Valga		1317	
Estonia	Valga		376	

Country	Admin 1	Admin 2	Reference ID	Number of entries*
Estonia	Valga		377	
Estonia	Viljandi		1317	
Estonia	Võru		1317	
Finland			409	
Finland	Lapland	Lapland	1341	2
Finland	Southern Finland		409	
Finland	Southern Finland	Uusimaa	1329	
Finland	Western Finland		34	
Finland	Western Finland	Central Ostrobothnia	465	
France	Alsace		1285	
France	Bourgogne		1285	
France	Champagne-Ardenne		1285	
France	Franche-Comté		1285	
France	Lorraine		1285	
Germany	Baden-Württemberg		1058	
Germany	Baden-Württemberg		1327	
Germany	Baden-Württemberg		969	
Germany	Baden-Württemberg	Freiburg	968	
Germany	Bayern		1058	
Germany	Bayern		1327	
Germany	Bayern		969	
Germany	Bayern	Mittelfranken	1287	
Germany	Bayern	Niederbayern	1287	
Germany	Bayern	Niederbayern	968	
Germany	Bayern	Oberbayern	1287	
Germany	Bayern	Oberpfalz	1287	
Germany	Bayern	Unterfranken	439	
Germany	Brandenburg		1058	
Germany	Brandenburg	Brandenburg	424	
Germany	Hessen		1058	
Germany	Hessen		1327	
Germany	Hessen		968	
Germany	Hessen		969	
Germany	Mecklenburg-Vorpommern		1121	
Germany	Mecklenburg-Vorpommern		523	
Germany	Nordrhein-Westfalen		1064	
Germany	Rheinland-Pfalz		1058	
Germany	Rheinland-Pfalz		1327	
Germany	Rheinland-Pfalz		968	
Germany	Rheinland-Pfalz		969	
Germany	Rheinland-Pfalz	Rheinhessen-Pfalz	1060	
Germany	Sachsen		969	
Germany	Sachsen-Anhalt		1121	
Germany	Sachsen-Anhalt		523	
Germany	Thüringen		1121	
Germany	Thüringen		969	
Greece	Anatoliki Makedonia kai Thraki		736	

Country	Admin 1	Admin 2	Reference ID	Number of entries*
Greece	Dytiki Makedonia		736	
Greece	Kentriki Makedonia		736	
Hungary	Borsod-Abaúj-Zemplén		1286	
Hungary	Fejér		784	
Hungary	Gyor-Moson-Sopron		784	
Hungary	Heves		1286	7
Hungary	Heves		784	
Hungary	Komárom-Esztergom		784	
Hungary	Nógrád		1286	8
Hungary	Nógrád		784	
Hungary	Somogy		784	
Hungary	Tolna		784	
Hungary	Vas		784	
Hungary	Veszprém		784	
Hungary	Zala		784	
Italy	Friuli-Venezia Giulia		336	
Italy	Piemonte	Torino	780	
Italy	Trentino-Alto Adige	Trento	1304	
Italy	Trentino-Alto Adige	Trento	160	
Italy	Trentino-Alto Adige	Trento	804	3
Italy	Trentino-Alto Adige	Trento	806	3
Italy	Veneto	Belluno	1304	
Italy	Veneto	Belluno	201	4
Latvia	Kurzeme	Dobele	968	
Latvia	Kurzeme	Kuldiga	1317	
Latvia	Kurzeme	Kuldiga	968	
Latvia	Kurzeme	Liepaja	1301	
Latvia	Kurzeme	Liepaja	968	
Latvia	Kurzeme	Saldus	968	
Latvia	Kurzeme	Tukums	968	
Latvia	Kurzeme	Ventspils	968	
Latvia	Latgale	Balvi	1317	
Latvia	Latgale	Balvi	968	
Latvia	Latgale	Daugavpils	968	
Latvia	Latgale	Jekabpils	968	
Latvia	Latgale	Kraslava	968	
Latvia	Latgale	Ludza	968	
Latvia	Latgale	Madona	968	
Latvia	Latgale	Preili	968	
Latvia	Latgale	Rezekne	968	
Latvia	Riga	Limba i	1317	
Latvia	Riga	Riga	126	
Latvia	Riga	Riga	1301	
Latvia	Riga	Riga	968	2
Latvia	Vidzeme		1301	
Latvia	Vidzeme	Aizkraukle	968	
Latvia	Vidzeme	Aluksne	1317	
Latvia	Vidzeme	Aluksne	968	

Country	Admin 1	Admin 2	Reference ID	Number of entries*
Latvia	Vidzeme	Gulbene	968	
Latvia	Vidzeme	Limbazi	968	
Latvia	Vidzeme	Madona	968	
Latvia	Vidzeme	Valka	968	
Latvia	Vidzeme	Valmiera	968	
Latvia	Zemgale	Aizkraukle	1317	
Latvia	Zemgale	Bauska	968	
Latvia	Zemgale	Jelgava	968	
Latvia	Zemgale	Ogre	968	
Liechtenstein			541	
Lithuania			489	
Lithuania	Alytaus		489	
Lithuania	Alytaus	Alytaus	1317	
Lithuania	iauliai	Akmenes	1317	
Lithuania	Kauno		489	4
Lithuania	Kauno	Bir tono	1317	
Lithuania	Klaipedos	Klaipedos	1317	
Lithuania	Marijampoles	Marijampoles	1317	
Lithuania	Panevezio		413	
Lithuania	Panevezio	Bir u	1317	
Lithuania	Siauliai		413	2
Lithuania	Taurages		489	2
Lithuania	Taurages	Jurbarko	1317	
Lithuania	Tel iai	Ma eikiu	1317	
Lithuania	Telsiai		489	
Lithuania	Utenos	Anyk ciu	1317	
Lithuania	Vilniaus		489	2
Lithuania	Vilniaus	alcininku	1317	
Norway	Aust-Agder		887	
Norway	Aust-Agder	Arendal	209	
Norway	Aust-Agder	Arendal	210	
Norway	Sør-Trøndelag		1290	
Poland	Greater Poland		942	
Poland	Kuyavian-Pomeranian		942	
Poland	Lesser Poland		942	
Poland	Lódz		942	
Poland	Lower Silesian		942	
Poland	Lublin		193	
Poland	Lublin		942	
Poland	Lublin	Lublin	403	
Poland	Lublin	Radzyn	192	
Poland	Lubusz		942	
Poland	Masovian		942	
Poland	Opole		942	
Poland	Podlachian		532	
Poland	Podlachian		942	
Poland	Podlachian	Bialystok	1350	2
Poland	Pomeranian		942	

Country	Admin 1	Admin 2	Reference ID	Number of entries*
Poland	Silesian		942	
Poland	Subcarpathian		942	
Poland	Swietokrzyskie		942	
Poland	Warmian-Masurian		942	
Poland	West Pomeranian		942	
Russia			1293	
Sweden	Blekinge		1054	
Sweden	Blekinge		1289	
Sweden	Blekinge	Karlskrona	1289	
Sweden	Blekinge	Olofström	1289	
Sweden	Blekinge	Ronneby	1289	
Sweden	Skåne		483	
Sweden	Stockholm	Söderhamn	636	
Sweden	Stockholm	Söderhamn	636	
Sweden	Stockholm	Upplands-Bro	636	
Switzerland	Aargau		1328	
Switzerland	Bern		1328	
Switzerland	Bern		165	
Switzerland	Neuchâtel		1328	
Switzerland	Sant Gallen		1328	
Switzerland	Schaffhausen		1328	
Switzerland	Thurgau		1328	
Switzerland	Thurgau		541	
Switzerland	Thurgau		855	
Switzerland	Zürich		556	
Turkey	Tokat		308	
Turkey	Yozgat		1351	

(*) If more than one.

Appendix B: Table of geographic data of *Anaplasma* spp. and *Ehrlichia* spp.

Table *9: Anaplasma* spp. and *Ehrlichia* spp., geographic distribution data.
See appendix R for the related complete reference.

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Anaplasma bovis	Italy	Basilicata	Potenza	156	
Anaplasma centrale	Egypt	Al Wadi al Jadid		1343	2
Anaplasma centrale	Italy	Basilicata	Matera	156	
Anaplasma centrale	Italy	Basilicata	Potenza	156	
Anaplasma centrale	Italy	Calabria	Crotone	156	
Anaplasma centrale	Italy	Calabria	Vibo Valentia	156	
Anaplasma centrale	Italy	Sicily	Palermo	366	2
Anaplasma marginale	Hungary	Borsod-Abaúj-Zemplén		443	2
Anaplasma marginale	Italy	Abruzzo	Bari	156	
Anaplasma marginale	Italy	Apulia		207	
Anaplasma marginale	Italy	Apulia	Foggia	156	
Anaplasma marginale	Italy	Basilicata		207	
Anaplasma marginale	Italy	Basilicata		996	
Anaplasma marginale	Italy	Basilicata	Matera	156	
Anaplasma marginale	Italy	Basilicata	Potenza	156	
Anaplasma marginale	Italy	Calabria		996	
Anaplasma marginale	Italy	Calabria	Crotone	156	
Anaplasma marginale	Italy	Calabria	Vibo Valentia	156	
Anaplasma marginale	Italy	Campania		207	
Anaplasma marginale	Italy	Campania		996	
Anaplasma marginale	Italy	Lazio		996	
Anaplasma marginale	Italy	Lombardia		996	
Anaplasma marginale	Italy	Marche		996	
Anaplasma marginale	Italy	Sicily		994	
Anaplasma marginale	Italy	Sicily		996	
Anaplasma marginale	Italy	Sicily	Agrigento	992	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Anaplasma marginale	Italy	Sicily	Caltanissetta	992	
Anaplasma marginale	Italy	Sicily	Catania	992	
Anaplasma marginale	Italy	Sicily	Enna	992	
Anaplasma marginale	Italy	Sicily	Messina	992	
Anaplasma marginale	Italy	Sicily	Palermo	242	
Anaplasma marginale	Italy	Sicily	Palermo	244	
Anaplasma marginale	Italy	Sicily	Palermo	366	2
Anaplasma marginale	Italy	Sicily	Palermo	992	
Anaplasma marginale	Italy	Sicily	Trapani	992	
Anaplasma marginale	Italy	Toscana		996	
Anaplasma marginale	Italy	Umbria		996	
Anaplasma marginale	Spain	Castilla-La Mancha	Ciudad Real	354	
Anaplasma marginale	Switzerland	Graubünden		1211	
Anaplasma marginale	Switzerland	Graubünden		270	
Anaplasma marginale	Switzerland	Graubünden		438	
Anaplasma ovis	Cyprus	Famagusta		775	2
Anaplasma ovis	Cyprus	Larnaca		775	2
Anaplasma ovis	Cyprus	Limassol		775	2
Anaplasma ovis	Cyprus	Nicosia		775	2
Anaplasma ovis	Cyprus	Paphos		775	2
Anaplasma ovis	Hungary	Borsod-Abaúj-Zemplén		443	2
Anaplasma ovis	Italy	Sicily		994	2
Anaplasma ovis	Italy	Sicily	Agrigento	992	2
Anaplasma ovis	Italy	Sicily	Caltanissetta	992	2
Anaplasma ovis	Italy	Sicily	Catania	992	2
Anaplasma ovis	Italy	Sicily	Enna	992	2
Anaplasma ovis	Italy	Sicily	Messina	992	2
Anaplasma ovis	Italy	Sicily	Palermo	242	
Anaplasma ovis	Italy	Sicily	Palermo	992	2
Anaplasma ovis	Italy	Sicily	Trapani	992	2

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Anaplasma ovis	Romania	Tulcea		59	
Anaplasma ovis	Spain	Andalucía	Cádiz	241	
Anaplasma ovis	Turkey	Elazig		24	
Anaplasma phagocytophilum	Albania	Tiranë		409	
Anaplasma phagocytophilum	Belarus	Minsk		1336	
Anaplasma phagocytophilum	Bulgaria	Sofia		448	
Anaplasma phagocytophilum	Bulgaria	Sofia	Stolichna	185	
Anaplasma phagocytophilum	Croatia	Koprivnicko-Krizevacka		656	
Anaplasma phagocytophilum	Cyprus	Famagusta		1139	
Anaplasma phagocytophilum	Czech Republic	Jihomoravsky		1338	3
Anaplasma phagocytophilum	Czech Republic	Moravskoslezsky		1338	
Anaplasma phagocytophilum	Czech Republic	Stredocesk		1091	
Anaplasma phagocytophilum	Czech Republic	Stredocesk		1092	3
Anaplasma phagocytophilum	Denmark	Copenhagen		888	
Anaplasma phagocytophilum	Denmark	Frederiksborg		888	
Anaplasma phagocytophilum	Denmark	Fyn		888	
Anaplasma phagocytophilum	Denmark	North Jutland		888	
Anaplasma phagocytophilum	Denmark	South Jutland		1120	
Anaplasma phagocytophilum	Denmark	South Jutland		888	
Anaplasma phagocytophilum	Egypt	Al Jizah		1343	
Anaplasma phagocytophilum	Estonia	Pärnu		1348	3
Anaplasma phagocytophilum	Estonia	Saare		1336	
Anaplasma phagocytophilum	France	Alsace	Bas-Rhin	484	
Anaplasma phagocytophilum	France	Alsace	Bas-Rhin	719	
Anaplasma phagocytophilum	France	Aquitaine	Dordogne	484	
Anaplasma phagocytophilum	France	Aquitaine	Gironde	484	
Anaplasma phagocytophilum	France	Aquitaine	Landes	484	
Anaplasma phagocytophilum	France	Aquitaine	Lot-Et-Garonne	484	
Anaplasma phagocytophilum	France	Aquitaine	Pyrénées-Atlantiques	484	2
Anaplasma phagocytophilum	France	Auvergne	Allier	484	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Anaplasma phagocytophilum	France	Auvergne	Cantal	484	
Anaplasma phagocytophilum	France	Auvergne	Haute-Loire	484	
Anaplasma phagocytophilum	France	Auvergne	Puy-De-Dôme	484	
Anaplasma phagocytophilum	France	Basse-Normandie	Calvados	484	
Anaplasma phagocytophilum	France	Basse-Normandie	Manche	484	
Anaplasma phagocytophilum	France	Basse-Normandie	Orne	484	
Anaplasma phagocytophilum	France	Bourgogne	Côte-d'Or	484	
Anaplasma phagocytophilum	France	Bourgogne	Nièvre	484	
Anaplasma phagocytophilum	France	Bourgogne	Saône-et-Loire	484	
Anaplasma phagocytophilum	France	Bourgogne	Saône-et-Loire	719	
Anaplasma phagocytophilum	France	Bourgogne	Yonne	484	
Anaplasma phagocytophilum	France	Bretagne	Côtes-d'Armor	484	
Anaplasma phagocytophilum	France	Bretagne	Finistère	484	
Anaplasma phagocytophilum	France	Bretagne	Ille-Et-Vilaine	484	
Anaplasma phagocytophilum	France	Bretagne	Morbihan	484	
Anaplasma phagocytophilum	France	Centre	Cher	484	
Anaplasma phagocytophilum	France	Centre	Eure-Et-Loir	484	
Anaplasma phagocytophilum	France	Centre	Eure-Et-Loir	719	
Anaplasma phagocytophilum	France	Centre	Indre	484	
Anaplasma phagocytophilum	France	Centre	Indre-Et-Loire	484	
Anaplasma phagocytophilum	France	Centre	Indre-Et-Loire	719	
Anaplasma phagocytophilum	France	Centre	Loir-Et-Cher	484	
Anaplasma phagocytophilum	France	Centre	Loiret	484	
Anaplasma phagocytophilum	France	Champagne-Ardenne	Ardennes	484	
Anaplasma phagocytophilum	France	Champagne-Ardenne	Haute-Marne	484	
Anaplasma phagocytophilum	France	Champagne-Ardenne	Marne	484	
Anaplasma phagocytophilum	France	Corse	Corse-Du-Sud	484	
Anaplasma phagocytophilum	France	Franche-Comté	Doubs	484	
Anaplasma phagocytophilum	France	Franche-Comté	Haute-Saône	484	
Anaplasma phagocytophilum	France	Franche-Comté	Haute-Saône	719	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Anaplasma phagocytophilum	France	Franche-Comté	Jura	484	
Anaplasma phagocytophilum	France	Franche-Comté	Territoire de Belfort	484	
Anaplasma phagocytophilum	France	Haute-Normandie	Eure	484	
Anaplasma phagocytophilum	France	Haute-Normandie	Seine-Maritime	484	
Anaplasma phagocytophilum	France	Île-de-France	Essonne	719	
Anaplasma phagocytophilum	France	Île-de-France	Seine-Et-Marne	484	
Anaplasma phagocytophilum	France	Île-de-France	Seine-Et-Marne	719	
Anaplasma phagocytophilum	France	Île-de-France	Yvelines	484	
Anaplasma phagocytophilum	France	Languedoc-Roussillon	Bouches-Du-Rhône	561	
Anaplasma phagocytophilum	France	Languedoc-Roussillon	Lozère	484	
Anaplasma phagocytophilum	France	Limousin	Corrèze	484	
Anaplasma phagocytophilum	France	Limousin	Corrèze	719	
Anaplasma phagocytophilum	France	Limousin	Creuse	484	
Anaplasma phagocytophilum	France	Limousin	Haute-Vienne	484	
Anaplasma phagocytophilum	France	Limousin	Haute-Vienne	719	
Anaplasma phagocytophilum	France	Lorraine	Meurthe-Et-Moselle	484	
Anaplasma phagocytophilum	France	Lorraine	Meurthe-Et-Moselle	719	
Anaplasma phagocytophilum	France	Lorraine	Meuse	484	
Anaplasma phagocytophilum	France	Lorraine	Meuse	484	
Anaplasma phagocytophilum	France	Lorraine	Moselle	484	
Anaplasma phagocytophilum	France	Lorraine	Moselle	719	
Anaplasma phagocytophilum	France	Lorraine	Vod	484	
Anaplasma phagocytophilum	France	Lorraine	Vosges	719	
Anaplasma phagocytophilum	France	Midi-Pyrénées	Aveyron	484	
Anaplasma phagocytophilum	France	Midi-Pyrénées	Haute-Garonne	484	
Anaplasma phagocytophilum	France	Midi-Pyrénées	Haute-Garonne	719	
Anaplasma phagocytophilum	France	Midi-Pyrénées	Hautes-Pyrénées	484	2
Anaplasma phagocytophilum	France	Midi-Pyrénées	Lot	484	
Anaplasma phagocytophilum	France	Midi-Pyrénées	Tarn	484	
Anaplasma phagocytophilum	France	Midi-Pyrénées	Tarn	719	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Anaplasma phagocytophilum	France	Midi-Pyrénées	Tarn-Et-Garonne	484	
Anaplasma phagocytophilum	France	Nord-Pas-de-Calais	Nord	484	
Anaplasma phagocytophilum	France	Nord-Pas-de-Calais	Pas-De-Calais	484	
Anaplasma phagocytophilum	France	Nord-Pas-de-Calais	Pas-De-Calais	719	
Anaplasma phagocytophilum	France	Pays de la Loire	Loire-Atlantique	484	
Anaplasma phagocytophilum	France	Pays de la Loire	Maine-Et-Loire	484	
Anaplasma phagocytophilum	France	Pays de la Loire	Maine-Et-Loire	719	
Anaplasma phagocytophilum	France	Pays de la Loire	Mayenne	484	
Anaplasma phagocytophilum	France	Pays de la Loire	Sarthe	484	
Anaplasma phagocytophilum	France	Pays de la Loire	Vendée	484	
Anaplasma phagocytophilum	France	Picardie	Aisne	719	
Anaplasma phagocytophilum	France	Picardie	Oise	484	
Anaplasma phagocytophilum	France	Picardie	Oise	719	
Anaplasma phagocytophilum	France	Picardie	Somme	484	
Anaplasma phagocytophilum	France	Poitou-Charentes	Charente	484	
Anaplasma phagocytophilum	France	Poitou-Charentes	Deux-Sèvres	484	
Anaplasma phagocytophilum	France	Poitou-Charentes	Vienne	484	
Anaplasma phagocytophilum	France	Provence-Alpes-Côte-d'Azur	Alpes-Maritimes	484	
Anaplasma phagocytophilum	France	Provence-Alpes-Côte-d'Azur	Bouches-Du-Rhône	484	
Anaplasma phagocytophilum	France	Provence-Alpes-Côte-d'Azur	Bouches-Du-Rhône	719	
Anaplasma phagocytophilum	France	Provence-Alpes-Côte-d'Azur	Var	484	
Anaplasma phagocytophilum	France	Provence-Alpes-Côte-d'Azur	Var	719	
Anaplasma phagocytophilum	France	Provence-Alpes-Côte-d'Azur	Vaucluse	484	
Anaplasma phagocytophilum	France	Rhône-Alpes	Ain	484	
Anaplasma phagocytophilum	France	Rhône-Alpes	Haute-Savoie	484	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Anaplasma phagocytophilum	France	Rhône-Alpes	Isère	484	
Anaplasma phagocytophilum	France	Rhône-Alpes	Loire	484	
Anaplasma phagocytophilum	France	Rhône-Alpes	Rhône	1032	
Anaplasma phagocytophilum	France	Rhône-Alpes	Rhône	484	
Anaplasma phagocytophilum	France	Rhône-Alpes	Savoie	484	
Anaplasma phagocytophilum	Germany	Baden-Württemberg		718	
Anaplasma phagocytophilum	Germany	Bayern		1352	
Anaplasma phagocytophilum	Germany	Berlin		540	
Anaplasma phagocytophilum	Germany	Berlin	Berlin	1294	
Anaplasma phagocytophilum	Germany	Brandenburg		540	
Anaplasma phagocytophilum	Germany	Thüringen		1352	
Anaplasma phagocytophilum	Greece	Kriti		1108	
Anaplasma phagocytophilum	Italy	Basilicata	Potenza	156	
Anaplasma phagocytophilum	Italy	Friuli-Venezia Giulia		191	8
Anaplasma phagocytophilum	Italy	Friuli-Venezia Giulia		639	
Anaplasma phagocytophilum	Italy	Friuli-Venezia Giulia		93	2
Anaplasma phagocytophilum	Italy	Lazio		832	
Anaplasma phagocytophilum	Italy	Lazio		833	
Anaplasma phagocytophilum	Italy	Sardegna		28	2
Anaplasma phagocytophilum	Italy	Sardegna		619	
Anaplasma phagocytophilum	Italy	Sicily		999	
Anaplasma phagocytophilum	Italy	Sicily	Agrigento	992	4
Anaplasma phagocytophilum	Italy	Sicily	Caltanissetta	992	4
Anaplasma phagocytophilum	Italy	Sicily	Catania	992	
Anaplasma phagocytophilum	Italy	Sicily	Enna	992	
Anaplasma phagocytophilum	Italy	Sicily	Messina	992	
Anaplasma phagocytophilum	Italy	Sicily	Palermo	242	4
Anaplasma phagocytophilum	Italy	Sicily	Palermo	243	
Anaplasma phagocytophilum	Italy	Sicily	Palermo	992	4
Anaplasma phagocytophilum	Italy	Sicily	Ragusa	992	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Anaplasma phagocytophilum	Italy	Sicily	Syracuse	992	
Anaplasma phagocytophilum	Italy	Sicily	Trapani	992	4
Anaplasma phagocytophilum	Italy	Trentino-Alto Adige	Trento	158	
Anaplasma phagocytophilum	Italy	Trentino-Alto Adige	Trento	806	4
Anaplasma phagocytophilum	Lithuania	Klaipedos		1336	
Anaplasma phagocytophilum	Moldova			1134	
Anaplasma phagocytophilum	Moldova	Chisinau		528	
Anaplasma phagocytophilum	Moldova	Chisinau		666	
Anaplasma phagocytophilum	Morocco	Taza - Al Hoceima - Taounate		643	
Anaplasma phagocytophilum	Norway	Aust-Agder		1323	2
Anaplasma phagocytophilum	Norway	Sør-Trøndelag	Hitra	1323	
Anaplasma phagocytophilum	Norway	Telemark	Kragerø	1323	
Anaplasma phagocytophilum	Poland	Greater Poland		1131	4
Anaplasma phagocytophilum	Poland	Lublin		1062	
Anaplasma phagocytophilum	Poland	Lublin		11	
Anaplasma phagocytophilum	Poland	Lublin		179	6
Anaplasma phagocytophilum	Poland	Lublin		990	
Anaplasma phagocytophilum	Poland	Lublin	Lublin	194	2
Anaplasma phagocytophilum	Poland	Masovian		1119	
Anaplasma phagocytophilum	Poland	Masovian	Warsaw	1098	
Anaplasma phagocytophilum	Poland	Podlachian		1129	
Anaplasma phagocytophilum	Poland	Podlachian	Augustów	0	2
Anaplasma phagocytophilum	Poland	Podlachian	Hajnówka	385	
Anaplasma phagocytophilum	Poland	Podlachian	Hajnówka	386	
Anaplasma phagocytophilum	Poland	Pomeranian		931	
Anaplasma phagocytophilum	Poland	Warmian-Masurian	Bialystok	0	
Anaplasma phagocytophilum	Poland	West Pomeranian		822	
Anaplasma phagocytophilum	Portugal	Faro		836	
Anaplasma phagocytophilum	Portugal	Madeira		1143	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Anaplasma phagocytophilum	Portugal	Madeira		238	
Anaplasma phagocytophilum	Portugal	Madeira		838	
Anaplasma phagocytophilum	Russia	Vologda		35	
Anaplasma phagocytophilum	Serbia	Branicevski		652	
Anaplasma phagocytophilum	Serbia	Grad Beograd		652	
Anaplasma phagocytophilum	Serbia	Macvanski		652	
Anaplasma phagocytophilum	Serbia	Ni avski		652	
Anaplasma phagocytophilum	Serbia	Pomoravski		652	
Anaplasma phagocytophilum	Serbia	Ra ki		652	
Anaplasma phagocytophilum	Serbia	Sremski		652	
Anaplasma phagocytophilum	Serbia	Zajecarski		652	
Anaplasma phagocytophilum	Slovakia	Banskobystricky		529	6
Anaplasma phagocytophilum	Slovakia	Banskobystricky		941	12
Anaplasma phagocytophilum	Slovakia	Bratislavsky		1349	
Anaplasma phagocytophilum	Slovakia	Kosicky		256	
Anaplasma phagocytophilum	Slovakia	Kosicky		499	
Anaplasma phagocytophilum	Slovakia	Kosicky		936	2
Anaplasma phagocytophilum	Slovakia	Nitriansky		1349	
Anaplasma phagocytophilum	Slovakia	Presov		936	
Anaplasma phagocytophilum	Slovakia	Zilinsky		1347	
Anaplasma phagocytophilum	Slovenia			191	
Anaplasma phagocytophilum	Spain	Andalucía	Cádiz	241	
Anaplasma phagocytophilum	Spain	Castilla y León		327	2
Anaplasma phagocytophilum	Spain	Comunidad de Madrid	Madrid	18	2
Anaplasma phagocytophilum	Spain	Galicia		360	
Anaplasma phagocytophilum	Spain	Galicia	Ourense	52	3
Anaplasma phagocytophilum	Spain	Galicia	Ourense	53	
Anaplasma phagocytophilum	Spain	Galicia	Pontevedra	52	4
Anaplasma phagocytophilum	Spain	Galicia	Pontevedra	53	
Anaplasma phagocytophilum	Spain	La Rioja	La Rioja	701	2

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Anaplasma phagocytophilum	Spain	La Rioja	La Rioja	773	
Anaplasma phagocytophilum	Spain	País Vasco		78	2
Anaplasma phagocytophilum	Spain	País Vasco		79	4
Anaplasma phagocytophilum	Switzerland	Bern		586	3
Anaplasma phagocytophilum	Switzerland	Graubünden		1211	
Anaplasma phagocytophilum	Switzerland	Graubünden		438	
Anaplasma phagocytophilum	Switzerland	Neuchâtel		586	3
Anaplasma phagocytophilum	Tunisia	Jendouba		643	
Anaplasma phagocytophilum	Turkey	Giresun		26	
Anaplasma phagocytophilum	Turkey	Rize		26	
Anaplasma phagocytophilum	Turkey	Trabzon		26	
Anaplasma phagocytophilum	Ukraine	Kharkiv		1134	
Anaplasma phagocytophilum	United Kingdom	England	Cheshire	134	
Anaplasma phagocytophilum	United Kingdom	England	Hampshire	808	
Anaplasma phagocytophilum	United Kingdom	England	Northumberland	131	
Anaplasma platys	Italy	Abruzzo		912	
Anaplasma platys	Italy	Sicily		994	
Anaplasma platys	Italy	Sicily		999	
Anaplasma platys	Italy	Sicily	Palermo	245	
Anaplasma platys	Tunisia	Jendouba		643	
Anaplasma platys	Turkey	Mugla		1012	
Anaplasma spp.	Albania	Durrës	Durrësit	185	
Anaplasma spp.	Albania	Kukës	Kukësit	185	2
Anaplasma spp.	Cyprus			1118	
Anaplasma spp.	Germany	Berlin	Berlin	1330	4
Anaplasma spp.	Germany	Berlin	Berlin	1346	
Anaplasma spp.	Slovakia	Bratislavsk		124	
Anaplasma spp.	Slovakia	Nitriansky		124	
Anaplasma spp.	Turkey	Antalya		185	2
Anaplasma spp.	Turkey	Kayseri		185	3

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Anaplasma spp.	Turkey	Malatya		185	

(*) If more than one.

Appendix C: Table of geographic data of *Rickettsia* spp.

Table 10: *Rickettsia* spp., geographic distribution data.
See appendix R for the related complete reference.

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Rickettsia aeschlimanni	Algeria			110	4
Rickettsia aeschlimanni	Croatia	Splitsko-Dalmatinska		781	
Rickettsia aeschlimanni	Egypt	Shamal Sina'		1343	
Rickettsia aeschlimanni	France	Corse	Corse-Du-Sud	624	
Rickettsia aeschlimanni	Russia	Stavropol'		1144	
Rickettsia aeschlimanni	Spain	Castilla y León		327	
Rickettsia aeschlimanni	Spain	Castilla y León		327	
Rickettsia aeschlimanni	Spain	Castilla y León		328	6
Rickettsia aeschlimanni	Spain	La Rioja	La Rioja	700	
Rickettsia aeschlimanni	Spain	La Rioja	La Rioja	704	
Rickettsia aeschlimanni	Spain	La Rioja	La Rioja	772	
Rickettsia conorii	Albania	Durrës	Durrësit	185	2
Rickettsia conorii	Albania	Kukës	Kukësit	185	3
Rickettsia conorii	Algeria			110	
Rickettsia conorii	Algeria	Oran		664	
Rickettsia conorii	France	Languedoc-Roussillon	Hérault	1292	
Rickettsia conorii	France	Provence-Alpes-Côte-d'Azur	Var	1299	
Rickettsia conorii	Greece	Anatoliki Makedonia kai Thraki		720	
Rickettsia conorii	Greece	Anatoliki Makedonia kai Thraki	Drama	222	
Rickettsia conorii	Greece	Anatoliki Makedonia kai Thraki	Kavala	222	
Rickettsia conorii	Greece	Dytiki Makedonia	Florina	222	
Rickettsia conorii	Greece	Dytiki Makedonia	Grevena	222	
Rickettsia conorii	Greece	Dytiki Makedonia	Kastoria	222	
Rickettsia conorii	Greece	Dytiki Makedonia	Kozani	222	
Rickettsia conorii	Greece	Kentriki Makedonia	Imathia	222	
Rickettsia conorii	Greece	Kentriki Makedonia	Khalkidiki	222	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Rickettsia conorii	Greece	Kentriki Makedonia	Kilkis	222	
Rickettsia conorii	Greece	Kentriki Makedonia	Pella	222	
Rickettsia conorii	Greece	Kentriki Makedonia	Pieria	222	
Rickettsia conorii	Greece	Kentriki Makedonia	Serrai	222	
Rickettsia conorii	Greece	Kentriki Makedonia	Thessaloniki	222	
Rickettsia conorii	Greece	Kriti		367	
Rickettsia conorii	Greece	Stereá Elláda	Fokis	778	
Rickettsia conorii	Greece	Thessalia	Trikala	222	
Rickettsia conorii	Israel			416	4
Rickettsia conorii	Italy	Piemonte	Cuneo	607	4
Rickettsia conorii	Italy	Piemonte	Cuneo	608	4
Rickettsia conorii	Italy	Sicily		999	2
Rickettsia conorii	Kosovo	Kosovska Mitrovica	Kosovska Mitrovica	346	2
Rickettsia conorii	Kosovo	Kosovska Mitrovica	Kosovska Mitrovica	827	
Rickettsia conorii	Kosovo	Pecki	Pec	827	
Rickettsia conorii	Morocco	Grand Casablanca		1104	
Rickettsia conorii	Serbia	Grad Beograd	Stari Grad	827	
Rickettsia conorii	Serbia	Pcinjski	Vranje	827	
Rickettsia conorii	Serbia	Raski	Tutin	827	
Rickettsia conorii	Serbia	Srednje-Banatski	Zrenjanin	827	
Rickettsia conorii	Serbia	Zlatiborski	Uzice	827	
Rickettsia conorii	Spain	Andalucía	Sevilla	95	
Rickettsia conorii	Spain	Castilla y León	Soria	681	
Rickettsia conorii	Spain	Cataluña	Barcelona	907	
Rickettsia conorii	Spain	Cataluña	Tarragona	907	
Rickettsia conorii	Spain	Galicia	Ourense	53	
Rickettsia conorii	Spain	Galicia	Pontevedra	53	
Rickettsia conorii	Spain	Islas Baleares		907	
Rickettsia conorii	Spain	La Rioja	La Rioja	1295	
Rickettsia conorii	Turkey	Antalya		185	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Rickettsia conorii	Turkey	Edirne		1122	
Rickettsia conorii	Turkey	Kayseri		185	3
Rickettsia conorii	Turkey	Kirklareli		1122	
Rickettsia conorii	Turkey	Malatya		185	
Rickettsia conorii	Turkey	Tekirdag		1122	
Rickettsia conorii israelensis	Italy	Sicily		369	
Rickettsia helvetica	Albania	Durrës	Durrësit	185	2
Rickettsia helvetica	Albania	Kukës	Kukësit	185	3
Rickettsia helvetica	Austria	Burgenland		265	
Rickettsia helvetica	Bulgaria	Sofia	Stolichna	185	
Rickettsia helvetica	Croatia	Medimurska		264	
Rickettsia helvetica	Denmark	North Jutland		0	
Rickettsia helvetica	Denmark	Vestsjælland		1146	
Rickettsia helvetica	Denmark	Vestsjælland	Korsør	973	
Rickettsia helvetica	France	Auvergne	Puy-De-Dôme	727	
Rickettsia helvetica	Germany	Bayern		1063	
Rickettsia helvetica	Germany	Berlin	Berlin	1294	
Rickettsia helvetica	Italy	Toscana		1281	
Rickettsia helvetica	Italy	Trentino-Alto Adige	Trento	1281	
Rickettsia helvetica	Italy	Veneto		1281	
Rickettsia helvetica	Moldova			1134	
Rickettsia helvetica	Netherlands	Flevoland		917	
Rickettsia helvetica	Netherlands	Friesland		917	
Rickettsia helvetica	Netherlands	Noord-Holland		917	
Rickettsia helvetica	Netherlands	Overijssel		917	
Rickettsia helvetica	Poland	Greater Poland		1145	3
Rickettsia helvetica	Poland	Greater Poland		932	7
Rickettsia helvetica	Poland	Lesser Poland		932	3
Rickettsia helvetica	Poland	Pomeranian		932	2
Rickettsia helvetica	Slovakia	Banskobystricky		941	12

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Rickettsia helvetica	Spain	Andalucía	Granada	1127	
Rickettsia helvetica	Spain	Andalucía	Huelva	1127	
Rickettsia helvetica	Spain	Andalucía	Jaén	611	
Rickettsia helvetica	Switzerland	Zürich		125	2
Rickettsia helvetica	Tunisia	Jendouba		0	
Rickettsia helvetica	Turkey	Antalya		185	2
Rickettsia helvetica	Turkey	Kayseri		185	2
Rickettsia helvetica	Turkey	Malatya		185	
Rickettsia helvetica	Ukraine	Kharkiv		1134	
Rickettsia massiliae	Algeria			110	3
Rickettsia massiliae	Greece	Stereá Elláda	Fokis	778	
Rickettsia massiliae	Morocco	Gharb - Chrarda - Béni Hssen		1104	
Rickettsia massiliae	Spain	Andalucía	Granada	1127	
Rickettsia massiliae	Spain	Andalucía	Jaén	611	3
Rickettsia massiliae	Spain	Andalucía	Sevilla	614	
Rickettsia massiliae	Spain	La Rioja	La Rioja	700	
Rickettsia massiliae	Spain	La Rioja	La Rioja	704	
Rickettsia massiliae	Switzerland	Ticino		96	
Rickettsia monacensis	Algeria	El Tarf		1111	
Rickettsia monacensis	Germany	Bayern		1112	
Rickettsia monacensis	Germany	Bayern		878	
Rickettsia monacensis	Moldova			1134	
Rickettsia monacensis	Morocco	Taza - Al Hoceima - Taounate		1104	
Rickettsia monacensis	Portugal	Madeira		238	
Rickettsia monacensis	Spain	Andalucía	Granada	1127	2
Rickettsia monacensis	Spain	Andalucía	Huelva	1127	2
Rickettsia monacensis	Spain	Andalucía	Jaén	611	2
Rickettsia monacensis	Spain	La Rioja		468	
Rickettsia monacensis	Spain	País Vasco		468	
Rickettsia monacensis	Tunisia	Jendouba		0	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Rickettsia monacensis	Ukraine	Kharkiv		1134	
Rickettsia mongolotimonae	France	Provence-Alpes-Côte-d'Azur	Bouches-Du-Rhône	348	
Rickettsia mongolotimonae	Greece	Kriti		776	2
Rickettsia raoultii	Germany	Baden-Württemberg	Freiburg	1137	
Rickettsia raoultii	Germany	Berlin	Berlin	1346	
Rickettsia raoultii	Italy	Toscana	Lucca	1332	
Rickettsia raoultii	Italy	Toscana	Lucca	862	
Rickettsia raoultii	Poland	Podlachian		1129	
Rickettsia raoultii	Spain	Andalucía	Granada	1127	
Rickettsia raoultii	Spain	Andalucía	Huelva	1127	2
Rickettsia raoultii	Spain	Andalucía	Jaén	611	2
Rickettsia rhipicephali	Greece	Stereá Elláda	Fokis	778	
Rickettsia slovaka	Croatia	Medimurska		264	
Rickettsia slovaka	Croatia	Splitsko-Dalmatinska		781	
Rickettsia slovaka	France	Bretagne		1130	
Rickettsia slovaka	Germany	Bayern		1137	
Rickettsia slovaka	Greece	Kentriki Makedonia	Khalkidiki	1303	
Rickettsia slovaka	Italy	Toscana	Lucca	1332	3
Rickettsia slovaka	Italy	Toscana	Lucca	862	
Rickettsia slovaka	Spain	Andalucía	Granada	1127	
Rickettsia slovaka	Spain	Andalucía	Jaén	611	
Rickettsia slovaka	Spain	Castilla y León		330	2
Rickettsia slovaka	Spain	Castilla y León	Burgos	587	
Rickettsia slovaka	Spain	Castilla y León	Palencia	587	
Rickettsia slovaka	Spain	La Rioja	La Rioja	1295	
Rickettsia slovaka	Spain	La Rioja	La Rioja	700	
Rickettsia slovaka	Spain	La Rioja	La Rioja	704	
Rickettsia slovaka	Switzerland	Ticino		96	
Rickettsia spp.	Albania	Tiranë		409	
Rickettsia spp.	Cyprus			1118	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Rickettsia spp.	Germany	Bayern		236	
Rickettsia spp.	Germany	Bayern		236	
Rickettsia spp.	Germany	Berlin	Berlin	1330	5
Rickettsia spp.	Germany	Berlin	Berlin	1346	
Rickettsia spp.	Germany	Brandenburg		236	2
Rickettsia spp.	Germany	Sachsen		236	2
Rickettsia spp.	Germany	Sachsen-Anhalt		236	
Rickettsia spp.	Italy	Friuli-Venezia Giulia		337	
Rickettsia spp.	Italy	Veneto	Belluno	752	
Rickettsia spp.	Poland	Podlachian		928	4
Rickettsia spp.	Poland	Warmian-Masurian		928	
Rickettsia spp.	Portugal	Madeira		238	
Rickettsia spp.	Russia	Vologda		35	
Rickettsia spp.	Slovakia	Banskobystricky		124	
Rickettsia spp.	Slovakia	Banskobystricky		529	15
Rickettsia spp.	Slovakia	Bratislavsk		124	
Rickettsia spp.	Slovakia	Nitriansky		124	3
Rickettsia spp.	Spain	Andalucía	Granada	1127	2
Rickettsia spp.	Spain	País Vasco		79	

(*) If more than one.

Appendix D: Table of geographic data of *Borrelia* spp.

Table 11: *Borrelia* spp. geographic distribution data.
See appendix R for the related complete reference

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia afzelii	Austria	Kärnten		114	
Borrelia afzelii	Austria	Niederösterreich		511	8
Borrelia afzelii	Austria	Oberösterreich		114	2
Borrelia afzelii	Austria	Steiermark		114	
Borrelia afzelii	Austria	Steiermark		963	
Borrelia afzelii	Austria	Tirol		114	2
Borrelia afzelii	Austria	Vorarlberg		114	2
Borrelia afzelii	Austria	Wien		511	4
Borrelia afzelii	Bulgaria	Sofia	Stolichna	185	
Borrelia afzelii	Croatia	Primorsko-Goranska		1011	
Borrelia afzelii	Czech Republic	Jihocesk		224	2
Borrelia afzelii	Czech Republic	Jihocesk		255	
Borrelia afzelii	Czech Republic	Jihomoravsky		550	6
Borrelia afzelii	Czech Republic	Jihomoravsky		742	
Borrelia afzelii	Czech Republic	Královéhradeck		225	
Borrelia afzelii	Czech Republic	Královéhradeck		230	
Borrelia afzelii	Czech Republic	Libereck		271	8
Borrelia afzelii	Czech Republic	Moravskoslezsk		220	
Borrelia afzelii	Czech Republic	Plzensk		230	
Borrelia afzelii	Czech Republic	Ústeck		550	5
Borrelia afzelii	Czech Republic	Zlínsk		550	3
Borrelia afzelii	Denmark	North Jutland		1026	
Borrelia afzelii	Finland	Western Finland		34	
Borrelia afzelii	France	Alsace	Haut-Rhin	331	
Borrelia afzelii	France	Île-de-France	Yvelines	753	
Borrelia afzelii	Germany	Baden-Württemberg	Tübingen	794	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia afzelii	Germany	Bayern		332	2
Borrelia afzelii	Germany	Bayern		333	5
Borrelia afzelii	Germany	Berlin	Berlin	1294	
Borrelia afzelii	Germany	Niedersachsen	Hannover	431	
Borrelia afzelii	Germany	Nordrhein-Westfalen		600	
Borrelia afzelii	Hungary	Pest		344	3
Borrelia afzelii	Ireland	Galway		380	2
Borrelia afzelii	Ireland	Kerry		754	
Borrelia afzelii	Italy	Friuli-Venezia Giulia		639	
Borrelia afzelii	Italy	Lazio		831	
Borrelia afzelii	Italy	Lazio		833	
Borrelia afzelii	Italy	Toscana		1331	
Borrelia afzelii	Italy	Toscana	Pisa	98	
Borrelia afzelii	Italy	Trentino-Alto Adige	Trento	609	3
Borrelia afzelii	Italy	Trentino-Alto Adige	Trento	741	
Borrelia afzelii	Latvia	Riga		319	3
Borrelia afzelii	Moldova	Chisinau		528	
Borrelia afzelii	Moldova	Chisinau		666	
Borrelia afzelii	Netherlands	Flevoland		1291	
Borrelia afzelii	Netherlands	Gelderland	Arnhem	365	
Borrelia afzelii	Netherlands	Noord-Holland		1050	
Borrelia afzelii	Netherlands	Overijssel		1050	
Borrelia afzelii	Norway	Aust-Agder		1323	2
Borrelia afzelii	Norway	Sør-Trøndelag	Hitra	1323	
Borrelia afzelii	Norway	Telemark		475	2
Borrelia afzelii	Norway	Telemark	Kragerø	1323	
Borrelia afzelii	Poland	Greater Poland		603	
Borrelia afzelii	Poland	Lublin	Lublin	194	
Borrelia afzelii	Poland	Lublin	Lublin City	1337	
Borrelia afzelii	Poland	Silesian	Tarnowskie	1288	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia afzelii	Poland	Warmian-Masurian		384	
Borrelia afzelii	Poland	Warmian-Masurian		738	2
Borrelia afzelii	Poland	Warmian-Masurian		739	2
Borrelia afzelii	Russia	Vologda		35	
Borrelia afzelii	Serbia	Branicevski		652	
Borrelia afzelii	Serbia	Grad Beograd		652	
Borrelia afzelii	Serbia	Macvanski		652	
Borrelia afzelii	Serbia	Ni avski		652	
Borrelia afzelii	Serbia	Pomoravski		652	
Borrelia afzelii	Serbia	Ra ki		652	
Borrelia afzelii	Serbia	Sremski		652	
Borrelia afzelii	Serbia	Zajecarski		652	
Borrelia afzelii	Slovakia			1320	
Borrelia afzelii	Slovakia	Bratislavsky		1349	
Borrelia afzelii	Slovakia	Kosicky		602	2
Borrelia afzelii	Slovakia	Nitriansky		1349	
Borrelia afzelii	Slovakia	Trenciansky		1349	
Borrelia afzelii	Slovakia	Trenciansky		603	
Borrelia afzelii	Slovakia	Zilinsky		1347	
Borrelia afzelii	Spain	La Rioja	La Rioja	315	
Borrelia afzelii	Spain	País Vasco		78	
Borrelia afzelii	Sweden	Gävleborg		350	
Borrelia afzelii	Sweden	Kalmar		350	
Borrelia afzelii	Sweden	Skåne		350	
Borrelia afzelii	Sweden	Skåne		696	
Borrelia afzelii	Sweden	Stockholm	Nynäshamn	470	
Borrelia afzelii	Sweden	Västerbotten	Umeå	470	
Borrelia afzelii	Switzerland	Graubünden		163	
Borrelia afzelii	Switzerland	Neuchâtel		143	
Borrelia afzelii	Switzerland	Neuchâtel		163	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia afzelii	Switzerland	Neuchâtel		368	
Borrelia afzelii	Switzerland	Ticino		1284	
Borrelia afzelii	Switzerland	Ticino		163	16
Borrelia afzelii	Switzerland	Valais		1284	
Borrelia afzelii	Switzerland	Valais		163	2
Borrelia afzelii	Turkey	Çankiri		396	
Borrelia afzelii	Turkey	Istanbul		395	
Borrelia afzelii	Turkey	Ordu		396	
Borrelia burgdorferi s.l.	Austria	Burgenland		114	2
Borrelia burgdorferi s.l.	Austria	Burgenland		258	
Borrelia burgdorferi s.l.	Austria	Burgenland	Eisenstadt	172	
Borrelia burgdorferi s.l.	Austria	Burgenland	Eisenstadt Umgebung	172	
Borrelia burgdorferi s.l.	Austria	Burgenland	Güssing	172	
Borrelia burgdorferi s.l.	Austria	Burgenland	Jennersdorf	172	
Borrelia burgdorferi s.l.	Austria	Burgenland	Mattersburg	172	
Borrelia burgdorferi s.l.	Austria	Burgenland	Neusiedl am See	172	
Borrelia burgdorferi s.l.	Austria	Burgenland	Oberpullendorf	172	
Borrelia burgdorferi s.l.	Austria	Burgenland	Oberwart	172	
Borrelia burgdorferi s.l.	Austria	Kärnten		114	2
Borrelia burgdorferi s.l.	Austria	Niederösterreich		114	2
Borrelia burgdorferi s.l.	Austria	Oberösterreich		114	2
Borrelia burgdorferi s.l.	Austria	Salzburg		114	2
Borrelia burgdorferi s.l.	Austria	Steiermark		258	
Borrelia burgdorferi s.l.	Austria	Tirol		114	2
Borrelia burgdorferi s.l.	Austria	Vorarlberg		114	2
Borrelia burgdorferi s.l.	Austria	Wien		114	2
Borrelia burgdorferi s.l.	Belgium	Antwerp		580	
Borrelia burgdorferi s.l.	Belgium	Brussels		580	
Borrelia burgdorferi s.l.	Belgium	East Flanders		580	
Borrelia burgdorferi s.l.	Belgium	East Flanders		668	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia burgdorferi s.l.	Belgium	Flemish Brabant		580	
Borrelia burgdorferi s.l.	Belgium	Flemish Brabant		615	
Borrelia burgdorferi s.l.	Belgium	Hainaut		580	
Borrelia burgdorferi s.l.	Belgium	Liege		580	
Borrelia burgdorferi s.l.	Belgium	Limburg		580	
Borrelia burgdorferi s.l.	Belgium	Luxembourg		580	
Borrelia burgdorferi s.l.	Belgium	Namur		580	
Borrelia burgdorferi s.l.	Belgium	Namur	Namur	1298	4
Borrelia burgdorferi s.l.	Belgium	Walloon Brabant		1333	
Borrelia burgdorferi s.l.	Belgium	Walloon Brabant		580	
Borrelia burgdorferi s.l.	Belgium	West Flanders		580	
Borrelia burgdorferi s.l.	Belgium	West Flanders		668	
Borrelia burgdorferi s.l.	Bulgaria			184	
Borrelia burgdorferi s.l.	Bulgaria	Sofia		448	
Borrelia burgdorferi s.l.	Bulgaria	Sofia	Stolichna	1319	2
Borrelia burgdorferi s.l.	Bulgaria	Stara Zagora		1007	2
Borrelia burgdorferi s.l.	Croatia	Koprivnicko-Krizevacka		656	
Borrelia burgdorferi s.l.	Czech Republic	Jihocesk		491	
Borrelia burgdorferi s.l.	Czech Republic	Jihomoravsky		1077	
Borrelia burgdorferi s.l.	Czech Republic	Jihomoravsky		1338	4
Borrelia burgdorferi s.l.	Czech Republic	Jihomoravsky		490	2
Borrelia burgdorferi s.l.	Czech Republic	Jihomoravsky		491	
Borrelia burgdorferi s.l.	Czech Republic	Jihomoravsky		669	
Borrelia burgdorferi s.l.	Czech Republic	Jihomoravsky	Brno	472	
Borrelia burgdorferi s.l.	Czech Republic	Kraj Vysocina		491	
Borrelia burgdorferi s.l.	Czech Republic	Královéhradeck		491	
Borrelia burgdorferi s.l.	Czech Republic	Libereck		491	
Borrelia burgdorferi s.l.	Czech Republic	Libereck	Liberec	472	
Borrelia burgdorferi s.l.	Czech Republic	Moravskoslezsk		1035	3
Borrelia burgdorferi s.l.	Czech Republic	Moravskoslezsk		491	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia burgdorferi s.l.	Czech Republic	Moravskoslezsky		1338	
Borrelia burgdorferi s.l.	Czech Republic	Olomouck		491	
Borrelia burgdorferi s.l.	Czech Republic	Pardubick		491	
Borrelia burgdorferi s.l.	Czech Republic	Pardubick	Ústí nad Orlicí	472	
Borrelia burgdorferi s.l.	Czech Republic	Plzensk		491	
Borrelia burgdorferi s.l.	Czech Republic	Prague		669	
Borrelia burgdorferi s.l.	Czech Republic	Ústeck		550	4
Borrelia burgdorferi s.l.	Czech Republic	Zlínsk		491	
Borrelia burgdorferi s.l.	Czech Republic	Zlínsk		550	4
Borrelia burgdorferi s.l.	Denmark	Copenhagen		888	
Borrelia burgdorferi s.l.	Denmark	Frederiksborg		888	
Borrelia burgdorferi s.l.	Denmark	Fyn		888	
Borrelia burgdorferi s.l.	Denmark	North Jutland		888	
Borrelia burgdorferi s.l.	Denmark	North Jutland		946	
Borrelia burgdorferi s.l.	Denmark	South Jutland		888	
Borrelia burgdorferi s.l.	Finland	Western Finland		34	2
Borrelia burgdorferi s.l.	France	Alsace		1285	
Borrelia burgdorferi s.l.	France	Alsace		572	
Borrelia burgdorferi s.l.	France	Alsace		851	
Borrelia burgdorferi s.l.	France	Alsace	Bas-Rhin	719	
Borrelia burgdorferi s.l.	France	Aquitaine		572	
Borrelia burgdorferi s.l.	France	Basse-Normandie		572	
Borrelia burgdorferi s.l.	France	Bourgogne		1285	
Borrelia burgdorferi s.l.	France	Bourgogne		572	
Borrelia burgdorferi s.l.	France	Bretagne		572	
Borrelia burgdorferi s.l.	France	Bretagne	Morbihan	626	
Borrelia burgdorferi s.l.	France	Centre		572	
Borrelia burgdorferi s.l.	France	Centre	Eure-Et-Loir	719	
Borrelia burgdorferi s.l.	France	Centre	Indre-Et-Loire	626	
Borrelia burgdorferi s.l.	France	Centre	Indre-Et-Loire	719	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia burgdorferi s.l.	France	Centre	Loiret	626	
Borrelia burgdorferi s.l.	France	Champagne-Ardenne		1285	
Borrelia burgdorferi s.l.	France	Champagne-Ardenne		572	
Borrelia burgdorferi s.l.	France	Champagne-Ardenne	Ardennes	626	
Borrelia burgdorferi s.l.	France	Franche-Comté		1285	
Borrelia burgdorferi s.l.	France	Franche-Comté		572	
Borrelia burgdorferi s.l.	France	Haute-Normandie		572	
Borrelia burgdorferi s.l.	France	Haute-Normandie	Eure	719	
Borrelia burgdorferi s.l.	France	Île-de-France		262	
Borrelia burgdorferi s.l.	France	Île-de-France		572	
Borrelia burgdorferi s.l.	France	Île-de-France	Seine-Et-Marne	626	
Borrelia burgdorferi s.l.	France	Limousin		572	
Borrelia burgdorferi s.l.	France	Limousin		851	
Borrelia burgdorferi s.l.	France	Lorraine		1285	
Borrelia burgdorferi s.l.	France	Lorraine		572	
Borrelia burgdorferi s.l.	France	Lorraine	Meurthe-Et-Moselle	719	
Borrelia burgdorferi s.l.	France	Lorraine	Meuse	626	
Borrelia burgdorferi s.l.	France	Lorraine	Moselle	626	3
Borrelia burgdorferi s.l.	France	Midi-Pyrénées		572	
Borrelia burgdorferi s.l.	France	Nord-Pas-de-Calais	Nord	408	
Borrelia burgdorferi s.l.	France	Pays de la Loire		572	
Borrelia burgdorferi s.l.	France	Pays de la Loire	Maine-Et-Loire	626	
Borrelia burgdorferi s.l.	France	Picardie		572	
Borrelia burgdorferi s.l.	France	Provence-Alpes-Côte-d'Azur	Alpes-Maritimes	719	
Borrelia burgdorferi s.l.	France	Provence-Alpes-Côte-d'Azur	Bouches-Du-Rhône	626	2
Borrelia burgdorferi s.l.	France	Rhône-Alpes		572	
Borrelia burgdorferi s.l.	France	Rhône-Alpes		851	
Borrelia burgdorferi s.l.	France	Rhône-Alpes	Ain	782	
Borrelia burgdorferi s.l.	France	Rhône-Alpes	Haute-Savoie	719	
Borrelia burgdorferi s.l.	France	Rhône-Alpes	Loir-Et-Cher	782	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia burgdorferi s.l.	France	Rhône-Alpes	Rhône	782	
Borrelia burgdorferi s.l.	Germany	Baden-Württemberg	Freiburg	691	
Borrelia burgdorferi s.l.	Germany	Baden-Württemberg	Stuttgart	691	
Borrelia burgdorferi s.l.	Germany	Bayern		564	
Borrelia burgdorferi s.l.	Germany	Bayern	Unterfranken	439	
Borrelia burgdorferi s.l.	Germany	Berlin		540	
Borrelia burgdorferi s.l.	Germany	Berlin		633	
Borrelia burgdorferi s.l.	Germany	Berlin	Berlin	1330	5
Borrelia burgdorferi s.l.	Germany	Berlin	Berlin	1346	
Borrelia burgdorferi s.l.	Germany	Brandenburg		540	
Borrelia burgdorferi s.l.	Germany	Brandenburg		633	
Borrelia burgdorferi s.l.	Germany	Hessen		930	
Borrelia burgdorferi s.l.	Germany	Hessen	Darmstadt	496	
Borrelia burgdorferi s.l.	Germany	Mecklenburg-Vorpommern		633	
Borrelia burgdorferi s.l.	Germany	Sachsen-Anhalt		633	
Borrelia burgdorferi s.l.	Germany	Thüringen		268	
Borrelia burgdorferi s.l.	Germany	Thüringen		633	
Borrelia burgdorferi s.l.	Greece	Attiki	Attica	476	
Borrelia burgdorferi s.l.	Italy	Calabria		381	
Borrelia burgdorferi s.l.	Italy	Friuli-Venezia Giulia		191	10
Borrelia burgdorferi s.l.	Italy	Friuli-Venezia Giulia		49	
Borrelia burgdorferi s.l.	Italy	Friuli-Venezia Giulia		93	3
Borrelia burgdorferi s.l.	Italy	Lazio		832	
Borrelia burgdorferi s.l.	Italy	Marche		325	
Borrelia burgdorferi s.l.	Italy	Molise		325	
Borrelia burgdorferi s.l.	Italy	Toscana	Arezzo	1283	
Borrelia burgdorferi s.l.	Italy	Toscana	Florence	1283	
Borrelia burgdorferi s.l.	Italy	Toscana	Siena	1283	
Borrelia burgdorferi s.l.	Italy	Trentino-Alto Adige	Trento	806	4
Borrelia burgdorferi s.l.	Italy	Veneto	Belluno	201	3

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia burgdorferi s.l.	Italy	Veneto	Belluno	752	
Borrelia burgdorferi s.l.	Lithuania		Birzu	1100	
Borrelia burgdorferi s.l.	Lithuania		Joniskio	1100	
Borrelia burgdorferi s.l.	Lithuania		Kupiskio	1100	
Borrelia burgdorferi s.l.	Lithuania		Pakruojo	1100	
Borrelia burgdorferi s.l.	Lithuania		Pasvalio	1100	
Borrelia burgdorferi s.l.	Lithuania		Rokiskio	1100	
Borrelia burgdorferi s.l.	Lithuania	Alytaus		1009	
Borrelia burgdorferi s.l.	Lithuania	Alytaus	Varenos	732	
Borrelia burgdorferi s.l.	Lithuania	iauliai	iauliu	732	
Borrelia burgdorferi s.l.	Lithuania	iauliai	Joniökio	732	
Borrelia burgdorferi s.l.	Lithuania	Kauno		1009	2
Borrelia burgdorferi s.l.	Lithuania	Klaipedos		1009	3
Borrelia burgdorferi s.l.	Lithuania	Klaipedos	ilutes	732	
Borrelia burgdorferi s.l.	Lithuania	Klaipedos	Klaipedos	1100	
Borrelia burgdorferi s.l.	Lithuania	Klaipedos	Klaipedos	732	
Borrelia burgdorferi s.l.	Lithuania	Klaipedos	Neringos	732	
Borrelia burgdorferi s.l.	Lithuania	Klaipedos	Skuodo	1100	
Borrelia burgdorferi s.l.	Lithuania	Marijampoles		1009	
Borrelia burgdorferi s.l.	Lithuania	Marijampoles	Marijampoles	732	
Borrelia burgdorferi s.l.	Lithuania	Panevezio		1009	
Borrelia burgdorferi s.l.	Lithuania	Panevezio	Paneveûio	732	
Borrelia burgdorferi s.l.	Lithuania	Panevezio	Rokiökio	732	
Borrelia burgdorferi s.l.	Lithuania	Siauliu		1009	4
Borrelia burgdorferi s.l.	Lithuania	Siauliu		1009	
Borrelia burgdorferi s.l.	Lithuania	Siauliu		1009	
Borrelia burgdorferi s.l.	Lithuania	Utenos		1009	2
Borrelia burgdorferi s.l.	Lithuania	Utenos	Utenos	732	
Borrelia burgdorferi s.l.	Lithuania	Utenos	Utenos	732	
Borrelia burgdorferi s.l.	Lithuania	Vilniaus		1009	2

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia burgdorferi s.l.	Lithuania	Vilniaus	Ukmerges	732	
Borrelia burgdorferi s.l.	Netherlands	Friesland	Ameland	467	
Borrelia burgdorferi s.l.	Netherlands	Noord-Holland		1050	
Borrelia burgdorferi s.l.	Norway	Aust-Agder	Birkenes	732	
Borrelia burgdorferi s.l.	Norway	Hordaland	Kvinnherad	732	
Borrelia burgdorferi s.l.	Norway	Rogaland		707	
Borrelia burgdorferi s.l.	Norway	Telemark	Kragerø	732	
Borrelia burgdorferi s.l.	Norway	Vest-Agder	Kristiansand	732	
Borrelia burgdorferi s.l.	Poland	Greater Poland		645	2
Borrelia burgdorferi s.l.	Poland	Greater Poland	Czarnków-Trzcianka	107	
Borrelia burgdorferi s.l.	Poland	Greater Poland	Jarocin	107	
Borrelia burgdorferi s.l.	Poland	Greater Poland	Krotoszyn	107	
Borrelia burgdorferi s.l.	Poland	Greater Poland	Leszno	107	
Borrelia burgdorferi s.l.	Poland	Greater Poland	Miedzychód	107	
Borrelia burgdorferi s.l.	Poland	Greater Poland	Poznan	107	
Borrelia burgdorferi s.l.	Poland	Greater Poland	Poznan	644	
Borrelia burgdorferi s.l.	Poland	Kuyavian-Pomeranian		1324	
Borrelia burgdorferi s.l.	Poland	Kuyavian-Pomeranian	Naklo	283	
Borrelia burgdorferi s.l.	Poland	Kuyavian-Pomeranian	Sepólno	283	
Borrelia burgdorferi s.l.	Poland	Kuyavian-Pomeranian	Wloclawek	284	
Borrelia burgdorferi s.l.	Poland	Lódz		1324	
Borrelia burgdorferi s.l.	Poland	Lódz	Lowicz	284	
Borrelia burgdorferi s.l.	Poland	Lower Silesian		267	
Borrelia burgdorferi s.l.	Poland	Lower Silesian		272	
Borrelia burgdorferi s.l.	Poland	Lower Silesian		513	6
Borrelia burgdorferi s.l.	Poland	Lublin		105	2
Borrelia burgdorferi s.l.	Poland	Lublin		1062	
Borrelia burgdorferi s.l.	Poland	Lublin		178	4
Borrelia burgdorferi s.l.	Poland	Lublin		193	
Borrelia burgdorferi s.l.	Poland	Lublin		925	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia burgdorferi s.l.	Poland	Lublin		990	
Borrelia burgdorferi s.l.	Poland	Lublin	Lubartów	192	
Borrelia burgdorferi s.l.	Poland	Lublin	Lublin	192	
Borrelia burgdorferi s.l.	Poland	Lublin	Lublin	194	
Borrelia burgdorferi s.l.	Poland	Lublin	Lublin	196	6
Borrelia burgdorferi s.l.	Poland	Lublin	Radzyn	192	
Borrelia burgdorferi s.l.	Poland	Lublin	Wlodawa	284	
Borrelia burgdorferi s.l.	Poland	Lubusz		1324	
Borrelia burgdorferi s.l.	Poland	Masovian		1324	
Borrelia burgdorferi s.l.	Poland	Masovian		531	7
Borrelia burgdorferi s.l.	Poland	Masovian	Kozienice	284	
Borrelia burgdorferi s.l.	Poland	Masovian	Kozienice	285	
Borrelia burgdorferi s.l.	Poland	Masovian	Przasnysz	284	
Borrelia burgdorferi s.l.	Poland	Masovian	Warsaw	1098	
Borrelia burgdorferi s.l.	Poland	Opole		1324	
Borrelia burgdorferi s.l.	Poland	Podlachian		1324	
Borrelia burgdorferi s.l.	Poland	Podlachian		715	
Borrelia burgdorferi s.l.	Poland	Podlachian	Hajnówka	334	
Borrelia burgdorferi s.l.	Poland	Pomeranian		1324	
Borrelia burgdorferi s.l.	Poland	Pomeranian		931	
Borrelia burgdorferi s.l.	Poland	Silesian		956	2
Borrelia burgdorferi s.l.	Poland	Swietokrzyskie		1324	
Borrelia burgdorferi s.l.	Poland	Warmian-Masurian		1324	
Borrelia burgdorferi s.l.	Poland	Warmian-Masurian		738	2
Borrelia burgdorferi s.l.	Poland	Warmian-Masurian		739	2
Borrelia burgdorferi s.l.	Poland	Warmian-Masurian	Lidzbark	283	
Borrelia burgdorferi s.l.	Poland	West Pomeranian		1324	
Borrelia burgdorferi s.l.	Poland	West Pomeranian		687	
Borrelia burgdorferi s.l.	Poland	West Pomeranian	Stargard	1296	
Borrelia burgdorferi s.l.	Poland	West Pomeranian	Szczecin	138	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia burgdorferi s.l.	Poland	West Pomeranian	Szczecin	891	5
Borrelia burgdorferi s.l.	Portugal	Lisboa	Mafra	76	
Borrelia burgdorferi s.l.	Russia	Leningrad		533	2
Borrelia burgdorferi s.l.	Russia	Moskva		522	
Borrelia burgdorferi s.l.	Russia	Novgorod		533	2
Borrelia burgdorferi s.l.	Russia	Vologda		35	
Borrelia burgdorferi s.l.	Serbia	Grad Beograd		654	3
Borrelia burgdorferi s.l.	Serbia	Grad Beograd		655	
Borrelia burgdorferi s.l.	Serbia	Toplicki		655	
Borrelia burgdorferi s.l.	Serbia	Zapadno-Backi		655	
Borrelia burgdorferi s.l.	Slovakia	Banskobystricky		529	4
Borrelia burgdorferi s.l.	Slovakia	Banskobystricky		87	
Borrelia burgdorferi s.l.	Slovakia	Banskobystricky		939	
Borrelia burgdorferi s.l.	Slovakia	Bratislavsk		87	
Borrelia burgdorferi s.l.	Slovakia	Bratislavsk		939	
Borrelia burgdorferi s.l.	Slovakia	Kosicky		256	
Borrelia burgdorferi s.l.	Slovakia	Kosicky		382	22
Borrelia burgdorferi s.l.	Slovakia	Kosicky		87	
Borrelia burgdorferi s.l.	Slovakia	Kosicky		934	18
Borrelia burgdorferi s.l.	Slovakia	Kosicky		936	3
Borrelia burgdorferi s.l.	Slovakia	Kosicky		940	4
Borrelia burgdorferi s.l.	Slovakia	Kosicky		945	
Borrelia burgdorferi s.l.	Slovakia	Nitriansky		87	
Borrelia burgdorferi s.l.	Slovakia	Pre ov		87	
Borrelia burgdorferi s.l.	Slovakia	Pre ov		939	
Borrelia burgdorferi s.l.	Slovakia	Presov		936	
Borrelia burgdorferi s.l.	Slovakia	Presov		940	6
Borrelia burgdorferi s.l.	Slovakia	Trenciansky		87	
Borrelia burgdorferi s.l.	Slovakia	Trenciansky		939	3
Borrelia burgdorferi s.l.	Slovakia	Trnavsk		87	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia burgdorferi s.l.	Slovakia	Zilinsky		1347	
Borrelia burgdorferi s.l.	Slovakia	Zilinsky		87	
Borrelia burgdorferi s.l.	Slovenia			191	3
Borrelia burgdorferi s.l.	Spain	Galicia	Ourense	53	
Borrelia burgdorferi s.l.	Spain	Galicia	Pontevedra	53	
Borrelia burgdorferi s.l.	Spain	La Rioja	La Rioja	705	
Borrelia burgdorferi s.l.	Spain	País Vasco		78	
Borrelia burgdorferi s.l.	Spain	País Vasco		79	2
Borrelia burgdorferi s.l.	Sweden	Dalarna		1312	
Borrelia burgdorferi s.l.	Sweden	Gävleborg		1312	
Borrelia burgdorferi s.l.	Sweden	Gotland		1312	
Borrelia burgdorferi s.l.	Sweden	Halland		1312	
Borrelia burgdorferi s.l.	Sweden	Halland	Varberg	470	
Borrelia burgdorferi s.l.	Sweden	Jämtland		1312	
Borrelia burgdorferi s.l.	Sweden	Jönköping		1312	
Borrelia burgdorferi s.l.	Sweden	Kalmar		1312	
Borrelia burgdorferi s.l.	Sweden	Kronoberg		1312	
Borrelia burgdorferi s.l.	Sweden	Orebro		1312	
Borrelia burgdorferi s.l.	Sweden	Östergötland		1312	
Borrelia burgdorferi s.l.	Sweden	Skåne		1312	
Borrelia burgdorferi s.l.	Sweden	Södermanland		1312	
Borrelia burgdorferi s.l.	Sweden	Stockholm		1312	
Borrelia burgdorferi s.l.	Sweden	Stockholm	Norrtälje	470	
Borrelia burgdorferi s.l.	Sweden	Uppsala		1312	
Borrelia burgdorferi s.l.	Sweden	Uppsala	Uppsala	470	
Borrelia burgdorferi s.l.	Sweden	Värmland		1312	
Borrelia burgdorferi s.l.	Sweden	Västerbotten		1318	
Borrelia burgdorferi s.l.	Sweden	Västerbotten	Umeå	1322	
Borrelia burgdorferi s.l.	Sweden	Västerbotten	Umeå	1322	
Borrelia burgdorferi s.l.	Sweden	Västernorrland		1312	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia burgdorferi s.l.	Sweden	Västmanland		1312	
Borrelia burgdorferi s.l.	Sweden	Västra Götaland		1312	
Borrelia burgdorferi s.l.	Switzerland	Genève		798	
Borrelia burgdorferi s.l.	Switzerland	Neuchâtel		1326	
Borrelia burgdorferi s.l.	Switzerland	Valais		1321	
Borrelia burgdorferi s.l.	Turkey	Bursa		101	
Borrelia burgdorferi s.l.	Turkey	Düzce		507	
Borrelia burgdorferi s.l.	Turkey	Isparta		252	
Borrelia burgdorferi s.l.	Turkey	Izmir		101	
Borrelia burgdorferi s.s.	Austria	Niederösterreich		114	
Borrelia burgdorferi s.s.	Austria	Niederösterreich		511	7
Borrelia burgdorferi s.s.	Austria	Oberösterreich		114	
Borrelia burgdorferi s.s.	Austria	Salzburg		114	
Borrelia burgdorferi s.s.	Austria	Tirol		114	
Borrelia burgdorferi s.s.	Austria	Wien		511	4
Borrelia burgdorferi s.s.	Bulgaria	Sofia	Stolichna	185	
Borrelia burgdorferi s.s.	Croatia	Primorsko-Goranska		1011	
Borrelia burgdorferi s.s.	Czech Republic	Jihocesk		224	2
Borrelia burgdorferi s.s.	Czech Republic	Jihocesk		255	
Borrelia burgdorferi s.s.	Czech Republic	Jihomoravsky		550	3
Borrelia burgdorferi s.s.	Czech Republic	Jihomoravsky		742	
Borrelia burgdorferi s.s.	Czech Republic	Královéhradeck		225	
Borrelia burgdorferi s.s.	Czech Republic	Královéhradeck		230	
Borrelia burgdorferi s.s.	Czech Republic	Libereck		271	4
Borrelia burgdorferi s.s.	Czech Republic	Moravskoslezsk		220	
Borrelia burgdorferi s.s.	Czech Republic	Plzensk		230	
Borrelia burgdorferi s.s.	Denmark	North Jutland		1026	
Borrelia burgdorferi s.s.	France	Alsace	Haut-Rhin	331	
Borrelia burgdorferi s.s.	France	Île-de-France	Yvelines	753	
Borrelia burgdorferi s.s.	Germany	Baden-Württemberg	Tübingen	794	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia burgdorferi s.s.	Germany	Bayern		332	2
Borrelia burgdorferi s.s.	Germany	Bayern		333	4
Borrelia burgdorferi s.s.	Germany	Berlin	Berlin	1294	
Borrelia burgdorferi s.s.	Germany	Niedersachsen	Hannover	431	
Borrelia burgdorferi s.s.	Germany	Nordrhein-Westfalen		600	
Borrelia burgdorferi s.s.	Hungary	Pest		344	3
Borrelia burgdorferi s.s.	Ireland	Kerry		754	
Borrelia burgdorferi s.s.	Italy	Friuli-Venezia Giulia		639	
Borrelia burgdorferi s.s.	Italy	Lazio		831	
Borrelia burgdorferi s.s.	Italy	Toscana		1331	
Borrelia burgdorferi s.s.	Italy	Toscana	Pisa	98	
Borrelia burgdorferi s.s.	Italy	Trentino-Alto Adige	Trento	741	
Borrelia burgdorferi s.s.	Latvia	Riga		319	
Borrelia burgdorferi s.s.	Latvia	Riga		319	
Borrelia burgdorferi s.s.	Moldova	Chisinau		528	
Borrelia burgdorferi s.s.	Moldova	Chisinau		666	
Borrelia burgdorferi s.s.	Morocco	Taza - Al Hoceima - Taounate		642	
Borrelia burgdorferi s.s.	Morocco	Taza - Al Hoceima - Taounate	Taza	841	
Borrelia burgdorferi s.s.	Norway	Telemark		475	
Borrelia burgdorferi s.s.	Poland	Greater Poland		603	
Borrelia burgdorferi s.s.	Poland	Greater Poland	Poznan	645	
Borrelia burgdorferi s.s.	Poland	Lublin	Lublin	194	
Borrelia burgdorferi s.s.	Poland	Lublin	Lublin City	1337	
Borrelia burgdorferi s.s.	Poland	Silesian	Tarnowskie	1288	
Borrelia burgdorferi s.s.	Poland	Warmian-Masurian		384	
Borrelia burgdorferi s.s.	Serbia	Branicevski		652	
Borrelia burgdorferi s.s.	Serbia	Grad Beograd		652	
Borrelia burgdorferi s.s.	Serbia	Macvanski		652	
Borrelia burgdorferi s.s.	Serbia	Ni avski		652	
Borrelia burgdorferi s.s.	Serbia	Pomoravski		652	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia burgdorferi s.s.	Serbia	Ra ki		652	
Borrelia burgdorferi s.s.	Serbia	Sremski		652	
Borrelia burgdorferi s.s.	Serbia	Zajecarski		652	
Borrelia burgdorferi s.s.	Slovakia	Kosicky		602	2
Borrelia burgdorferi s.s.	Spain	País Vasco		80	
Borrelia burgdorferi s.s.	Sweden	Blekinge		350	
Borrelia burgdorferi s.s.	Sweden	Gävleborg		350	
Borrelia burgdorferi s.s.	Sweden	Kalmar		350	
Borrelia burgdorferi s.s.	Sweden	Skåne		350	
Borrelia burgdorferi s.s.	Sweden	Stockholm	Stockholm	350	
Borrelia burgdorferi s.s.	Switzerland	Neuchâtel		143	
Borrelia burgdorferi s.s.	Switzerland	Neuchâtel		163	
Borrelia burgdorferi s.s.	Switzerland	Valais		163	2
Borrelia burgdorferi s.s.	Turkey	Istanbul		395	
Borrelia garinii	Austria	Burgenland		114	2
Borrelia garinii	Austria	Kärnten		114	2
Borrelia garinii	Austria	Niederösterreich		114	
Borrelia garinii	Austria	Niederösterreich		511	6
Borrelia garinii	Austria	Oberösterreich		114	2
Borrelia garinii	Austria	Salzburg		114	2
Borrelia garinii	Austria	Steiermark		963	
Borrelia garinii	Austria	Tirol		114	
Borrelia garinii	Austria	Vorarlberg		114	2
Borrelia garinii	Austria	Wien		114	2
Borrelia garinii	Austria	Wien		511	3
Borrelia garinii	Bulgaria	Sofia	Stolichna	185	
Borrelia garinii	Croatia	Primorsko-Goranska		1011	
Borrelia garinii	Czech Republic	Jihocesk		224	2
Borrelia garinii	Czech Republic	Jihocesk		255	
Borrelia garinii	Czech Republic	Jihomoravsky		742	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia garinii	Czech Republic	Královéhradeck		225	
Borrelia garinii	Czech Republic	Královéhradeck		230	
Borrelia garinii	Czech Republic	Libereck		271	9
Borrelia garinii	Czech Republic	Moravskoslezsk		220	
Borrelia garinii	Czech Republic	Ústeck		550	
Borrelia garinii	Denmark	North Jutland		1026	
Borrelia garinii	Finland	Western Finland		34	
Borrelia garinii	France	Alsace	Haut-Rhin	331	
Borrelia garinii	France	Île-de-France	Yvelines	753	
Borrelia garinii	Germany	Baden-Württemberg	Tübingen	794	
Borrelia garinii	Germany	Bayern		332	2
Borrelia garinii	Germany	Bayern		333	5
Borrelia garinii	Germany	Berlin	Berlin	1294	
Borrelia garinii	Germany	Niedersachsen	Hannover	431	
Borrelia garinii	Germany	Nordrhein-Westfalen		600	
Borrelia garinii	Hungary	Baranya		341	
Borrelia garinii	Hungary	Somogy		341	
Borrelia garinii	Hungary	Veszprém		341	
Borrelia garinii	Ireland	Galway		380	
Borrelia garinii	Ireland	Kerry		754	
Borrelia garinii	Italy	Friuli-Venezia Giulia		639	
Borrelia garinii	Italy	Lazio		831	
Borrelia garinii	Italy	Lazio		833	
Borrelia garinii	Italy	Toscana		1331	
Borrelia garinii	Italy	Toscana	Pisa	98	
Borrelia garinii	Italy	Trentino-Alto Adige	Trento	1344	
Borrelia garinii	Italy	Trentino-Alto Adige	Trento	609	
Borrelia garinii	Italy	Trentino-Alto Adige	Trento	741	
Borrelia garinii	Italy	Veneto	Belluno	1344	
Borrelia garinii	Latvia	Riga		319	3

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia garinii	Moldova	Chisinau		528	
Borrelia garinii	Moldova	Chisinau		666	
Borrelia garinii	Morocco	Taza - Al Hoceima - Taounate		642	
Borrelia garinii	Morocco	Taza - Al Hoceima - Taounate	Taza	841	
Borrelia garinii	Netherlands	Gelderland	Arnhem	365	
Borrelia garinii	Netherlands	Noord-Holland		1050	
Borrelia garinii	Netherlands	Overijssel		1050	
Borrelia garinii	Norway	Aust-Agder		1323	2
Borrelia garinii	Norway	Finnmark		558	
Borrelia garinii	Norway	Sør-Trøndelag	Hitra	1323	
Borrelia garinii	Norway	Telemark		475	
Borrelia garinii	Poland	Greater Poland		603	2
Borrelia garinii	Poland	Greater Poland	Poznan	645	
Borrelia garinii	Poland	Lublin	Lublin City	1337	
Borrelia garinii	Poland	Silesian	Tarnowskie	1288	
Borrelia garinii	Poland	Warmian-Masurian		384	
Borrelia garinii	Poland	Warmian-Masurian		738	2
Borrelia garinii	Poland	Warmian-Masurian		739	2
Borrelia garinii	Portugal	Aveiro		597	
Borrelia garinii	Portugal	Azores		597	
Borrelia garinii	Portugal	Beja		597	
Borrelia garinii	Portugal	Braga		597	
Borrelia garinii	Portugal	Castelo Branco		597	
Borrelia garinii	Portugal	Coimbra		597	
Borrelia garinii	Portugal	Évora		597	
Borrelia garinii	Portugal	Faro		597	
Borrelia garinii	Portugal	Guarda		597	
Borrelia garinii	Portugal	Leiria		597	
Borrelia garinii	Portugal	Lisboa		597	
Borrelia garinii	Portugal	Lisboa	Mafra	76	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia garinii	Portugal	Madeira		597	
Borrelia garinii	Portugal	Portalegre		597	
Borrelia garinii	Portugal	Porto		597	
Borrelia garinii	Portugal	Santarém		597	
Borrelia garinii	Portugal	Setúbal		597	
Borrelia garinii	Portugal	Viana do Castelo		597	
Borrelia garinii	Portugal	Viseu		597	
Borrelia garinii	Russia	Vologda		35	
Borrelia garinii	Serbia	Branicevski		652	
Borrelia garinii	Serbia	Grad Beograd		652	
Borrelia garinii	Serbia	Macvanski		652	
Borrelia garinii	Serbia	Ni avski		652	
Borrelia garinii	Serbia	Pomoravski		652	
Borrelia garinii	Serbia	Ra ki		652	
Borrelia garinii	Serbia	Sremski		652	
Borrelia garinii	Serbia	Zajecarski		652	
Borrelia garinii	Slovakia	Bratislavsky		1349	
Borrelia garinii	Slovakia	Kosicky		1349	
Borrelia garinii	Slovakia	Kosicky		602	2
Borrelia garinii	Slovakia	Nitriansky		1349	
Borrelia garinii	Slovakia	Trenciansky		1349	
Borrelia garinii	Slovakia	Zilinsky		1349	
Borrelia garinii	Spain	La Rioja	La Rioja	315	
Borrelia garinii	Spain	País Vasco		80	
Borrelia garinii	Sweden			695	
Borrelia garinii	Sweden	Gävleborg		350	
Borrelia garinii	Sweden	Gotland	Gotland	470	
Borrelia garinii	Sweden	Halland	Kungsbacka	470	
Borrelia garinii	Sweden	Jönköping		426	
Borrelia garinii	Sweden	Kalmar		350	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia garinii	Sweden	Skåne		350	
Borrelia garinii	Sweden	Skåne		696	
Borrelia garinii	Sweden	Skåne	Båstad	470	
Borrelia garinii	Sweden	Uppsala	Älvkarleby	470	
Borrelia garinii	Sweden	Uppsala	Tierp	470	
Borrelia garinii	Switzerland	Neuchâtel		143	
Borrelia garinii	Switzerland	Neuchâtel		163	
Borrelia garinii	Switzerland	Ticino		1284	2
Borrelia garinii	Switzerland	Ticino		163	
Borrelia garinii	Switzerland	Ticino		485	
Borrelia garinii	Switzerland	Valais		1284	2
Borrelia garinii	Switzerland	Valais		163	
Borrelia garinii	Turkey	Istanbul		395	
Borrelia lusitaniae	Bulgaria	Sofia	Stolichna	185	
Borrelia lusitaniae	Denmark	North Jutland		1026	
Borrelia lusitaniae	Hungary			1320	3
Borrelia lusitaniae	Hungary	Pest		344	3
Borrelia lusitaniae	Italy	Toscana	Pisa	98	
Borrelia lusitaniae	Italy	Trentino-Alto Adige	Trento	741	
Borrelia lusitaniae	Moldova	Chisinau		528	
Borrelia lusitaniae	Moldova	Chisinau		666	
Borrelia lusitaniae	Morocco	Taza - Al Hoceima - Taounate		425	
Borrelia lusitaniae	Morocco	Taza - Al Hoceima - Taounate		642	
Borrelia lusitaniae	Poland	Greater Poland		603	2
Borrelia lusitaniae	Poland	Lublin	Lublin City	1337	
Borrelia lusitaniae	Portugal	Lisboa	Mafra	76	
Borrelia lusitaniae	Portugal	Madeira		238	
Borrelia lusitaniae	Portugal	Setúbal	Grândola	76	
Borrelia lusitaniae	Romania			1320	
Borrelia lusitaniae	Romania	Tulcea		603	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia lusitaniae	Serbia	Branicevski		652	
Borrelia lusitaniae	Serbia	Macvanski		652	
Borrelia lusitaniae	Serbia	Ni avski		652	
Borrelia lusitaniae	Serbia	Pomoravski		652	
Borrelia lusitaniae	Serbia	Ra ki		652	
Borrelia lusitaniae	Serbia	Sremski		652	
Borrelia lusitaniae	Serbia	Zajecarski		652	
Borrelia lusitaniae	Serbia	Zajecarski		652	
Borrelia lusitaniae	Slovakia			1320	2
Borrelia lusitaniae	Slovakia	Banskobystricky		602	
Borrelia lusitaniae	Slovakia	Bratislavsky		1349	
Borrelia lusitaniae	Slovakia	Kosicky		1349	
Borrelia lusitaniae	Slovakia	Kosicky		602	2
Borrelia lusitaniae	Slovakia	Nitriansky		1349	
Borrelia lusitaniae	Slovakia	Trenciansky		1349	
Borrelia lusitaniae	Slovakia	Trenciansky		603	
Borrelia lusitaniae	Slovakia	Zilinsky		1347	
Borrelia lusitaniae	Slovakia	Zilinsky		1349	
Borrelia lusitaniae	Spain	País Vasco		80	
Borrelia lusitaniae	Switzerland	Ticino		1284	
Borrelia lusitaniae	Switzerland	Ticino		163	7
Borrelia lusitaniae	Switzerland	Valais		1284	
Borrelia lusitaniae	Tunisia	Jendouba		425	2
Borrelia lusitaniae	Turkey	Istanbul		395	
Borrelia miyamotoi	Sweden	Gävleborg		350	
Borrelia miyamotoi	Sweden	Kalmar		350	
Borrelia miyamotoi	Sweden	Skåne		350	
Borrelia spielmanii	Germany	Bayern		333	2
Borrelia spielmanii	Germany	Bayern		333	
Borrelia spielmanii	Germany	Niedersachsen	Hannover	431	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia valaisiana	Austria	Burgenland		114	
Borrelia valaisiana	Austria	Niederösterreich		114	2
Borrelia valaisiana	Austria	Oberösterreich		114	2
Borrelia valaisiana	Austria	Salzburg		114	
Borrelia valaisiana	Austria	Vorarlberg		114	2
Borrelia valaisiana	Austria	Wien		114	
Borrelia valaisiana	Bulgaria	Sofia	Stolichna	185	
Borrelia valaisiana	Czech Republic	Jihocesk		255	
Borrelia valaisiana	Czech Republic	Jihomoravsky		742	
Borrelia valaisiana	Czech Republic	Královéhradeck		225	
Borrelia valaisiana	Czech Republic	Královéhradeck		230	
Borrelia valaisiana	Czech Republic	Libereck		271	9
Borrelia valaisiana	Czech Republic	Moravskoslezsk		220	
Borrelia valaisiana	Czech Republic	Plzensk		230	
Borrelia valaisiana	France	Alsace	Haut-Rhin	331	
Borrelia valaisiana	Germany	Bayern		333	5
Borrelia valaisiana	Germany	Berlin	Berlin	1294	
Borrelia valaisiana	Germany	Niedersachsen	Hannover	431	
Borrelia valaisiana	Germany	Nordrhein-Westfalen		600	
Borrelia valaisiana	Ireland	Galway		380	
Borrelia valaisiana	Ireland	Kerry		754	
Borrelia valaisiana	Italy	Lazio		831	
Borrelia valaisiana	Italy	Lazio		833	
Borrelia valaisiana	Italy	Toscana		1331	
Borrelia valaisiana	Italy	Trentino-Alto Adige	Trento	609	3
Borrelia valaisiana	Italy	Trentino-Alto Adige	Trento	741	
Borrelia valaisiana	Italy	Veneto	Belluno	1344	
Borrelia valaisiana	Italy	Veneto	Belluno	324	
Borrelia valaisiana	Latvia	Riga		319	3
Borrelia valaisiana	Moldova	Chisinau		528	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Borrelia valaisiana	Moldova	Chisinau		666	
Borrelia valaisiana	Netherlands	Flevoland		1291	
Borrelia valaisiana	Netherlands	Gelderland	Arnhem	365	
Borrelia valaisiana	Netherlands	Noord-Holland		1050	
Borrelia valaisiana	Netherlands	Overijssel		1050	2
Borrelia valaisiana	Poland	Greater Poland		603	2
Borrelia valaisiana	Poland	Lublin	Lublin City	1337	
Borrelia valaisiana	Portugal	Lisboa	Mafra	76	
Borrelia valaisiana	Serbia	Branicevski		652	
Borrelia valaisiana	Serbia	Grad Beograd		652	
Borrelia valaisiana	Serbia	Macvanski		652	
Borrelia valaisiana	Serbia	Ni avski		652	
Borrelia valaisiana	Serbia	Pomoravski		652	
Borrelia valaisiana	Serbia	Ra ki		652	
Borrelia valaisiana	Serbia	Sremski		652	
Borrelia valaisiana	Serbia	Zajecarski		652	
Borrelia valaisiana	Slovakia	Kosicky		602	2
Borrelia valaisiana	Slovakia	Zilinsky		1347	
Borrelia valaisiana	Spain	La Rioja	La Rioja	315	
Borrelia valaisiana	Spain	País Vasco		80	
Borrelia valaisiana	Switzerland	Neuchâtel		143	
Borrelia valaisiana	Switzerland	Neuchâtel		163	
Borrelia valaisiana	Switzerland	Neuchâtel		368	
Borrelia valaisiana	Switzerland	Ticino		1284	
Borrelia valaisiana	Switzerland	Ticino		163	
Borrelia valaisiana	Switzerland	Ticino		485	
Borrelia valaisiana	Switzerland	Valais		1284	
Borrelia valaisiana	Switzerland	Valais		163	
Borrelia valaisiana	Turkey	Istanbul		395	

(*) If more than one.

Appendix E: Table of geographic data of *Babesia* spp.

Table 12: *Babesia* spp. geographic distribution data.
See appendix R for the related complete reference.

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Babesia bigemina	Egypt	Al Jizah		1101	2
Babesia bigemina	Italy	Apulia		207	
Babesia bigemina	Italy	Basilicata		207	
Babesia bigemina	Italy	Calabria		997	
Babesia bigemina	Italy	Calabria	Crotone	156	
Babesia bigemina	Italy	Campania		207	
Babesia bigemina	Italy	Emilia-Romagna	Bologna	755	
Babesia bigemina	Italy	Lazio		997	
Babesia bigemina	Italy	Lazio	Roma	755	
Babesia bigemina	Italy	Marche		997	
Babesia bigemina	Italy	Sicily		997	
Babesia bigemina	Italy	Sicily	Palermo	366	2
Babesia bigemina	Italy	Sicily	Ragusa	366	
Babesia bigemina	Italy	Umbria		997	
Babesia bigemina	Italy	Umbria	Perugia	755	
Babesia bigemina	Italy	Veneto		997	
Babesia bigemina	Italy	Veneto	Padua	755	
Babesia bigemina	Morocco	Doukkala - Abda		291	
Babesia bigemina	Morocco	Gharb - Chrarda - Béni Hssen		291	
Babesia bigemina	Morocco	Marrakech - Tensift - Al Haouz		291	
Babesia bigemina	Morocco	Tadla - Azilal		291	
Babesia bigemina	Spain	Islas Baleares		41	
Babesia bigemina	Spain	País Vasco		363	2
Babesia bigemina	Switzerland	Graubünden		434	
Babesia bigemina	Turkey	Antalya		508	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Babesia bigemina	Turkey	Kayseri		457	
Babesia bovis	Egypt	Al Jizah		1101	2
Babesia bovis	Italy	Calabria		997	3
Babesia bovis	Italy	Calabria	Crotone	156	2
Babesia bovis	Italy	Campania		997	3
Babesia bovis	Italy	Emilia-Romagna	Bologna	755	
Babesia bovis	Italy	Lazio		997	3
Babesia bovis	Italy	Lazio	Roma	755	
Babesia bovis	Italy	Marche		997	3
Babesia bovis	Italy	Sicily		997	3
Babesia bovis	Italy	Sicily	Palermo	366	3
Babesia bovis	Italy	Umbria		997	3
Babesia bovis	Italy	Umbria	Perugia	755	
Babesia bovis	Italy	Veneto		997	3
Babesia bovis	Italy	Veneto	Padua	755	
Babesia bovis	Spain	Islas Baleares		41	
Babesia bovis	Spain	País Vasco		363	
Babesia bovis	Spain	País Vasco		364	
Babesia bovis	Tunisia	Jendouba		641	3
Babesia bovis	Tunisia	Nabeul		641	
Babesia bovis	Tunisia	Nabeul		641	
Babesia bovis	Turkey	Kayseri		457	
Babesia bovis	Turkey	Tekirdag		43	4
Babesia caballi	Hungary	Hajdú-Bihar		441	
Babesia caballi	Italy	Calabria		997	2
Babesia caballi	Italy	Emilia-Romagna		997	2
Babesia caballi	Italy	Emilia-Romagna	Bologna	755	
Babesia caballi	Italy	Lazio		997	2
Babesia caballi	Italy	Lazio	Roma	755	
Babesia caballi	Italy	Marche		997	2

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Babesia caballi	Italy	Sardegna		997	2
Babesia caballi	Italy	Sicily		997	2
Babesia caballi	Italy	Toscana		606	
Babesia caballi	Italy	Umbria		997	2
Babesia caballi	Italy	Umbria	Perugia	755	
Babesia caballi	Italy	Veneto	Padua	755	
Babesia caballi	Spain	Galicia		146	
Babesia caballi	Spain	País Vasco		363	3
Babesia caballi	Turkey	Ankara		390	2
Babesia caballi	Turkey	Malatya		25	
Babesia canis	Albania	Tiranë		409	
Babesia canis	Egypt	Asyut		510	
Babesia canis	Germany	Baden-Württemberg		83	
Babesia canis	Germany	Baden-Württemberg	Freiburg	576	
Babesia canis	Germany	Bayern		576	
Babesia canis	Germany	Bayern		83	
Babesia canis	Germany	Berlin		83	
Babesia canis	Germany	Brandenburg		83	
Babesia canis	Germany	Bremen		83	
Babesia canis	Germany	Hamburg		83	
Babesia canis	Germany	Hessen		83	
Babesia canis	Germany	Mecklenburg-Vorpommern		83	
Babesia canis	Germany	Niedersachsen		83	
Babesia canis	Germany	Nordrhein-Westfalen		83	
Babesia canis	Germany	Rheinland-Pfalz		83	
Babesia canis	Germany	Saarland		83	
Babesia canis	Germany	Sachsen		83	
Babesia canis	Germany	Sachsen-Anhalt		83	
Babesia canis	Germany	Schleswig-Holstein		83	
Babesia canis	Germany	Thüringen		83	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Babesia canis	Greece	Attiki	Attica	476	
Babesia canis	Hungary	Hajdú-Bihar		441	
Babesia canis	Italy	Emilia-Romagna		1107	
Babesia canis	Italy	Emilia-Romagna	Bologna	755	
Babesia canis	Italy	Emilia-Romagna	Bologna	755	
Babesia canis	Italy	Friuli-Venezia Giulia		1107	
Babesia canis	Italy	Lazio		1107	
Babesia canis	Italy	Lazio		997	
Babesia canis	Italy	Lazio	Roma	755	3
Babesia canis	Italy	Lombardia		997	
Babesia canis	Italy	Marche		997	
Babesia canis	Italy	Sicily		997	2
Babesia canis	Italy	Sicily		999	2
Babesia canis	Italy	Toscana		1107	
Babesia canis	Italy	Umbria		1107	
Babesia canis	Italy	Umbria		997	
Babesia canis	Italy	Umbria	Perugia	755	3
Babesia canis	Italy	Veneto		1107	
Babesia canis	Italy	Veneto	Padua	755	
Babesia canis	Poland	Masovian	Warsaw	1098	
Babesia canis	United Kingdom	England	Kent	440	
Babesia canis canis	Croatia	Bjelovarska-Bilogorska		88	
Babesia canis canis	Croatia	Grad Zagreb		88	2
Babesia canis canis	Croatia	Medimurska		88	
Babesia canis canis	Croatia	Vara dinska		88	
Babesia canis canis	Hungary	Budapest		340	
Babesia canis canis	Hungary	Gyor-Moson-Sopron		341	
Babesia canis canis	Hungary	Pest		341	
Babesia canis canis	Hungary	Veszprém		341	
Babesia canis canis	Italy	Friuli-Venezia Giulia		1107	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Babesia canis canis	Italy	Lazio		1107	
Babesia canis canis	Italy	Umbria		1107	
Babesia canis canis	Italy	Veneto		1107	
Babesia canis canis	Poland	Pomeranian		190	
Babesia canis canis	Spain	Cataluña	Barcelona	978	
Babesia canis vogeli	Croatia	Bjelovarska-Bilogorska		88	
Babesia canis vogeli	Croatia	Grad Zagreb		88	2
Babesia canis vogeli	Croatia	Medimurska		88	
Babesia canis vogeli	Croatia	Vara dinska		88	
Babesia canis vogeli	Italy	Emilia-Romagna		1107	
Babesia canis vogeli	Spain	Cataluña	Barcelona	978	
Babesia divergens	Belgium	Flemish Brabant		321	2
Babesia divergens	Estonia	Ida-Viru		1335	
Babesia divergens	France	Rhône-Alpes	Rhône	261	
Babesia divergens	Germany	Bayern		564	
Babesia divergens	Hungary	Borsod-Abaúj-Zemplén		442	
Babesia divergens	Hungary	Heves		442	
Babesia divergens	Italy	Sicily	Palermo	366	
Babesia divergens	Italy	Veneto		997	
Babesia divergens	Poland	West Pomeranian	Szczecin	890	
Babesia divergens	Slovakia	Bratislavsky		1349	
Babesia divergens	Slovakia	Nitriansky		1349	
Babesia divergens	Spain	País Vasco		364	
Babesia divergens	Switzerland	Graubünden		435	
Babesia divergens	Switzerland	Graubünden		622	
Babesia divergens	Switzerland	Ticino		435	2
Babesia divergens	Turkey	Kayseri		457	
Babesia equi	Italy	Emilia-Romagna	Bologna	755	
Babesia equi	Italy	Lazio	Roma	755	
Babesia equi	Italy	Umbria	Perugia	755	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Babesia equi	Italy	Veneto	Padua	755	
Babesia equi	Turkey	Malatya		25	
Babesia gibsoni	Croatia	Bjelovarska-Bilogorska		88	
Babesia gibsoni	Croatia	Grad Zagreb		88	2
Babesia gibsoni	Croatia	Medimurska		88	
Babesia gibsoni	Croatia	Vara dinska		88	
Babesia gibsoni	Germany	Baden-Württemberg	Tübingen	417	
Babesia gibsoni	Hungary	Budapest		323	
Babesia gibsoni	Spain	Cataluña	Barcelona	978	
Babesia major	Italy	Apulia		157	
Babesia major	Italy	Basilicata		157	
Babesia major	Italy	Calabria		157	
Babesia major	Spain	País Vasco		364	
Babesia major	Turkey	Amasya		46	
Babesia major	Turkey	Giresun		46	
Babesia major	Turkey	Gümüshane		46	
Babesia major	Turkey	Tokat		46	
Babesia major	Turkey	Trabzon		46	
Babesia microti	Czech Republic	Jihomoravsky		820	
Babesia microti	Estonia	Harju		1335	
Babesia microti	Estonia	Ida-Viru		1335	
Babesia microti	Estonia	Pärnu		1335	2
Babesia microti	Estonia	Tartu		1335	2
Babesia microti	Estonia	Tartu		1348	2
Babesia microti	Finland	Western Finland		34	
Babesia microti	Italy	Emilia-Romagna		1107	2
Babesia microti	Poland			549	
Babesia microti	Poland	Lower Silesian	Katowice City	504	
Babesia microti	Poland	Lublin		1062	
Babesia microti	Poland	Lublin	Parczew	1061	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Babesia microti	Poland	Lublin	Pulawy	1061	
Babesia microti	Poland	Lublin	Wlodawa	1061	
Babesia microti	Poland	Masovian		504	
Babesia microti	Poland	Podlachian		504	
Babesia microti	Poland	Podlachian	Bialystok	72	
Babesia microti	Poland	Pomeranian	Sopot	504	
Babesia microti	Poland	Warmian-Masurian		1046	8
Babesia microti	Poland	Warmian-Masurian		737	
Babesia microti	Poland	Warmian-Masurian		879	4
Babesia microti	Poland	West Pomeranian		504	
Babesia microti	Poland	West Pomeranian	Szczecin	890	
Babesia microti	Poland	West Pomeranian	Szczecin	891	5
Babesia microti	Slovakia	Bratislavsky		1349	
Babesia microti	Slovakia	Nitriansky		1349	
Babesia microti	Spain	La Rioja	La Rioja	315	
Babesia microti	Switzerland	Graubünden		1305	
Babesia microti	Turkey	Nigde		188	
Babesia microti	United Kingdom	England	Northumberland	131	
Babesia motasi	Romania	Tulcea		59	
Babesia motasi	Spain	País Vasco		677	
Babesia ovis	Romania	Tulcea		59	
Babesia ovis	Spain	País Vasco		677	
Babesia ovis	Turkey	Afyon		186	
Babesia ovis	Turkey	Diyarbakir		23	2
Babesia ovis	Turkey	Elazig		23	2
Babesia ovis	Turkey	Elazig		45	4
Babesia ovis	Turkey	Erzincan		23	2
Babesia ovis	Turkey	Erzurum		23	2
Babesia ovis	Turkey	Igdir		23	2
Babesia ovis	Turkey	Kayseri		458	2

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Babesia ovis	Turkey	Malatya		23	2
Babesia ovis	Turkey	Mardin		23	2
Babesia ovis	Turkey	Mus		23	2
Babesia ovis	Turkey	Sanliurfa		303	
Babesia spp.	Austria	Burgenland	Oberwart	115	
Babesia spp.	Austria	Kärnten	Wolfsberg	115	
Babesia spp.	Austria	Niederösterreich		115	
Babesia spp.	Austria	Oberösterreich	Voitsberg	115	
Babesia spp.	Austria	Salzburg	Hallein	115	
Babesia spp.	Austria	Salzburg	Sankt Johann im Pongau	115	
Babesia spp.	Austria	Steiermark	Graz Umgebung	115	
Babesia spp.	Austria	Steiermark	Mürzzuschlag	115	
Babesia spp.	Austria	Tirol	Imst	115	
Babesia spp.	Austria	Vorarlberg	Bludenz	115	
Babesia spp.	Austria	Wien	Wien	115	
Babesia spp.	Estonia	Harju		1335	
Babesia spp.	Estonia	Ida-Viru		1335	
Babesia spp.	Estonia	Pärnu		1335	2
Babesia spp.	Estonia	Tartu		1335	2
Babesia spp.	France	Nord-Pas-de-Calais	Nord	408	
Babesia spp.	Greece	Ipeiros	Ioannina	985	2
Babesia spp.	Greece	Thessalia	Trikala	985	2
Babesia spp.	Italy	Calabria		997	
Babesia spp.	Italy	Veneto	Belluno	752	
Babesia spp.	Netherlands	Gelderland	Arnhem	447	
Babesia spp.	Netherlands	Zuid-Holland		447	
Babesia spp.	Switzerland	Graubünden		1211	
Babesia spp.	Switzerland	Graubünden		438	
Babesia spp.	Switzerland	Neuchâtel		166	
Babesia spp.	Switzerland	Ticino		166	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Babesia spp.	Switzerland	Valais		166	
Babesia spp.	Switzerland	Zürich		166	
Babesia spp.	Turkey	Diyarbakir		1066	
Babesia vogeli	Turkey	Istanbul		394	

(*) If more than one.

Appendix F: Table of geographic data of *Theileria* spp.

Table 13: *Theileria* spp. geographic distribution data.
See appendix R for the related complete reference.

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Theileria annae	Spain	País Vasco		363	
Theileria annulata	Egypt	Ad Daqahliyah		295	
Theileria annulata	Egypt	Ad Daqahliyah		301	
Theileria annulata	Egypt	Al Gharbiyah		295	
Theileria annulata	Italy	Sicily	Palermo	366	4
Theileria annulata	Italy	Sicily	Ragusa	366	
Theileria annulata	Morocco	Doukkala - Abda		701	
Theileria annulata	Spain	Islas Baleares		40	
Theileria annulata	Spain	Islas Baleares		41	
Theileria annulata	Spain	País Vasco		363	
Theileria annulata	Spain	País Vasco		364	
Theileria annulata	Tunisia	Béja		641	
Theileria annulata	Tunisia	Bizerte		641	
Theileria annulata	Tunisia	Bizerte		641	
Theileria annulata	Tunisia	Jendouba		641	3
Theileria annulata	Tunisia	Nabeul		641	2
Theileria annulata	Tunisia	Zaghouan		641	2
Theileria annulata	Turkey	Adiyaman		282	3
Theileria annulata	Turkey	Amasya		46	
Theileria annulata	Turkey	Ankara		844	
Theileria annulata	Turkey	Ankara		845	3
Theileria annulata	Turkey	Antalya		508	
Theileria annulata	Turkey	Bingöl		22	
Theileria annulata	Turkey	Bingöl		282	3
Theileria annulata	Turkey	Elazig		22	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Theileria annulata	Turkey	Elazig		282	3
Theileria annulata	Turkey	Erzincan		282	3
Theileria annulata	Turkey	Erzurum		22	
Theileria annulata	Turkey	Erzurum		282	3
Theileria annulata	Turkey	Giresun		46	
Theileria annulata	Turkey	Gümüshane		46	
Theileria annulata	Turkey	Kars		282	
Theileria annulata	Turkey	Kayseri		456	
Theileria annulata	Turkey	Malatya		282	3
Theileria annulata	Turkey	Mus		22	
Theileria annulata	Turkey	Mus		282	3
Theileria annulata	Turkey	Sanliurfa		282	3
Theileria annulata	Turkey	Tekirdag		43	4
Theileria annulata	Turkey	Tokat		46	
Theileria annulata	Turkey	Trabzon		46	
Theileria annulata	Turkey	Van		282	3
Theileria buffeli	Italy	Apulia	Foggia	156	
Theileria buffeli	Italy	Basilicata	Matera	156	
Theileria buffeli	Italy	Basilicata	Potenza	156	
Theileria buffeli	Italy	Sicily	Palermo	366	4
Theileria buffeli	Spain	País Vasco		363	
Theileria buffeli	Spain	País Vasco		364	
Theileria buffeli	Tunisia	Bizerte		641	2
Theileria buffeli	Tunisia	Nabeul		641	2
Theileria buffeli	Tunisia	Zaghouan		641	2
Theileria buffeli	Turkey	Ankara		254	
Theileria buffeli	Turkey	Bingöl		22	
Theileria buffeli	Turkey	Elazig		22	
Theileria buffeli	Turkey	Erzurum		22	
Theileria buffeli	Turkey	Kayseri		456	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Theileria buffeli	Turkey	Mus		22	
Theileria caballi	Croatia	Bjelovarska-Bilogorska		88	
Theileria caballi	Croatia	Grad Zagreb		88	2
Theileria caballi	Croatia	Medimurska		88	
Theileria caballi	Croatia	Vara dinska		88	
Theileria equi	Croatia	Bjelovarska-Bilogorska		88	
Theileria equi	Croatia	Grad Zagreb		88	2
Theileria equi	Croatia	Medimurska		88	
Theileria equi	Croatia	Vara dinska		88	
Theileria equi	Italy	Calabria		997	2
Theileria equi	Italy	Lazio		997	2
Theileria equi	Italy	Marche		997	2
Theileria equi	Italy	Sardegna		997	2
Theileria equi	Italy	Sicily		997	2
Theileria equi	Italy	Toscana		606	
Theileria equi	Italy	Umbria		997	2
Theileria equi	Italy	Veneto		997	2
Theileria equi	Morocco	Fès - Boulemane	Fès	800	
Theileria equi	Morocco	Grand Casablanca	Rabat	800	
Theileria equi	Morocco	Marrakech - Tensift - Al Haouz	Marrakech	800	
Theileria equi	Morocco	Taza - Al Hoceima - Taounate	Taza	800	
Theileria equi	Spain	Galicia		146	
Theileria equi	Spain	País Vasco		363	2
Theileria equi	Turkey	Ankara		390	2
Theileria orientalis	Turkey	Bingöl		22	
Theileria orientalis	Turkey	Elazig		22	
Theileria orientalis	Turkey	Erzurum		22	
Theileria orientalis	Turkey	Mus		22	
Theileria ovis	Croatia	Splitsko-Dalmatinska		277	
Theileria ovis	Spain	País Vasco		363	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Theileria ovis	Spain	País Vasco		677	
Theileria ovis	Turkey	Aksaray		1353	4
Theileria ovis	Turkey	Bingöl		1353	
Theileria ovis	Turkey	Çankiri		1353	
Theileria ovis	Turkey	Çankiri		1353	
Theileria ovis	Turkey	Diyarbakir		44	2
Theileria ovis	Turkey	Elazig		1353	
Theileria ovis	Turkey	Elazig		21	6
Theileria ovis	Turkey	Erzincan		44	2
Theileria ovis	Turkey	Erzurum		44	2
Theileria ovis	Turkey	Kars		44	2
Theileria ovis	Turkey	Malatya		44	2
Theileria ovis	Turkey	Mardin		44	2
Theileria ovis	Turkey	Mersin		1353	2
Theileria ovis	Turkey	Mus		44	2
Theileria ovis	Turkey	Van		1353	
Theileria sergenti	Turkey	Bingöl		22	
Theileria sergenti	Turkey	Elazig		22	
Theileria sergenti	Turkey	Erzurum		22	
Theileria sergenti	Turkey	Mus		22	
Theileria spp.	Switzerland	Graubünden		1211	
Theileria spp.	Switzerland	Graubünden		438	
Theileria spp.	Turkey	Amasya		46	
Theileria spp.	Turkey	Giresun		46	
Theileria spp.	Turkey	Gümüshane		46	
Theileria spp.	Turkey	Tokat		46	
Theileria spp.	Turkey	Trabzon		46	

(*) If more than one.

Appendix G: Table of geographic data of equine piroplasmoses

Table 14: Equine piroplasmoses, geographic distribution data.
See appendix R for the related complete reference.

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Theileria caballi	Croatia	Bjelovarska-Bilogorska		88	
Theileria equi	Croatia	Bjelovarska-Bilogorska		88	
Theileria caballi	Croatia	Grad Zagreb		88	2
Theileria equi	Croatia	Grad Zagreb		88	2
Theileria caballi	Croatia	Medimurska		88	
Theileria equi	Croatia	Medimurska		88	
Theileria caballi	Croatia	Varazdinska		88	
Theileria equi	Croatia	Varazdinska		88	
Ehrlichia equi	Denmark	North Jutland		946	
Babesia caballi	Hungary	Hajdú-Bihar		441	
Babesia caballi	Italy	Calabria		997	2
Theileria equi	Italy	Calabria		997	2
Babesia caballi	Italy	Emilia-Romagna		997	2
Babesia caballi	Italy	Emilia-Romagna	Bologna	755	
Babesia equi	Italy	Emilia-Romagna	Bologna	755	
Babesia caballi	Italy	Lazio		997	2
Theileria equi	Italy	Lazio		997	2
Babesia caballi	Italy	Lazio	Roma	755	
Babesia equi	Italy	Lazio	Roma	755	
Babesia caballi	Italy	Marche		997	2
Theileria equi	Italy	Marche		997	2
Babesia caballi	Italy	Sardegna		997	2
Theileria equi	Italy	Sardegna		997	2
Babesia caballi	Italy	Sicily		997	2
Theileria equi	Italy	Sicily		997	2

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Babesia caballi	Italy	Toscana		606	2
Theileria equi	Italy	Toscana		606	
Babesia caballi	Italy	Umbria		997	2
Theileria equi	Italy	Umbria		997	2
Babesia caballi	Italy	Umbria	Perugia	755	
Babesia equi	Italy	Umbria	Perugia	755	
Theileria equi	Italy	Veneto		997	2
Babesia caballi	Italy	Veneto	Padua	755	
Babesia equi	Italy	Veneto	Padua	755	
Theileria equi	Morocco	Fès - Boulemane	Fès	800	
Theileria equi	Morocco	Grand Casablanca	Rabat	800	
Theileria equi	Morocco	Marrakech - Tensift - Al Haouz	Marrakech	800	
Theileria equi	Morocco	Taza - Al Hoceima - Taounate	Taza	800	
Babesia caballi	Spain	Galicia		146	
Theileria equi	Spain	Galicia		146	
Babesia caballi	Spain	País Vasco		363	3
Theileria equi	Spain	País Vasco		363	2
Babesia caballi	Turkey	Ankara		390	2
Theileria equi	Turkey	Ankara		390	2
Babesia caballi	Turkey	Malatya		25	
Babesia equi	Turkey	Malatya		25	

(*) If more than one.

Appendix H: Table of geographic data of *Bartonella* spp.

Table 15: *Bartonella* spp. geographic distribution data.
See appendix R for the related complete reference.

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Bartonella henselae	Croatia	Zadarska		1194	
Bartonella henselae	Denmark	Frederiksborg	Helsingør	304	
Bartonella henselae	Denmark	Fyn	Søndersø	304	
Bartonella henselae	France	Île-de-France		1179	
Bartonella henselae	France	Lorraine	Meurthe-Et-Moselle	1179	
Bartonella henselae	France	Provence-Alpes-Côte-d'Azur	Bouches-Du-Rhône	1179	
Bartonella henselae	France	Rhône-Alpes	Rhône	1179	
Bartonella henselae	Greece	Kriti		1246	
Bartonella henselae	Italy	Emilia-Romagna		1182	2
Bartonella henselae	Italy	Emilia-Romagna	Modena	1181	
Bartonella henselae	Italy	Friuli-Venezia Giulia		830	
Bartonella henselae	Italy	Lombardia		1182	2
Bartonella henselae	Italy	Sardegna		1182	
Bartonella henselae	Italy	Toscana		1182	
Bartonella henselae	Italy	Toscana		1195	
Bartonella henselae	Italy	Toscana		1237	4
Bartonella henselae	Norway	Sør-Trøndelag		1161	
Bartonella henselae	Poland			1177	
Bartonella henselae	Poland	Lódz		1138	
Bartonella henselae	Poland	Lublin		1138	
Bartonella henselae	Poland	Masovian		1138	
Bartonella henselae	Poland	Masovian	Warsaw	763	2
Bartonella henselae	Spain	Andalucía		1128	4
Bartonella henselae	Spain	Cataluña	Barcelona	1261	
Bartonella henselae	Turkey	Ankara		1175	
Bartonella quintana	France	Île-de-France		1206	

Species	Country	Admin 1	Admin 2	Reference	Number of entries*
Bartonella quintana	France	Provence-Alpes-Côte-d'Azur	Bouches-Du-Rhône	1265	
Bartonella quintana	Italy	Toscana		1195	
Bartonella quintana	Poland			1177	
Bartonella quintana	Poland	Masovian		1138	
Bartonella spp.	Albania	Tiranë		409	
Bartonella spp.	Algeria	Alger		1167	4
Bartonella spp.	Algeria	Biskra		1167	4
Bartonella spp.	Algeria	Mascara		1167	4
Bartonella spp.	Algeria	Tiaret		1167	4
Bartonella spp.	Czech Republic	Jihomoravsky		427	4
Bartonella spp.	Czech Republic	Prague		427	2
Bartonella spp.	France	Nord-Pas-de-Calais	Nord	408	
Bartonella spp.	Greece	Thessalia	Thessaloniki	1191	
Bartonella spp.	Italy	Apulia	Taranto	1191	
Bartonella spp.	Italy	Basilicata		1191	
Bartonella spp.	Spain	Andalucía		1128	2
Bartonella vinsonii	Denmark	Fyn	Søndersø	304	2

(*) If more than one.

Appendix I: Table of geographic data of *Francisella tularensis*

Table 16: ***Francisella tularensis*** **geographic distribution data.**
See appendix R for the related complete reference

Country	Admin 1	Admin 2	Reference	Number of entries*
Austria	Burgenland		259	
Austria	Niederösterreich		259	
Austria	Niederösterreich	Gänserndorf	1053	
Austria	Niederösterreich	Gänserndorf	401	5
Austria	Niederösterreich	Korneuburg	401	
Austria	Niederösterreich	Mistelbach	1053	
Austria	Steiermark		259	
Croatia	Koprivnicko-Krizevacka		656	
Czech Republic	Jihomoravsky		1053	
Czech Republic	Jihomoravsky		171	
France	Pays de la Loire	Vendée	882	
Germany	Hessen		509	2
Germany	Niedersachsen		509	7
Slovakia	Banskobystricky		401	2
Slovakia	Trnavsk		401	4
Spain	Castilla y León		39	3
Spain	Castilla y León	Soria	31	
Spain	Castilla y León	Valladolid	617	
Spain	Castilla y León	Valladolid	91	
Sweden	Dalarna		300	
Sweden	Gävleborg		300	
Sweden	Jämtland		300	
Sweden	Västernorrland		300	
Turkey	Amasya		560	
Turkey	Ankara		19	
Turkey	Antalya		19	
Turkey	Bursa		19	
Turkey	Düzce		710	
Turkey	Edirne		19	
Turkey	Edirne		250	
Turkey	Edirne		515	
Turkey	Kars		19	
Turkey	Kars		825	
Turkey	Kastamonu		19	
Turkey	Kirklareli		19	
Turkey	Kirklareli		250	
Turkey	Kirklareli		515	
Turkey	Kocaeli		19	
Turkey	Samsun		19	
Turkey	Tekirdag		19	
Turkey	Tekirdag		250	
Turkey	Tekirdag		515	
Turkey	Van		19	
Turkey	Zinguldak		19	

(*) If more than one.

Appendix J:Table of geographic data of *Coxiella burnetii*

Table 17: ***Coxiella burnetii*** **geographic distribution data.**
See appendix R for the related complete reference.

Country	Admin 1	Admin 2	Reference	Number of entries*
Albania	Berat		1174	2
Albania	Dibër	Dibrës	1174	3
Albania	Dibër	Matit	1174	
Albania	Elbasan		1174	3
Albania	Elbasan	Gramshit	1174	3
Albania	Elbasan	Librazhdit	1174	2
Albania	Fier		1174	
Albania	Fier	Lushnjës	1174	2
Albania	Gjirokastër		1174	
Albania	Gjirokastër	Përmetit	1174	3
Albania	Korçë	Kolonjës	1174	
Albania	Lezhë		1174	2
Albania	Tiranë	Kavajës	1174	
Albania	Tiranë	Tiranës	1174	3
Algeria	Sétif		1221	
Belgium	Antwerp		1198	
Belgium	East Flanders		1198	
Belgium	Flemish Brabant		1198	
Belgium	Hainaut		1198	
Belgium	West Flanders		1198	
Bosnia and Herzegovina	Federacija Bosna i Hercegovina		1209	9
Bosnia and Herzegovina	Federacija Bosna i Hercegovina		1276	
Bosnia and Herzegovina	Repuplika Srpska		1276	
Bulgaria	Sofia	Botevgrad	1254	
Cyprus			1118	
Cyprus	Famagusta		777	4
Cyprus	Larnaca		777	4
Cyprus	Limassol		777	3
Cyprus	Nicosia		777	4
Cyprus	Paphos		777	5
Denmark	Århus		1149	
Denmark	Frederiksborg		1149	
Denmark	Fyn		1149	
Denmark	North Jutland		1149	
Denmark	Ribe		1149	
Denmark	Ringkøbing		1149	
Denmark	South Jutland		1149	
Denmark	Storstrøm		1149	
Denmark	Vejle		1149	
Denmark	Vestsjælland		1149	
Denmark	Viborg		1149	

Country	Admin 1	Admin 2	Reference	Number of entries*
Egypt	Al Jizah		1343	
Egypt	Qina		1343	
Egypt	Shamal Sina'		1343	
France	Centre		1164	
Germany	Baden-Württemberg		599	
Germany	Bayern		599	
Germany	Berlin		599	
Germany	Brandenburg		599	
Germany	Bremen		599	
Germany	Hamburg		599	
Germany	Hessen		599	
Germany	Mecklenburg-Vorpommern		599	
Germany	Niedersachsen		599	
Germany	Nordrhein-Westfalen		599	
Germany	Rheinland-Pfalz		599	
Germany	Saarland		599	
Germany	Sachsen		599	
Germany	Sachsen-Anhalt		599	
Germany	Schleswig-Holstein		599	
Germany	Thüringen		599	
Greece	Anatoliki Makedonia kai Thraki	Drama	1254	
Greece	Anatoliki Makedonia kai Thraki	Evros	1254	
Greece	Anatoliki Makedonia kai Thraki	Kavala	1254	
Greece	Anatoliki Makedonia kai Thraki	Rodopi	1254	
Greece	Anatoliki Makedonia kai Thraki	Xanthi	1254	
Greece	Dytiki Makedonia	Florina	1254	
Greece	Dytiki Makedonia	Grevena	1254	
Greece	Dytiki Makedonia	Grevena	1254	
Greece	Dytiki Makedonia	Kastoria	1254	
Greece	Dytiki Makedonia	Kozani	1254	
Greece	Kentriki Makedonia	Imathia	1254	
Greece	Kentriki Makedonia	Khalkidiki	1254	
Greece	Kentriki Makedonia	Kilkis	1254	
Greece	Kentriki Makedonia	Pella	1254	
Greece	Kentriki Makedonia	Pieria	1254	
Greece	Kentriki Makedonia	Serrai	1254	
Greece	Kentriki Makedonia	Thessaloniki	1254	
Israel	Haifa		1252	
Israel	Jerusalem		1275	
Italy	Apulia		1257	3
Italy	Apulia	Bari	1247	
Italy	Basilicata		1257	2
Italy	Campania		1259	
Italy	Emilia-Romagna	Modena	1354	
Italy	Emilia-Romagna	Parma	1354	
Italy	Emilia-Romagna	Reggio Nell'Emilia	1354	
Italy	Lombardia		1197	12
Italy	Lombardia	Cremona	1300	

Country	Admin 1	Admin 2	Reference	Number of entries*
Italy	Lombardia	Mantua	1300	
Italy	Sardegna		1236	2
Italy	Sicily		999	
Italy	Veneto	Padua	1300	
Montenegro	_abljak		1222	
Montenegro	Andrijevica		1222	
Montenegro	Berane		1222	
Montenegro	Cetinje		1222	
Montenegro	Danilovgrad		1222	
Montenegro	Mojkovac		1222	
Montenegro	Nikoic		1222	
Montenegro	Pljevlja		1222	
Montenegro	Plu_ine		1222	
Montenegro	Podgorica		1222	
Montenegro	Ulcinj		1222	
Netherlands	Gelderland		1271	
Netherlands	Noord-Brabant		1271	
Poland	Lublin		1184	
Slovakia	Kosicky		1193	
Spain	Castilla y León	Soria	1250	
Spain	Castilla-La Mancha	Albacete	1158	
Spain	Castilla-La Mancha	Toledo	989	3
Spain	Cataluña	Barcelona	1153	
Spain	País Vasco		1201	
Spain	País Vasco		1266	3
Spain	País Vasco		78	
Spain	País Vasco		79	
Tunisia	Sousse		1159	
Turkey	Ankara		1214	
Turkey	Ankara		1216	
Turkey	Antalya		1160	
Turkey	Antalya		1204	
Turkey	Aydin		1215	
Turkey	Bolu		1213	
Turkey	Diyarbakir		1160	
Turkey	Kayseri		1214	
Turkey	Nigde		1214	
Turkey	Samsun		1160	
Turkey	Tokat		1203	
United Kingdom	Northern Ireland	Antrim	1239	
United Kingdom	Northern Ireland	Ballymena	1239	
United Kingdom	Northern Ireland	Banbridge	1239	
United Kingdom	Northern Ireland	Craigavon	1239	
United Kingdom	Northern Ireland	Derry	1239	
United Kingdom	Northern Ireland	Down	1239	
United Kingdom	Northern Ireland	Dungannon	1239	
United Kingdom	Northern Ireland	Fermanagh	1239	
United Kingdom	Northern Ireland	Limavady	1239	

Country	Admin 1	Admin 2	Reference	Number of entries*
United Kingdom	Northern Ireland	Magherafelt	1239	
United Kingdom	Northern Ireland	Moyle	1239	
United Kingdom	Northern Ireland	Omagh	1239	
United Kingdom	Northern Ireland	Strabane	1239	

(*) If more than one.

Appendix K: Table of geographic data of *Ixodes ricinus*

Table 18: ***Ixodes ricinus*** **geographic distribution data.**
See appendix R for the related complete reference.

Country	Admin 1	Admin 2	Reference	Number of entries*
Algeria	Alger	Ain Benian	0	3
Algeria	Constantine	Didouche Mourad	0	
Algeria	Guelma	Hammam Debagh	0	
Algeria	Guelma	Hammam Debagh	0	
Algeria	Tlemcen	Tlemcen	0	5
Austria	Burgenland	Oberpullendorf	0	
Austria	Burgenland	Oberwart	0	
Austria	Kärnten	Villach	0	
Austria	Kärnten	Wolfsberg	0	
Austria	Niederösterreich	Mistelbach	0	
Austria	Oberösterreich	Braunau am Inn	0	
Austria	Oberösterreich	Urfahr Umgebung	0	
Austria	Salzburg	Hallein	0	
Austria	Salzburg	Sankt Johann im Pongau	0	
Austria	Steiermark	Deutschlandsberg	0	
Austria	Steiermark	Graz Umgebung	0	
Austria	Steiermark	Mürzzuschlag	0	
Austria	Steiermark	Voitsberg	0	
Austria	Steiermark	Weiz	0	
Austria	Tirol	Imst	0	
Austria	Tirol	Schwaz	0	
Austria	Vorarlberg	Bludenz	0	1
Austria	Vorarlberg	Feldkirch	0	
Belgium	Antwerp	Turnhout	0	
Belgium	Liege	LiËge	0	
Belgium	West Flanders	Brugge	0	
Bulgaria	Blagoevgrad	Gotse Delchev	0	4
Bulgaria	Blagoevgrad	Sandanski	0	2
Bulgaria	Burgas	Burgas	0	12
Bulgaria	Burgas	Kameno	0	2
Bulgaria	Burgas	Malko Tarnovo	0	
Bulgaria	Burgas	Tsarevo	0	2
Bulgaria	Dobrich	Shabla	0	2
Bulgaria	Grad Sofiya	Stolichna	0	10
Bulgaria	Kardzhali	Kirkovo	0	2
Bulgaria	Kardzhali	Momchilgrad	0	2
Bulgaria	Kyustendil	Rila	0	2
Bulgaria	Lovech	Letnitsa	0	2
Bulgaria	Montana	Montana	0	2
Bulgaria	Pazardzhik	Pazardzhik	0	2
Bulgaria	Pazardzhik	Strelcha	0	2
Bulgaria	Plovdiv	Krichim	0	4
Bulgaria	Plovdiv	Plovdiv	0	2

Country	Admin 1	Admin 2	Reference	Number of entries*
Bulgaria	Sliven	Sliven	0	8
Bulgaria	Smolyan	Zlatograd	0	2
Bulgaria	Sofia	Svoge	0	2
Bulgaria	Sofia	Zlatitsa	0	6
Bulgaria	Stara Zagora	Chirpan	0	2
Bulgaria	Stara Zagora	Haskovo	69	
Bulgaria	Stara Zagora	Pavel Banya	0	2
Bulgaria	Varna	Valchi Dol	0	
Bulgaria	Vidin	Belogradchik	0	2
Bulgaria	Vratsa	Vratsa	0	2
Bulgaria	Yambol	Bolyarovo	0	2
Croatia	Medimurska		0	4
Croatia	Primorsko-Goranska		0	4
Croatia	Vara dinska		0	
Czech Republic	Jihocesk		216	
Czech Republic	Jihocesk	Ceské Budejovice	0	10
Czech Republic	Jihocesk	Jindrichuv Hradec	0	4
Czech Republic	Jihocesk	Písek	0	4
Czech Republic	Jihocesk	Tábor	0	4
Czech Republic	Jihomoravsky		1082	
Czech Republic	Jihomoravsky		427	4
Czech Republic	Jihomoravsky		490	2
Czech Republic	Jihomoravsky		742	
Czech Republic	Jihomoravsky	Blansko	0	6
Czech Republic	Jihomoravsky	Breclav	0	12
Czech Republic	Jihomoravsky	Brno	0	4
Czech Republic	Jihomoravsky	Brno	472	
Czech Republic	Jihomoravsky	Brno-Venkov	0	6
Czech Republic	Jihomoravsky	Vy kov	0	3
Czech Republic	Jihomoravsky	Znojmo	0	13
Czech Republic	Kraj Vysocina	dár nad Sázavou	0	
Czech Republic	Kraj Vysocina	Trebíc	0	
Czech Republic	Královéhradeck	Náchod	0	3
Czech Republic	Královéhradeck	Trutnov	0	2
Czech Republic	Královéhradeck	Trutnov	620	
Czech Republic	Královéhradeck	Trutnov	621	
Czech Republic	Libereck		271	24
Czech Republic	Libereck	Liberec	0	
Czech Republic	Libereck	Liberec	472	
Czech Republic	Moravskoslezsk		220	
Czech Republic	Moravskoslezsk	Bruntál	0	5
Czech Republic	Moravskoslezsk	Opava	0	4
Czech Republic	Olomouck	Jeseník	0	
Czech Republic	Olomouck	Olomouc	0	
Czech Republic	Olomouck	Prostejov	0	
Czech Republic	Pardubick	Ústí nad Orlicí	0	
Czech Republic	Pardubick	Ústí nad Orlicí	472	
Czech Republic	Plzensk	Domaûlice	0	

Country	Admin 1	Admin 2	Reference	Number of entries*
Czech Republic	Plzensk	Klatovy	0	4
Czech Republic	Plzensk	Plzen	0	2
Czech Republic	Plzensk	Plzen - jih	0	6
Czech Republic	Plzensk	Plzen - sever	0	7
Czech Republic	Plzensk	Rokycany	0	2
Czech Republic	Plzensk	Tachov	0	
Czech Republic	Prague		216	
Czech Republic	Prague		427	2
Czech Republic	Stredocesk	Bene ov	0	5
Czech Republic	Stredocesk	Beroun	0	3
Czech Republic	Stredocesk	Kolín	0	2
Czech Republic	Stredocesk	Praha - v chod	0	2
Czech Republic	Stredocesk	Praha - západ	0	2
Czech Republic	Stredocesk	Príbram	0	4
Czech Republic	Zlínsk	Kromerí	0	2
Denmark	Århus		888	
Denmark	Århus	Ebeltoft	0	
Denmark	Århus	Hammel	0	
Denmark	Århus	Skanderborg	0	
Denmark	Bornholm		888	
Denmark	Copenhagen		478	2
Denmark	Copenhagen		479	
Denmark	Copenhagen		888	
Denmark	Frederiksborg		888	
Denmark	Frederiksborg	Helsinge	0	
Denmark	Fyn		888	
Denmark	North Jutland		888	
Denmark	Ribe		888	
Denmark	Ringkøbing		888	
Denmark	Roskilde		888	
Denmark	South Jutland		888	
Denmark	Storstrøm		888	
Denmark	Vejle		888	
Denmark	Vestsjælland		888	
Denmark	Vestsjælland	Korsør	973	
Denmark	Viborg		888	
Estonia	Harju		0	27
Estonia	Hiiu		0	13
Estonia	Järva		0	18
Estonia	Jıgeva		0	13
Estonia	Lääne		0	17
Estonia	Lääne-Viru		0	26
Estonia	Pärnu		0	30
Estonia	Põlva		0	8
Estonia	Rapla		0	23
Estonia	Saare		0	24
Estonia	Tartu		0	11
Estonia	Valga		0	12

Country	Admin 1	Admin 2	Reference	Number of entries*
Estonia	Viljandi		0	17
Estonia	Vıru		0	11
Faroe Islands			471	5
Finland	Southern Finland	Uusimaa	0	2
France	Alsace	Bas-Rhin	0	60
France	Alsace	Haut-Rhin	0	28
France	Alsace	Haut-Rhin	331	
France	Aquitaine	Dordogne	0	39
France	Aquitaine	Gironde	0	21
France	Aquitaine	Landes	0	24
France	Aquitaine	Lot-Et-Garonne	0	7
France	Aquitaine	Pyrénées-Atlantiques	0	18
France	Auvergne	Allier	0	33
France	Auvergne	Cantal	0	31
France	Auvergne	Haute-Loire	0	
France	Auvergne	Puy-De-Dôme	0	7
France	Auvergne	Puy-De-Dôme	132	7
France	Basse-Normandie	Calvados	0	22
France	Basse-Normandie	Manche	0	24
France	Basse-Normandie	Orne	0	14
France	Bourgogne	Côte-d'Or	0	11
France	Bourgogne	Nièvre	0	9
France	Bourgogne	Saône-et-Loire	0	45
France	Bourgogne	Yonne	0	30
France	Bretagne	Côtes-d'Armor	0	88
France	Bretagne	Finistère	0	37
France	Bretagne	Ille-Et-Vilaine	0	43
France	Bretagne	Morbihan	0	50
France	Centre	Cher	0	30
France	Centre	Eure-Et-Loir	0	10
France	Centre	Indre	0	21
France	Centre	Indre-Et-Loire	0	29
France	Centre	Loir-Et-Cher	0	12
France	Centre	Loiret	0	10
France	Champagne-Ardenne	Ardennes	0	3
France	Champagne-Ardenne	Aube	0	38
France	Champagne-Ardenne	Haute-Marne	0	24
France	Champagne-Ardenne	Marne	0	16
France	Corse	Corse-Du-Sud	0	2
France	Franche-Comté	Doubs	0	7
France	Franche-Comté	Haute-Saône	0	8
France	Franche-Comté	Jura	0	15
France	Haute-Normandie	Eure	0	20
France	Haute-Normandie	Seine-Maritime	0	4
France	Île-de-France	Essonne	0	18
France	Île-de-France	Seine-Et-Marne	0	31
France	Île-de-France	Val-D'Oise	0	10
France	Île-de-France	Val-De-Marne	0	8

Country	Admin 1	Admin 2	Reference	Number of entries*
France	Île-de-France	Ville de Paris	0	8
France	Île-de-France	Yvelines	0	40
France	Île-de-France	Yvelines	1024	
France	Languedoc-Roussillon	Aude	0	8
France	Languedoc-Roussillon	Gard	0	2
France	Languedoc-Roussillon	Hérault	0	
France	Languedoc-Roussillon	Pyrénées-Orientales	0	10
France	Limousin	Corrèze	0	14
France	Limousin	Creuse	0	21
France	Limousin	Haute-Vienne	0	4
France	Lorraine	Meurthe-Et-Moselle	0	24
France	Lorraine	Meuse	0	50
France	Lorraine	Vosges	0	19
France	Midi-Pyrénées	Ariège	0	17
France	Midi-Pyrénées	Aveyron	0	20
France	Midi-Pyrénées	Gers	0	11
France	Midi-Pyrénées	Haute-Garonne	0	13
France	Midi-Pyrénées	Hautes-Pyrénées	0	14
France	Midi-Pyrénées	Lot	0	2
France	Midi-Pyrénées	Tarn	0	8
France	Midi-Pyrénées	Tarn-Et-Garonne	0	4
France	Nord-Pas-de-Calais	Nord	0	6
France	Nord-Pas-de-Calais	Pas-De-Calais	0	2
France	Pays de la Loire	Loire-Atlantique	0	23
France	Pays de la Loire	Maine-Et-Loire	0	16
France	Pays de la Loire	Mayenne	0	14
France	Pays de la Loire	Sarthe	0	24
France	Pays de la Loire	Vendée	0	7
France	Picardie	Aisne	0	18
France	Picardie	Oise	0	26
France	Picardie	Somme	0	2
France	Poitou-Charentes	Charente	0	11
France	Poitou-Charentes	Charente-Maritime	0	9
France	Poitou-Charentes	Deux-Sèvres	0	8
France	Poitou-Charentes	Vienne	0	10
France	Provence-Alpes-Côte-d'Azur	Alpes-De-Haute-Provence	0	6
France	Provence-Alpes-Côte-d'Azur	Alpes-Maritimes	0	4
France	Provence-Alpes-Côte-d'Azur	Bouches-Du-RhÙne	0	14
France	Provence-Alpes-Côte-d'Azur	Hautes-Alpes	0	8
France	Provence-Alpes-Côte-d'Azur	Var	0	10
France	Provence-Alpes-Côte-d'Azur	Vaucluse	0	2
France	Rhône-Alpes	Ain	0	208
France	Rhône-Alpes	Ardèche	0	6
France	Rhône-Alpes	Drôme	0	27
France	Rhône-Alpes	Haute-Savoie	0	87
France	Rhône-Alpes	Isère	0	159
France	Rhône-Alpes	Loire	0	4
France	Rhône-Alpes	Rhône	0	4

Country	Admin 1	Admin 2	Reference	Number of entries*
France	Rhône-Alpes	Savoie	0	83
Germany	Baden-Württemberg	Freiburg	0	36
Germany	Baden-Württemberg	Karlsruhe	0	18
Germany	Baden-Württemberg	Stuttgart	0	16
Germany	Baden-Württemberg	Tübingen	0	17
Germany	Bayern		332	2
Germany	Bayern		333	5
Germany	Bayern		564	
Germany	Bayern	Mittelfranken	0	6
Germany	Bayern	Niederbayern	0	52
Germany	Bayern	Oberbayern	0	29
Germany	Bayern	Oberfranken	0	2
Germany	Bayern	Oberpfalz	0	14
Germany	Bayern	Schwaben	0	4
Germany	Bayern	Unterfranken	0	4
Germany	Berlin		236	
Germany	Brandenburg		236	
Germany	Brandenburg	Brandenburg	0	294
Germany	Hessen	Darmstadt	496	5
Germany	Hessen	Gieflen	0	5
Germany	Hessen	Kassel	0	
Germany	Mecklenburg-Vorpommern	Mecklenburg-Vorpommern	0	114
Germany	Niedersachsen	Braunschweig	0	
Germany	Nordrhein-Westfalen		600	
Germany	Nordrhein-Westfalen		857	
Germany	Nordrhein-Westfalen	Köln	0	3
Germany	Nordrhein-Westfalen	Munster	0	
Germany	Rheinland-Pfalz	Koblenz	0	
Germany	Rheinland-Pfalz	Rheinhessen-Pfalz	0	
Germany	Saarland	Saarland	0	
Germany	Sachsen	Chemnitz	0	2
Germany	Sachsen	Leipzig	0	
Germany	Sachsen-Anhalt	Dessau	0	15
Germany	Sachsen-Anhalt	Halle	0	
Germany	Sachsen-Anhalt	Magdeburg	0	12
Germany	Thüringen		268	
Germany	Thüringen	Thüringen	0	121
Greece	Anatoliki Makedonia kai Thraki		735	2
Greece	Anatoliki Makedonia kai Thraki	Drama	0	15
Greece	Anatoliki Makedonia kai Thraki	Evros	0	9
Greece	Anatoliki Makedonia kai Thraki	Kavala	0	12
Greece	Anatoliki Makedonia kai Thraki	Rodopi	0	
Greece	Dytiki Makedonia		735	2
Greece	Dytiki Makedonia	Florina	0	3
Greece	Dytiki Makedonia	Grevena	0	12
Greece	Dytiki Makedonia	Kozani	0	8
Greece	Ipeiros	Preveza	0	2
Greece	Kentriki Makedonia		735	3

Country	Admin 1	Admin 2	Reference	Number of entries*
Greece	Kentriki Makedonia	Khalkidiki	0	6
Greece	Kentriki Makedonia	Khalkidiki	1303	3
Greece	Kentriki Makedonia	Kilkis	0	16
Greece	Kentriki Makedonia	Pieria	0	8
Greece	Kentriki Makedonia	Serrai	0	24
Greece	Kentriki Makedonia	Thessaloniki	0	7
Hungary	Bács-Kiskun		0	2
Hungary	Bács-Kiskun		322	2
Hungary	Bács-Kiskun		341	
Hungary	Baranya		0	
Hungary	Baranya		322	2
Hungary	Baranya		341	
Hungary	Békés		341	
Hungary	Borsod-Abaúj-Zemplén		0	
Hungary	Borsod-Abaúj-Zemplén		322	5
Hungary	Borsod-Abaúj-Zemplén		341	
Hungary	Borsod-Abaúj-Zemplén		443	
Hungary	Budapest		322	8
Hungary	Csongrád		341	
Hungary	Fejér		0	2
Hungary	Fejér		322	7
Hungary	Gyor-Moson-Sopron		0	
Hungary	Gyor-Moson-Sopron		322	
Hungary	Gyor-Moson-Sopron		341	
Hungary	Hajdú-Bihar		0	
Hungary	Hajdú-Bihar		322	
Hungary	Heves		0	
Hungary	Jász-Nagykun-Szolnok		0	
Hungary	Komárom-Esztergom		341	
Hungary	Pest		0	4
Hungary	Pest		344	3
Hungary	Somogy		341	
Hungary	Szabolcs-Szatmár-Bereg		341	
Hungary	Vas		341	
Hungary	Veszprém		0	3
Hungary	Veszprém		341	
Hungary	Zala		0	
Ireland	Cavan		0	3
Ireland	Clare		0	2
Ireland	Cork		0	5
Ireland	Donegal		0	2
Ireland	Dublin		0	3
Ireland	Galway		0	10
Ireland	Galway		380	
Ireland	Kerry		0	8
Ireland	Kerry		419	
Ireland	Kerry		420	
Ireland	Kerry		754	

Country	Admin 1	Admin 2	Reference	Number of entries*
Ireland	Kilkenny		0	
Ireland	Limerick		0	2
Ireland	Longford		0	2
Ireland	Mayo		0	6
Ireland	Meath		0	
Ireland	Monaghan		0	2
Ireland	Offaly		0	
Ireland	Roscommon		0	2
Ireland	Sligo		0	
Ireland	Waterford		0	
Ireland	Wexford		0	
Ireland	Wicklow		0	2
Italy	Abruzzo	L'Aquila	0	32
Italy	Abruzzo	Teramo	0	4
Italy	Apulia	Bari	0	2
Italy	Apulia	Lecce	0	2
Italy	Basilicata	Matera	0	6
Italy	Basilicata	Potenza	0	8
Italy	Calabria	Catanzaro	0	2
Italy	Calabria	Reggio Di Calabria	0	2
Italy	Campania		802	
Italy	Campania	Avellino	0	
Italy	Emilia-Romagna	Bologna	0	8
Italy	Emilia-Romagna	Ferrara	0	12
Italy	Emilia-Romagna	Forli' - Cesena	0	3
Italy	Emilia-Romagna	Parma	0	12
Italy	Emilia-Romagna	Piacenza	0	9
Italy	Emilia-Romagna	Ravenna	0	6
Italy	Emilia-Romagna	Reggio Nell'Emilia	0	2
Italy	Emilia-Romagna	Rimini	0	2
Italy	Friuli-Venezia Giulia		215	
Italy	Friuli-Venezia Giulia	Pordenone	0	10
Italy	Friuli-Venezia Giulia	Trieste	0	7
Italy	Friuli-Venezia Giulia	Udine	0	9
Italy	Lazio	Frosinone	0	5
Italy	Lazio	Latina	0	18
Italy	Lazio	Rieti	0	10
Italy	Lazio	Roma	0	23
Italy	Lazio	Viterbo	0	13
Italy	Liguria	Genova	0	8
Italy	Liguria	Imperia	0	2
Italy	Liguria	Savona	0	12
Italy	Lombardia		847	
Italy	Lombardia	Brescia	0	
Italy	Lombardia	Como	0	4
Italy	Lombardia	Lecco	0	2
Italy	Lombardia	Monza and Brianza	0	2
Italy	Lombardia	Pavia	0	4

Country	Admin 1	Admin 2	Reference	Number of entries*
Italy	Lombardia	Sondrio	0	4
Italy	Lombardia	Varese	0	2
Italy	Piemonte	Alessandria	0	2
Italy	Piemonte	Biella	0	2
Italy	Piemonte	Cuneo	0	6
Italy	Piemonte	Novara	0	12
Italy	Piemonte	Torino	0	8
Italy	Piemonte	Vercelli	0	2
Italy	Sardegna	Oristano	0	2
Italy	Sicily	Palermo	0	6
Italy	Sicily	Palermo	242	
Italy	Toscana		1331	
Italy	Toscana	Florence	0	3
Italy	Toscana	Grosseto	0	6
Italy	Toscana	Livorno	0	2
Italy	Toscana	Lucca	0	
Italy	Toscana	Pisa	0	6
Italy	Toscana	Pistoia	0	2
Italy	Toscana	Siena	0	2
Italy	Trentino-Alto Adige	Bolzano	0	28
Italy	Trentino-Alto Adige	Trento	0	150
Italy	Trentino-Alto Adige	Trento	160	
Italy	Trentino-Alto Adige	Trento	609	11
Italy	Trentino-Alto Adige	Trento	741	
Italy	Umbria	Perugia	0	6
Italy	Umbria	Terni	0	2
Italy	Veneto	Belluno	0	9
Italy	Veneto	Padua	0	2
Italy	Veneto	Treviso	0	2
Italy	Veneto	Verona	0	
Italy	Veneto	Verona	0	9
Italy	Veneto	Vicenza	0	14
Kosovo	Gnjilane	Kosovska Kamenica	0	
Kosovo	Kosovska Mitrovica	Kosovska Mitrovica	0	
Kosovo	Kosovska Mitrovica	Kosovska Mitrovica	346	
Kosovo	Prizren	Dragaö	0	
Kosovo	Prizren	Prizren	0	4
Latvia	Kurzeme	Kuldiga	0	8
Latvia	Kurzeme	Kuldiga	126	
Latvia	Kurzeme	Liepaja	0	
Latvia	Kurzeme	Liepaja	126	
Latvia	Kurzeme	Saldus	0	7
Latvia	Kurzeme	Saldus	126	
Latvia	Kurzeme	Talsi	0	4
Latvia	Kurzeme	Talsi	126	
Latvia	Kurzeme	Ventspils	0	
Latvia	Kurzeme	Ventspils	126	
Latvia	Latgale	Daugavpils	126	

Country	Admin 1	Admin 2	Reference	Number of entries*
Latvia	Latgale	Kraslava	126	
Latvia	Riga	Limba i	0	3
Latvia	Riga	Limba i	126	
Latvia	Riga	Ogre	0	5
Latvia	Riga	Ogre	126	
Latvia	Riga	Riga	0	5
Latvia	Riga	Riga	126	
Latvia	Riga	Tukums	0	
Latvia	Riga	Tukums	126	
Latvia	Vidzeme	Cesis	0	
Latvia	Vidzeme	Cesis	0	2
Latvia	Vidzeme	Cesis	126	
Latvia	Vidzeme	Valka	0	4
Latvia	Vidzeme	Valka	126	
Latvia	Vidzeme	Valmiera	0	4
Latvia	Vidzeme	Valmiera	126	
Latvia	Zemgale	Aizkraukle	0	3
Latvia	Zemgale	Aizkraukle	126	
Latvia	Zemgale	Bauska	0	2
Latvia	Zemgale	Bauska	126	
Latvia	Zemgale	Dobele	0	4
Latvia	Zemgale	Dobele	126	
Latvia	Zemgale	Jelgava	0	2
Latvia	Zemgale	Jelgava	126	
Libya	Al Hizam Al Akhdar		0	2
Lithuania	Alytaus	Alytaus	0	
Lithuania	Alytaus	Varenos	0	
Lithuania	Alytaus	Varenos	732	
Lithuania	iauliai	iauliu	0	2
Lithuania	iauliai	iauliu	732	
Lithuania	iauliai	Joniökio	0	
Lithuania	iauliai	Joniökio	732	
Lithuania	iauliai	Kelmes	0	
Lithuania	iauliai	Kelmes	732	
Lithuania	iauliai	Pakruojo	0	
Lithuania	Kauno	Kauno	0	2
Lithuania	Kauno	Kauno	732	
Lithuania	Kauno	Prienu	0	
Lithuania	Kauno	Prienu	732	
Lithuania	Klaipedos		733	
Lithuania	Klaipedos	ilutes	0	3
Lithuania	Klaipedos	ilutes	732	
Lithuania	Klaipedos	Klaipedos	0	
Lithuania	Klaipedos	Klaipedos	732	
Lithuania	Klaipedos	Neringos	0	
Lithuania	Klaipedos	Neringos	732	
Lithuania	Marijampoles	Marijampoles	0	
Lithuania	Marijampoles	Marijampoles	732	

Country	Admin 1	Admin 2	Reference	Number of entries*
Lithuania	Panevezio		733	
Lithuania	Panevezio	Paneveûio	0	
Lithuania	Panevezio	Paneveûio	732	
Lithuania	Panevezio	Rokiökio	0	
Lithuania	Panevezio	Rokiökio	732	
Lithuania	Utenos	Ignalinos	0	
Lithuania	Utenos	Utenos	0	2
Lithuania	Utenos	Utenos	732	2
Lithuania	Utenos	Zarasu	0	
Lithuania	Vilniaus		733	
Lithuania	Vilniaus	Ukmerges	0	
Lithuania	Vilniaus	Ukmerges	732	
Lithuania	Vilniaus	Vilniaus	0	
Lithuania	Vilniaus	Vilniaus	732	
Moldova	Anenii Noi		667	
Moldova	Balti		667	
Moldova	Basarabeasca		667	
Moldova	Bender		667	
Moldova	Briceni		667	
Moldova	Cahul		667	
Moldova	Calarasi		667	
Moldova	Cantemir		667	
Moldova	Causeni		667	
Moldova	Chisinau		667	
Moldova	Cimislia		667	
Moldova	Criuleni		667	
Moldova	Donduseni		667	
Moldova	Drochia		667	
Moldova	Dubasari		667	
Moldova	Edinet		667	
Moldova	Falesti		667	
Moldova	Floresti		667	
Moldova	Gagauzia		667	
Moldova	Glodeni		667	
Moldova	Hîncesti		667	
Moldova	Ialoveni		667	
Moldova	Leova		667	
Moldova	Nisporeni		667	
Moldova	Ocnita		667	
Moldova	Orhei		667	
Moldova	Rezina		667	
Moldova	Rîscani		667	
Moldova	Sîngerei		667	
Moldova	Soldanesti		667	
Moldova	Soroca		667	
Moldova	Stefan Voda		667	
Moldova	Straseni		667	
Moldova	Taraclia		667	

Country	Admin 1	Admin 2	Reference	Number of entries*
Moldova	Telenesti		667	
Moldova	Transnistria		667	
Moldova	Ungheni		667	
Morocco	Chaouia - Ouardigha	Ben Slimane	0	13
Morocco	Gharb - Chrarda - Béni Hssen	Kénitra	0	2
Morocco	Meknès - Tafilalet	Ifrane	0	7
Morocco	Rabat - Salé - Zemmour - Zaer	Khémisset	0	13
Morocco	Tadla - Azilal	Azilal	0	3
Morocco	Tanger - Tétouan	Chefchaouen	0	3
Netherlands	Drenthe	Westerveld	0	
Netherlands	Friesland	Ameland	0	2
Netherlands	Friesland	Opsterland	0	
Netherlands	Friesland	Terschelling	0	
Netherlands	Gelderland	Brummen	0	
Netherlands	Gelderland	Buren	0	
Netherlands	Gelderland	Epe	0	
Netherlands	Gelderland	Nijkerk	0	2
Netherlands	Gelderland	Nunspeet	0	3
Netherlands	Noord-Brabant	Halderberge	0	
Netherlands	Noord-Brabant	Moerdijk	0	
Netherlands	Noord-Brabant	Oisterwijk	0	
Netherlands	Noord-Holland	Amsterdam	0	
Netherlands	Noord-Holland	Heemskerk	0	
Netherlands	Noord-Holland	Hilversum	0	
Netherlands	Overijssel	Deventer	0	
Netherlands	Overijssel	Raalte	0	
Netherlands	Overijssel	Zwolle	0	
Netherlands	Utrecht	Bunnik	0	4
Netherlands	Utrecht	De Bilt	0	2
Netherlands	Utrecht	Doorn	0	
Netherlands	Utrecht	Leersum	0	
Netherlands	Utrecht	Maarn	0	
Netherlands	Utrecht	Soest	0	
Netherlands	Utrecht	Utrecht	0	4
Netherlands	Utrecht	Zeist	0	2
Netherlands	Zeeland	Middelburg	0	
Netherlands	Zeeland	Schouwen-Duiveland	0	
Netherlands	Zeeland	Sluis	0	
Netherlands	Zuid-Holland	Pijnacker-Nootdorp	0	
Netherlands	Zuid-Holland	Waddinxveen	0	
Netherlands	Zuid-Holland	Warmond	0	
Norway	Akershus	Aurskog-Høland	0	
Norway	Akershus	Sørum	0	
Norway	Ãstfold	Aremark	0	
Norway	Ãstfold	Halden	0	
Norway	Ãstfold	Marker	0	
Norway	Ãstfold	Sarpsborg	0	
Norway	Ãstfold	Spydeberg	0	

Country	Admin 1	Admin 2	Reference	Number of entries*
Norway	Aust-Agder		733	
Norway	Aust-Agder	Arendal	0	
Norway	Aust-Agder	Birkenes	0	2
Norway	Aust-Agder	Birkenes	732	
Norway	Aust-Agder	Froland	0	
Norway	Aust-Agder	Grimstad	0	
Norway	Aust-Agder	Lillesand	0	
Norway	Aust-Agder	Lillesand	732	
Norway	Aust-Agder	Tvedestrand	0	
Norway	Aust-Agder	Vegårshei	0	
Norway	Buskerud	Flesberg	0	
Norway	Hordaland	Bergen	0	
Norway	Hordaland	Eidfjord	0	
Norway	Hordaland	Etne	0	
Norway	Hordaland	Kvinnherad	0	4
Norway	Hordaland	Kvinnherad	732	
Norway	Hordaland	Lindås	0	
Norway	Hordaland	Masfjorden	0	
Norway	Hordaland	Masfjorden	0	
Norway	Hordaland	Modalen	0	
Norway	Hordaland	Odda	0	
Norway	Hordaland	Samnanger	0	
Norway	Hordaland	Ullensvang	0	
Norway	Hordaland	Vaksdal	0	
Norway	Hordaland	Vaksdal	0	
Norway	Hordaland	Voss	0	4
Norway	Møre og Romsdal		1116	8
Norway	Møre og Romsdal	Norddal	0	
Norway	Møre og Romsdal	Ørsta	0	
Norway	Møre og Romsdal	Rauma	0	
Norway	Møre og Romsdal	Sunndal	0	
Norway	Møre og Romsdal	Surnadal	0	
Norway	Møre og Romsdal	Ulstein	0	
Norway	Møre og Romsdal	Volda	0	
Norway	Rogaland	Bjerkreim	0	2
Norway	Rogaland	Gjesdal	0	
Norway	Rogaland	Hjelmeland	0	2
Norway	Rogaland	Lund	0	
Norway	Rogaland	Sandnes	0	
Norway	Rogaland	Sauda	0	2
Norway	Rogaland	Suldal	0	
Norway	Sogn og Fjordane	Askvoll	0	
Norway	Sogn og Fjordane	Aurland	0	
Norway	Sogn og Fjordane	Førde	0	
Norway	Sogn og Fjordane	Gaular	0	3
Norway	Sogn og Fjordane	Gloppen	0	3
Norway	Sogn og Fjordane	Gulen	0	
Norway	Sogn og Fjordane	Gulen	732	

Country	Admin 1	Admin 2	Reference	Number of entries*
Norway	Sogn og Fjordane	Hyllestad	0	
Norway	Sogn og Fjordane	Hyllestad	732	
Norway	Sogn og Fjordane	Stryn	0	2
Norway	Sør-Trøndelag	Hitra	1323	
Norway	Telemark		1116	8
Norway	Telemark	Drangedal	0	
Norway	Telemark	Drangedal	732	
Norway	Telemark	Kragerø	0	3
Norway	Telemark	Kragerø	732	
Norway	Telemark	Skien	0	2
Norway	Vest-Agder		1116	8
Norway	Vest-Agder		733	2
Norway	Vest-Agder	Audnedal	0	
Norway	Vest-Agder	Flekkefjord	0	
Norway	Vest-Agder	Hægebostad	0	
Norway	Vest-Agder	Kristiansand	0	
Norway	Vest-Agder	Kristiansand	732	
Norway	Vest-Agder	Kvinesdal	0	
Norway	Vest-Agder	Marnardal	0	2
Norway	Vest-Agder	Songdalen	0	2
Norway	Vest-Agder	Vennesla	0	
Norway	Vestfold		1116	7
Norway	Vestfold		810	
Norway	Vestfold	Larvik	0	2
Norway	Vestfold	Vaale	0	
Poland	Greater Poland		603	
Poland	Greater Poland		645	2
Poland	Greater Poland	Chodziez	0	2
Poland	Greater Poland	Czarnków-Trzcianka	0	4
Poland	Greater Poland	Gniezno	0	
Poland	Greater Poland	Gostyn	0	
Poland	Greater Poland	Gostyn	0	
Poland	Greater Poland	Grodzisk Wielkopolski	0	2
Poland	Greater Poland	Kalisz	0	
Poland	Greater Poland	Kalisz City	0	
Poland	Greater Poland	Kepno	0	3
Poland	Greater Poland	Koscian	0	2
Poland	Greater Poland	Krotoszyn	0	
Poland	Greater Poland	Leszno	0	2
Poland	Greater Poland	Miedzychód	0	2
Poland	Greater Poland	Nowy Tomysl	0	2
Poland	Greater Poland	Oborniki	0	
Poland	Greater Poland	Ostrów Wielkopolski	0	2
Poland	Greater Poland	Ostrzeszów	0	3
Poland	Greater Poland	Pleszew	0	
Poland	Greater Poland	Poznan	0	13
Poland	Greater Poland	Poznan	644	
Poland	Greater Poland	Poznan	645	3

Country	Admin 1	Admin 2	Reference	Number of entries*
Poland	Greater Poland	Poznan City	0	3
Poland	Greater Poland	Rawicz	0	
Poland	Greater Poland	Slupca	0	
Poland	Greater Poland	Srem	0	4
Poland	Greater Poland	Sroda Wielkopolska	0	3
Poland	Greater Poland	Turek	0	
Poland	Greater Poland	Wagrowiec	0	3
Poland	Greater Poland	Wolsztyn	0	
Poland	Greater Poland	Zlotów	0	
Poland	Kuyavian-Pomeranian	Bydgoszcz City	0	
Poland	Kuyavian-Pomeranian	Chelmno	0	2
Poland	Kuyavian-Pomeranian	Grudziadz	0	
Poland	Kuyavian-Pomeranian	Grudziadz City	0	
Poland	Kuyavian-Pomeranian	Inowroclaw	0	2
Poland	Kuyavian-Pomeranian	Lipno	0	
Poland	Kuyavian-Pomeranian	Naklo	0	2
Poland	Kuyavian-Pomeranian	Rypin	0	3
Poland	Kuyavian-Pomeranian	Swiecie	0	
Poland	Kuyavian-Pomeranian	Torun City	0	2
Poland	Kuyavian-Pomeranian	Tuchola	0	4
Poland	Lesser Poland	Bochnia	0	
Poland	Lesser Poland	Brzesko|Brzeg	0	
Poland	Lesser Poland	Chrzanów	0	4
Poland	Lesser Poland	Gorlice	0	
Poland	Lesser Poland	Kraków	0	12
Poland	Lesser Poland	Kraków City	0	3
Poland	Lesser Poland	Limanowa	0	2
Poland	Lesser Poland	Miechów	0	5
Poland	Lesser Poland	Myslenice	0	2
Poland	Lesser Poland	Nowy Sacz	0	3
Poland	Lesser Poland	Nowy Targ	0	6
Poland	Lesser Poland	Olkusz	0	5
Poland	Lesser Poland	Oswiecim	0	4
Poland	Lesser Poland	Proszowice	0	
Poland	Lesser Poland	Sucha	0	3
Poland	Lesser Poland	Tarnów	0	
Poland	Lesser Poland	Tarnów City	0	2
Poland	Lesser Poland	Tatra	0	
Poland	Lesser Poland	Wieliczka	0	4
Poland	Lódz	Kutno	0	
Poland	Lódz	Lowicz	0	2
Poland	Lódz	LÛdz	0	
Poland	Lódz	Pabianice	0	3
Poland	Lódz	Sieradz	0	3
Poland	Lódz	TomaszÛw Mazowiecki	0	
Poland	Lódz	WieruszÛw	0	
Poland	Lódz	Zgierz	0	
Poland	Lower Silesian	Boleslawiec	0	

Country	Admin 1	Admin 2	Reference	Number of entries*
Poland	Lower Silesian	Dzierzoniów	0	4
Poland	Lower Silesian	Jelenia Góra	0	4
Poland	Lower Silesian	Klodzko	0	8
Poland	Lower Silesian	Legnica	0	
Poland	Lower Silesian	Lubin	0	
Poland	Lower Silesian	Lwówek Slaski	0	
Poland	Lower Silesian	Milicz	0	2
Poland	Lower Silesian	Olesnica	0	
Poland	Lower Silesian	Sroda Slaska	0	4
Poland	Lower Silesian	Strzelin	0	
Poland	Lower Silesian	Swidnica	0	
Poland	Lower Silesian	Trzebnica	0	2
Poland	Lower Silesian	Wolów	0	
Poland	Lower Silesian	Wroclaw	0	6
Poland	Lower Silesian	Wroclaw	0	4
Poland	Lower Silesian	Wroclaw	513	
Poland	Lower Silesian	Zabkowice	0	3
Poland	Lower Silesian	Zgorzelec	0	
Poland	Lublin		102	
Poland	Lublin		104	3
Poland	Lublin		105	2
Poland	Lublin		953	4
Poland	Lublin	Bilgoraj	0	2
Poland	Lublin	Chelm	0	2
Poland	Lublin	Hrubieszów	0	
Poland	Lublin	Janów	0	
Poland	Lublin	Krasnik	0	4
Poland	Lublin	Lubartów	0	4
Poland	Lublin	Lublin	0	2
Poland	Lublin	Lublin City	0	2
Poland	Lublin	Pulawy	0	3
Poland	Lublin	Radzyn	0	
Poland	Lublin	Tomaszów	0	3
Poland	Lublin	Wlodawa	0	5
Poland	Lublin	Zamosc	0	6
Poland	Lubusz	Gorzów	0	3
Poland	Lubusz	Miedzyrzecz	0	3
Poland	Lubusz	Slubice	0	
Poland	Lubusz	Strzelce-Drezdenko	0	
Poland	Lubusz	Sulecin	0	3
Poland	Lubusz	Swiebodzin	0	
Poland	Lubusz	Zielona Góra	0	
Poland	Masovian		964	
Poland	Masovian	Ciechanów	0	2
Poland	Masovian	Garwolin	0	
Poland	Masovian	Legionowo	0	
Poland	Masovian	Losice	0	
Poland	Masovian	Minsk	0	

Country	Admin 1	Admin 2	Reference	Number of entries*
Poland	Masovian	Mlawa	0	2
Poland	Masovian	Nowy Dwór Mazowiecki	0	
Poland	Masovian	Ostroleka	0	2
Poland	Masovian	Otwock	0	
Poland	Masovian	Piaseczno	0	3
Poland	Masovian	Plock	0	
Poland	Masovian	Przysucha	0	
Poland	Masovian	Radom	0	2
Poland	Masovian	Warsaw	0	3
Poland	Masovian	Warsaw	1099	
Poland	Masovian	Warsaw West	0	4
Poland	Masovian	Wegrów	0	
Poland	Masovian	Wyszków	0	
Poland	Masovian	Zuromin	0	
Poland	Opole	Glubczyce	0	
Poland	Opole	Kedzierzyn-Kozle	0	
Poland	Opole	Namyslów	0	3
Poland	Opole	Nysa	0	4
Poland	Opole	Opole	0	2
Poland	Opole	Prudnik	0	
Poland	Opole	Strzelce	0	3
Poland	Podlachian		1340	
Poland	Podlachian		464	
Poland	Podlachian	Augustów	0	9
Poland	Podlachian	Bialystok	0	4
Poland	Podlachian	Bielsk	0	3
Poland	Podlachian	Grajewo	0	2
Poland	Podlachian	Hajnówka	0	8
Poland	Podlachian	Hajnówka	385	
Poland	Podlachian	Lomza	0	
Poland	Podlachian	Monki	0	2
Poland	Podlachian	Siemiatycze	0	5
Poland	Podlachian	Sokólka	0	2
Poland	Podlachian	Suwalki	0	2
Poland	Podlachian	Zambrów	0	
Poland	Pomeranian		843	
Poland	Pomeranian	Bytów	0	4
Poland	Pomeranian	Chojnice	0	5
Poland	Pomeranian	Czluchów	0	3
Poland	Pomeranian	Gdansk	0	6
Poland	Pomeranian	Gdansk City	0	3
Poland	Pomeranian	Gdynia	0	5
Poland	Pomeranian	Kartuzy	0	9
Poland	Pomeranian	Koscierzyna	0	5
Poland	Pomeranian	Kwidzyn	0	4
Poland	Pomeranian	Lebork	0	4
Poland	Pomeranian	Malbork	0	2
Poland	Pomeranian	Nowy Dwór Gdanski	0	6

Country	Admin 1	Admin 2	Reference	Number of entries*
Poland	Pomeranian	Puck	0	7
Poland	Pomeranian	Slupsk	0	5
Poland	Pomeranian	Slupsk City	0	
Poland	Pomeranian	Sopot	0	
Poland	Pomeranian	Starogard	0	3
Poland	Pomeranian	Sztum	0	2
Poland	Pomeranian	Tczew	0	2
Poland	Pomeranian	Wejherowo	0	9
Poland	Silesian	Bytom	0	
Poland	Silesian	Chorzów	0	
Poland	Silesian	Cieszyn	0	
Poland	Silesian	Czestochowa	0	4
Poland	Silesian	Gliwice	0	
Poland	Silesian	Katowice City	0	3
Poland	Silesian	Klobuck	0	
Poland	Silesian	Lubliniec	0	2
Poland	Silesian	Mikolów	0	2
Poland	Silesian	Myslowice	0	
Poland	Silesian	Myszków	0	3
Poland	Silesian	Rybnik	0	
Poland	Silesian	Siemianowice Slaskie	0	
Poland	Silesian	Zabrze	0	
Poland	Silesian	Zawiercie	0	7
Poland	Silesian	Zywiec	0	2
Poland	Subcarpathian	Bieszczady	0	3
Poland	Subcarpathian	Jaslo	0	
Poland	Subcarpathian	Kolbuszowa	0	
Poland	Subcarpathian	Krosno	0	
Poland	Subcarpathian	Lesko	0	3
Poland	Subcarpathian	Lezajsk	0	2
Poland	Subcarpathian	Lubaczów	0	2
Poland	Subcarpathian	Nisko	0	
Poland	Subcarpathian	Przemysl	0	
Poland	Subcarpathian	Przeworsk	0	
Poland	Subcarpathian	Rzeszów City	0	2
Poland	Subcarpathian	Sanok	0	
Poland	Swietokrzyskie	Busko	0	
Poland	Swietokrzyskie	Kielce	0	3
Poland	Swietokrzyskie	Kielce City	0	2
Poland	Swietokrzyskie	Sandomierz	0	
Poland	Swietokrzyskie	Skarzysko	0	2
Poland	Swietokrzyskie	StaszÛw	0	
Poland	Warmian-Masurian		738	
Poland	Warmian-Masurian		739	2
Poland	Warmian-Masurian	Bartoszyce	0	3
Poland	Warmian-Masurian	Braniewo	0	2
Poland	Warmian-Masurian	Dzialdowo	0	
Poland	Warmian-Masurian	Elblag	0	3

Country	Admin 1	Admin 2	Reference	Number of entries*
Poland	Warmian-Masurian	Elk	0	
Poland	Warmian-Masurian	Gizycko	0	3
Poland	Warmian-Masurian	Ilawa	0	3
Poland	Warmian-Masurian	Ketrzyn	0	
Poland	Warmian-Masurian	Lidzbark	0	
Poland	Warmian-Masurian	Mragowo	0	3
Poland	Warmian-Masurian	Nidzica	0	
Poland	Warmian-Masurian	Olecko	0	
Poland	Warmian-Masurian	Olsztyn	0	18
Poland	Warmian-Masurian	Olsztyn	546	
Poland	Warmian-Masurian	Olsztyn City	0	
Poland	Warmian-Masurian	Ostróda	0	4
Poland	Warmian-Masurian	Pisz	0	5
Poland	Warmian-Masurian	Szczytno	0	2
Poland	Warmian-Masurian	Wegorzewo	0	2
Poland	West Pomeranian	Bialogard	0	2
Poland	West Pomeranian	Choszczno	0	2
Poland	West Pomeranian	Drawsko	0	3
Poland	West Pomeranian	Goleniów	0	
Poland	West Pomeranian	Gryfice	0	3
Poland	West Pomeranian	Gryfino	0	3
Poland	West Pomeranian	Kamien	0	8
Poland	West Pomeranian	Kolobrzeg	0	
Poland	West Pomeranian	Koszalin	0	3
Poland	West Pomeranian	Koszalin City	0	2
Poland	West Pomeranian	Lobez	0	2
Poland	West Pomeranian	Myslibórz	0	
Poland	West Pomeranian	Police	0	2
Poland	West Pomeranian	Pyrzyce	0	
Poland	West Pomeranian	Slawno	0	8
Poland	West Pomeranian	Stargard	0	5
Poland	West Pomeranian	Swidwin	0	
Poland	West Pomeranian	Szczecin	0	2
Poland	West Pomeranian	Szczecin	138	
Poland	West Pomeranian	Szczecin	893	8
Poland	West Pomeranian	Szczecin	894	
Poland	West Pomeranian	Szczecinek	0	3
Poland	West Pomeranian	Walcz	0	3
Portugal	Braga		1143	
Portugal	Évora	Montemor-o-Novo	0	2
Portugal	Évora	Viana do Alentejo	0	2
Portugal	Faro	Monchique	0	2
Portugal	Faro	Vila do Bispo	0	2
Portugal	Lisboa		1143	
Portugal	Lisboa	Mafra	0	2
Portugal	Madeira		1143	
Portugal	Portalegre		1143	
Portugal	Portalegre	Avis	0	2

Country	Admin 1	Admin 2	Reference	Number of entries*
Portugal	Santarém	Alpiarça	0	2
Portugal	Setúbal		1143	
Portugal	Setúbal	Alcácer do Sal	0	8
Portugal	Setúbal	Barreiro	0	2
Portugal	Setúbal	Grândola	0	6
Portugal	Setúbal	Montijo	0	2
Portugal	Setúbal	Palmela	0	10
Portugal	Viana do Castelo	Arcos de Valdevez	0	2
Romania	Alba		769	
Romania	Arad		769	
Romania	Arges		769	
Romania	Bihor		769	
Romania	Botosani		769	
Romania	Braila		769	
Romania	Buzau		769	
Romania	Calarasi		769	
Romania	Caras-Severin		769	
Romania	Cluj		769	
Romania	Constanta		769	
Romania	Covasna		0	
Romania	Dâmbovita		460	
Romania	Dolj		769	
Romania	Galati		769	
Romania	Giurgiu		769	
Romania	Gorj		769	
Romania	Hunedoara		0	
Romania	Iasi		0	
Romania	Mehedinti		769	
Romania	Mures		769	
Romania	Satu Mare		769	
Romania	Suceava		0	6
Romania	Suceava		460	
Romania	Suceava		462	
Romania	Suceava		769	
Romania	Teleorman		460	
Romania	Teleorman		462	
Romania	Timis		0	
Romania	Timis		177	4
Romania	Tulcea		0	4
Romania	Tulcea		198	2
Romania	Tulcea		460	
Romania	Tulcea		603	
Romania	Tulcea		769	
Romania	Vâlcea		0	2
Romania	Vrancea		769	
Russia	City of St, Petersburg		35	
Russia	Kaliningrad		35	
Russia	Moskva		522	

Country	Admin 1	Admin 2	Reference	Number of entries*
Serbia	Grad Beograd		654	3
Serbia	Grad Beograd	Grocka	0	
Serbia	Grad Beograd	Mladenovac	0	
Serbia	Grad Beograd	Rakovica	785	
Serbia	Grad Beograd	Stari Grad	785	
Serbia	Grad Beograd	Voûdovac	0	
Serbia	Moravicki	Cacak	0	
Serbia	Moravicki	Gornji Milanovac	0	
Serbia	Ni avski	Aleksinac	0	
Serbia	Ni avski	Svrljig	0	
Serbia	Pirotski	Bela Palanka	0	
Serbia	Ra ki	Kraljevo	0	
Serbia	Ra ki	Novi Pazar	0	
Serbia	umadijski	Arandelovac	0	
Serbia	umadijski	Kragujevac	0	
Serbia	umadijski	Topola	0	
Serbia	Zajecarski	Boljevac	0	
Serbia	Zajecarski	Knja evac	0	2
Serbia	Zajecarski	Zajecar	0	2
Serbia	Zapadno-Backi	Sombor	0	
Serbia	Zlatiborski	Bajina Baöta	0	
Serbia	Zlatiborski	Priboj	0	
Serbia	Zlatiborski	Prijepolje	0	2
Slovakia	Banskobystricky		0	
Slovakia	Banskobystricky		140	6
Slovakia	Banskobystricky		449	
Slovakia	Banskobystricky	éarnovica	0	3
Slovakia	Banskobystricky	éiar nad Hronom	0	2
Slovakia	Bratislavsk	Bratislava II	0	2
Slovakia	Bratislavsk	Malacky	0	10
Slovakia	Bratislavsk	Senec	0	
Slovakia	Bratislavsky		1349	
Slovakia	Kosicky		140	14
Slovakia	Kosicky		602	
Slovakia	Kosicky		914	16
Slovakia	Kosicky	Koöice I	0	5
Slovakia	Kosicky	Koöice III	0	
Slovakia	Kosicky	Koöice IV	0	
Slovakia	Kosicky	Koöice-okolie	0	5
Slovakia	Nitriansky		1349	
Slovakia	Nitriansky	Levice	0	9
Slovakia	Nitriansky	Nitra	0	2
Slovakia	Nitriansky	Nové Zámky	0	3
Slovakia	Nitriansky	Topolcany	0	
Slovakia	Nitriansky	Zlaté Moravce	0	5
Slovakia	Pre ov	Ke marok	0	
Slovakia	Pre ov	Stará Lubovna	0	2
Slovakia	Trenciansky		140	2

Country	Admin 1	Admin 2	Reference	Number of entries*
Slovakia	Trenciansky		603	
Slovakia	Trenciansky	Ilava	0	4
Slovakia	Trenciansky	Myjava	0	4
Slovakia	Trenciansky	Nové Mesto nad Váhom	0	4
Slovakia	Trenciansky	Partizánske	0	
Slovakia	Trenciansky	Pova ská Bystrica	0	4
Slovakia	Trenciansky	Prievidza	0	
Slovakia	Trenciansky	Púchov	0	3
Slovakia	Trenciansky	Trencín	0	3
Slovakia	Trnavsk		140	3
Slovakia	Trnavsk	Dunajská Streda	0	3
Slovakia	Trnavsk	Pie tany	0	3
Slovakia	Trnavsk	Senica	0	8
Slovakia	Trnavsk	Skalica	0	
Slovakia	Trnavsk	Trnava	0	
Slovakia	Zilinsky		140	2
Slovakia	Zilinsky	Bytca	0	2
Slovakia	Zilinsky	Cadca	0	2
Slovakia	Zilinsky	Martin	0	
Slovakia	Zilinsky	Námestovo	0	
Slovakia	Zilinsky	Tvrdo ín	0	
Slovenia	Gorenjska	Bled	0	
Slovenia	Gorenjska	Cerklje na Gorenjskem	0	
Slovenia	Gorenjska	Cerklje na Gorenjskem	527	
Slovenia	Gorenjska	elezniki	0	
Slovenia	Gorenjska	Gorenja Vas-Poljane	0	
Slovenia	Gorenjska	Preddvor	0	
Slovenia	Gori ka	Brda	0	2
Slovenia	Gori ka	Cerkno	0	
Slovenia	Jugovzhodna Slovenija	Kocevje	0	2
Slovenia	Jugovzhodna Slovenija	Sodrazica	527	
Slovenia	Notranjsko-kra ka	Ilirska Bistrica	0	
Slovenia	Notranjsko-kra ka	Pivka	0	
Slovenia	Obalno-kra ka		527	
Slovenia	Obalno-kra ka	Divaca	0	
Slovenia	Obalno-kra ka	Hrpelje-Kozina	0	
Slovenia	Obalno-kra ka	Koper	0	
Slovenia	Osrednjeslovenska	Grosuplje	0	
Slovenia	Osrednjeslovenska	Kamnik	527	
Slovenia	Osrednjeslovenska	Ljubljana	0	3
Slovenia	Osrednjeslovenska	Medvode	0	2
Slovenia	Osrednjeslovenska	Medvode	527	2
Slovenia	Osrednjeslovenska	Velike La ce	0	
Slovenia	Savinjska	Mozirje	527	
Slovenia	Savinjska	Tabor	0	
Slovenia	Zasavska	Zagorje ob Savi	0	
Spain	Andalucía	Cádiz	0	8
Spain	Andalucía	Córdoba	0	4

Country	Admin 1	Admin 2	Reference	Number of entries*
Spain	Andalucía	Granada	0	12
Spain	Andalucía	Huelva	0	12
Spain	Andalucía	Jaén	0	8
Spain	Andalucía	Jaén	611	3
Spain	Andalucía	Málaga	0	2
Spain	Aragón	Huesca	0	6
Spain	Aragón	Zaragoza	0	2
Spain	Cantabria	Cantabria	0	9
Spain	Castilla y León	Burgos	0	9
Spain	Castilla y León	León	0	3
Spain	Castilla y León	Toledo	821	2
Spain	Castilla-La Mancha	Ciudad Real	0	2
Spain	Castilla-La Mancha	Cuenca	821	
Spain	Cataluña	Barcelona	0	2
Spain	Cataluña	Girona	0	4
Spain	Comunidad Foral de Navarra	Navarra	0	4
Spain	Extremadura	Badajoz	0	14
Spain	Extremadura	Cáceres	0	51
Spain	Galicia	Lugo	0	2
Spain	Islas Baleares	Baleares	1345	
Spain	La Rioja	La Rioja	0	21
Spain	La Rioja	La Rioja	315	17
Spain	País Vasco		77	
Spain	País Vasco	Álava	0	38
Spain	País Vasco	Guipúzcoa	0	9
Spain	País Vasco	Vizcaya	0	41
Spain	Principado de Asturias		821	
Spain	Región de Murcia	Murcia	616	
Sweden	Blekinge		1339	2
Sweden	Blekinge		350	
Sweden	Dalarna		1339	2
Sweden	Gävleborg		1339	3
Sweden	Gävleborg		350	
Sweden	Gotland		1339	2
Sweden	Gotland	Gotland	470	2
Sweden	Halland		1339	2
Sweden	Halland	Kungsbacka	470	
Sweden	Halland	Varberg	470	
Sweden	Jämtland		1339	
Sweden	Jönköping		1339	2
Sweden	Kalmar		1339	2
Sweden	Kalmar	Kalmar	350	
Sweden	Kronoberg		1339	2
Sweden	Norrbotten		1339	
Sweden	Orebro		1339	
Sweden	Östergötland		1339	2
Sweden	Skåne		1339	2
Sweden	Skåne		350	

Country	Admin 1	Admin 2	Reference	Number of entries*
Sweden	Skåne	Båstad	470	
Sweden	Skåne	Simrishamn	584	
Sweden	Södermanland		1339	
Sweden	Stockholm		1339	2
Sweden	Stockholm	Norrtälje	470	
Sweden	Stockholm	Nynäshamn	470	2
Sweden	Stockholm	Stockholm	350	
Sweden	Uppsala		1339	2
Sweden	Uppsala	Älvkarleby	470	
Sweden	Uppsala	Tierp	470	
Sweden	Uppsala	Uppsala	470	
Sweden	Värmland		1339	2
Sweden	Västerbotten		1339	
Sweden	Västerbotten	Umeå	1322	
Sweden	Västerbotten	Umeå	470	
Sweden	Västernorrland		1339	2
Sweden	Västmanland		1339	
Sweden	Västra Götaland		1339	2
Switzerland	Aargau		0	7
Switzerland	Basel-Landschaft		524	
Switzerland	Bern		0	7
Switzerland	Fribourg		0	
Switzerland	Graubünden		435	5
Switzerland	Jura		0	
Switzerland	Lucerne		0	2
Switzerland	Neuchâtel		0	2
Switzerland	Neuchâtel		450	2
Switzerland	Neuchâtel		487	
Switzerland	Sankt Gallen		0	3
Switzerland	Schaffhausen		0	6
Switzerland	Ticino		0	8
Switzerland	Ticino		435	2
Switzerland	Valais		0	
Switzerland	Valais		1284	4
Switzerland	Valais		1321	
Switzerland	Vaud		0	
Switzerland	Zürich		0	19
Tunisia	Béja	Béja Nord	0	2
Tunisia	Béja	Mejez El Bab	0	
Tunisia	Béja	Nefza	0	6
Tunisia	Béja	Testour	0	2
Tunisia	Bizerte	Sejnane	0	7
Tunisia	Jendouba	Aïn Draham	0	10
Tunisia	Jendouba	Balta Bou Aouane	0	
Tunisia	Jendouba	Ghardimaou	0	3
Tunisia	Jendouba	Tabarka	0	3
Tunisia	Kairouan	Chebika	0	
Tunisia	Le Kef	Nebeur	0	3

Country	Admin 1	Admin 2	Reference	Number of entries*
Tunisia	Siliana	Bouarada	0	
Tunisia	Siliana	Kesra	0	2
Tunisia	Sousse	Kondar	0	
Tunisia	Tataouine	Ghomrassen	0	
Tunisia	Zaghouan	Zriba	0	3
Turkey	Artvin		0	
Turkey	Burdur		0	2
Turkey	Burdur		1008	
Turkey	Giresun		0	5
Turkey	Istanbul		0	3
Turkey	Istanbul		145	
Turkey	Rize		0	4
Turkey	Samsun		0	7
Turkey	Sinop		0	12
Turkey	Trabzon		0	5
United Kingdom	England	Bedfordshire	0	3
United Kingdom	England	Berkshire	0	4
United Kingdom	England	Buckinghamshire	0	2
United Kingdom	England	Cambridgeshire	0	15
United Kingdom	England	Cheshire	0	
United Kingdom	England	Cornwall	0	17
United Kingdom	England	Croydon	0	
United Kingdom	England	Cumbria	0	17
United Kingdom	England	Derbyshire	0	
United Kingdom	England	Devon	0	13
United Kingdom	England	Dorset	0	41
United Kingdom	England	Durham	0	
United Kingdom	England	East Sussex	0	2
United Kingdom	England	Essex	0	12
United Kingdom	England	Gloucestershire	0	3
United Kingdom	England	Hampshire	0	28
United Kingdom	England	Herefordshire	0	7
United Kingdom	England	Hounslow	0	
United Kingdom	England	Isle of Wight	0	2
United Kingdom	England	Kensington and Chelsea	0	
United Kingdom	England	Kent	0	7
United Kingdom	England	Kingston upon Thames	0	
United Kingdom	England	Lambeth	0	
United Kingdom	England	Lancashire	0	
United Kingdom	England	Lancashire	559	
United Kingdom	England	Leicester	0	
United Kingdom	England	Leicestershire	0	4
United Kingdom	England	Lincolnshire	0	2
United Kingdom	England	Luton	0	
United Kingdom	England	Merseyside	0	2
United Kingdom	England	Merton	0	
United Kingdom	England	Milton Keynes	0	
United Kingdom	England	Norfolk	0	53

Country	Admin 1	Admin 2	Reference	Number of entries*
United Kingdom	England	North Somerset	0	
United Kingdom	England	North Yorkshire	0	5
United Kingdom	England	North Yorkshire	1297	3
United Kingdom	England	Northamptonshire	0	
United Kingdom	England	Northumberland	0	20
United Kingdom	England	Northumberland	131	
United Kingdom	England	Nottinghamshire	0	2
United Kingdom	England	Oxfordshire	0	3
United Kingdom	England	Peterborough	0	
United Kingdom	England	Plymouth	0	2
United Kingdom	England	Poole	0	
United Kingdom	England	Portsmouth	0	2
United Kingdom	England	Richmond upon Thames	0	
United Kingdom	England	Somerset	0	4
United Kingdom	England	Staffordshire	0	4
United Kingdom	England	Suffolk	0	17
United Kingdom	England	Surrey	0	8
United Kingdom	England	Sutton	0	
United Kingdom	England	Thurrock	0	
United Kingdom	England	Torbay	0	
United Kingdom	England	Tyne and Wear	0	
United Kingdom	England	Waltham Forest	0	
United Kingdom	England	Warwickshire	0	2
United Kingdom	England	West Sussex	0	12
United Kingdom	England	Wiltshire	0	8
United Kingdom	England	Worcestershire	0	
United Kingdom	Northern Ireland	Down	0	
United Kingdom	Northern Ireland	Dungannon	0	
United Kingdom	Northern Ireland	Fermanagh	0	4
United Kingdom	Northern Ireland	Newry and Mourne	0	
United Kingdom	Northern Ireland	Omagh	0	
United Kingdom	Scotland		1114	
United Kingdom	Scotland	Aberdeen	302	
United Kingdom	Scotland	Aberdeenshire	0	19
United Kingdom	Scotland	Angus	0	8
United Kingdom	Scotland	Argyll and Bute	0	40
United Kingdom	Scotland	Dumfries and Galloway	0	17
United Kingdom	Scotland	East Ayrshire	0	2
United Kingdom	Scotland	Eilean Siar	0	5
United Kingdom	Scotland	Fife	0	
United Kingdom	Scotland	Highland	0	104
United Kingdom	Scotland	Moray	0	5
United Kingdom	Scotland	North Ayshire	0	6
United Kingdom	Scotland	Perthshire and Kinross	0	17
United Kingdom	Scotland	Renfrewshire	0	
United Kingdom	Scotland	Scottish Borders	0	11
United Kingdom	Scotland	Shetland Islands	0	3
United Kingdom	Scotland	South Ayrshire	0	4

Country	Admin 1	Admin 2	Reference	Number of entries*
United Kingdom	Scotland	South Lanarkshire	0	2
United Kingdom	Scotland	Stirling	0	8
United Kingdom	Scotland	West Dunbartonshire	0	2
United Kingdom	Wales	Anglesey	0	6
United Kingdom	Wales	Bridgend	0	
United Kingdom	Wales	Cardiff	0	
United Kingdom	Wales	Carmarthenshire	0	14
United Kingdom	Wales	Ceredigion	0	19
United Kingdom	Wales	Conwy	0	5
United Kingdom	Wales	Denbighshire	0	
United Kingdom	Wales	Gwynedd	0	30
United Kingdom	Wales	Monmouthshire	0	2
United Kingdom	Wales	Neath Port Talbot	0	2
United Kingdom	Wales	Pembrokeshire	0	9
United Kingdom	Wales	Powys	0	16
United Kingdom	Wales	Swansea	631	
United Kingdom	Wales	Torfaen	0	
United Kingdom	Wales	Vale of Glamorgan	0	2

(*) If more than one.

Appendix L: Table of geographic data of *Haemaphysalis punctata*

Table 19: *Haemaphysalis punctata* geographic distribution data.
See appendix R for the related complete reference.

Country	Admin 1	Admin 2	Reference	Number of entries*
Albania	Elbasan	Elbasanit	0	
Albania	Gjirokastër	Gjirokastrës	0	
Albania	Korçë	Pogradecit	0	
Albania	Vlorë	Vlorës	0	
Algeria	Alger	Bouzareah	0	2
Algeria	Bouira	Ain El Hadjar	0	2
Algeria	Bouira	Ain Turk	0	
Algeria	Bouira	Lakhdaria	0	
Algeria	Médéa	Medea	0	
Algeria	Relizane	Oued Rhiou	0	
Algeria	Sétif	Ain Arnat	0	2
Algeria	Tiaret	Sougueur	0	2
Algeria	Tizi Ouzou	Boghni	0	2
Algeria	Tizi Ouzou	Tizi-Ghenif	0	2
Algeria	Tlemcen	Tlemcen	0	2
Bulgaria	Montana	Montana	0	
Bulgaria	Vratsa	Vratsa	0	
Croatia	Karlovacka		0	
Croatia	Splitsko-Dalmatinska		0	2
Croatia	Splitsko-Dalmatinska		277	
Croatia	Splitsko-Dalmatinska		781	
Croatia	Zadarska		0	
France	Aquitaine	Dordogne	0	3
France	Aquitaine	Dordogne	1280	
France	Aquitaine	Gironde	0	
France	Aquitaine	Gironde	1280	
France	Aquitaine	Landes	0	7
France	Aquitaine	Landes	1280	
France	Aquitaine	Pyrénées-Atlantiques	0	5
France	Aquitaine	Pyrénées-Atlantiques	1280	
France	Auvergne	Puy-De-Dôme	0	2
France	Auvergne	Puy-De-Dôme	0	
France	Basse-Normandie	Manche	1280	
France	Bourgogne	Côte-d'Or	0	
France	Bourgogne	Côte-d'Or	1280	
France	Centre	Eure-Et-Loir	0	
France	Centre	Indre	0	
France	Centre	Indre	1280	
France	Centre	Indre-Et-Loire	1280	
France	Corse		1280	
France	Corse	Corse-Du-Sud	0	7
France	Corse	Haute-Corse	0	
France	Île-de-France	Seine-Et-Marne	0	

Country	Admin 1	Admin 2	Reference	Number of entries*
France	Île-de-France	Seine-Et-Marne	1280	
France	Île-de-France	Seine-Maritime	1280	
France	Île-de-France	Val-De-Marne	0	
France	Île-de-France	Ville de Paris	1280	
France	Languedoc-Roussillon	Aude	0	
France	Languedoc-Roussillon	Hérault	0	
France	Languedoc-Roussillon	Pyrénées-Orientales	0	10
France	Languedoc-Roussillon	Pyrénées-Orientales	1280	
France	Limousin	Haute-Vienne	0	3
France	Midi-Pyrénées	Aveyron	0	5
France	Midi-Pyrénées	Aveyron	1280	
France	Midi-Pyrénées	Lot	0	4
France	Midi-Pyrénées	Lot	1280	
France	Midi-Pyrénées	Tarn	0	
France	Pays de la Loire	Vendée	0	7
France	Poitou-Charentes	Vienne	1280	
France	Provence-Alpes-Côte-d'Azur	Alpes-De-Haute-Provence	0	9
France	Provence-Alpes-Côte-d'Azur	Alpes-De-Haute-Provence	1280	
France	Provence-Alpes-Côte-d'Azur	Alpes-Maritimes	0	
France	Provence-Alpes-Côte-d'Azur	Bouches-Du-Rhône	0	7
France	Provence-Alpes-Côte-d'Azur	Hautes-Alpes	0	3
France	Provence-Alpes-Côte-d'Azur	Var	0	3
France	Rhône-Alpes	Ain	0	2
France	Rhône-Alpes	Ain	1280	
France	Rhône-Alpes	Ardèche	0	8
France	Rhône-Alpes	Drôme	0	14
France	Rhône-Alpes	Isère	0	
France	Rhône-Alpes	Savoie	0	3
Greece	Anatoliki Makedonia kai Thraki	Drama	0	6
Greece	Anatoliki Makedonia kai Thraki	Evros	0	6
Greece	Anatoliki Makedonia kai Thraki	Kavala	0	6
Greece	Attiki	Attica	0	2
Greece	Dytiki Makedonia	Grevena	0	10
Greece	Dytiki Makedonia	Kozani	0	5
Greece	Ipeiros	Ioannina	0	2
Greece	Ipeiros	Preveza	0	2
Greece	Kentriki Makedonia	Khalkidiki	0	2
Greece	Kentriki Makedonia	Kilkis	0	3
Greece	Kentriki Makedonia	Pella	0	3
Greece	Kentriki Makedonia	Pieria	0	
Greece	Kentriki Makedonia	Serrai	0	8
Greece	Kentriki Makedonia	Thessaloniki	0	3
Greece	Stereá Elláda	Boeotia	0	
Greece	Stereá Elláda	Evritania	0	
Italy	Abruzzo	Chieti	0	2
Italy	Abruzzo	L'Aquila	0	26

Country	Admin 1	Admin 2	Reference	Number of entries*
Italy	Abruzzo	Teramo	0	5
Italy	Apulia	Foggia	0	5
Italy	Apulia	Lecce	0	3
Italy	Campania		802	
Italy	Campania	Avellino	0	4
Italy	Campania	Caserta	0	
Italy	Emilia-Romagna	Ferrara	0	2
Italy	Emilia-Romagna	Forli' - Cesena	0	2
Italy	Emilia-Romagna	Modena	0	
Italy	Emilia-Romagna	Parma	0	2
Italy	Emilia-Romagna	Piacenza	0	
Italy	Lazio	Latina	0	3
Italy	Lazio	Rieti	0	3
Italy	Lazio	Roma	0	10
Italy	Lazio	Viterbo	0	3
Italy	Liguria	Genova	0	2
Italy	Lombardia	Varese	0	
Italy	Marche	Ancona	0	2
Italy	Molise	Isernia	0	
Italy	Piemonte	Alessandria	0	
Italy	Sardegna	Cagliari	0	
Italy	Sardegna	Carbonia-Iglesias	0	
Italy	Sardegna	Nuoro	0	3
Italy	Sardegna	Olbia-Tempio	0	
Italy	Sardegna	Oristano	0	4
Italy	Sardegna	Sassari	0	11
Italy	Sicily	Palermo	0	3
Italy	Sicily	Palermo	242	
Italy	Sicily	Palermo	366	
Italy	Sicily	Palermo	998	
Italy	Sicily	Trapani	0	
Italy	Toscana		1331	
Italy	Toscana	Florence	0	2
Italy	Toscana	Pisa	0	3
Italy	Toscana	Pistoia	0	
Italy	Trentino-Alto Adige	Bolzano	0	2
Italy	Trentino-Alto Adige	Trento	0	
Italy	Umbria	Perugia	0	2
Italy	Umbria	Terni	0	
Italy	Veneto	Verona	0	
Kosovo	Kosovska Mitrovica	Kosovska Mitrovica	0	
Kosovo	Pristina	Priötina	0	
Kosovo	Uroöevac	Uroöevac	0	
Libya	Ajdabiya		0	
Libya	Al Jabal al Akhdar		0	2
Libya	An Nuqat al Khams		0	
Libya	Tarhunah-Masallatah		0	
Macedonia	Pelagonia	Bitola	0	

Country	Admin 1	Admin 2	Reference	Number of entries*
Macedonia	Polog	Tetovo	0	2
Macedonia	Skopje	Centar	0	2
Macedonia	Southwestern	Ohrid	0	
Moldova	Cahul		667	
Moldova	Cantemir		667	
Moldova	Causeni		667	
Moldova	Cimislia		667	
Moldova	Leova		667	
Moldova	Taraclia		667	
Montenegro	Kolacin		0	
Morocco	Gharb - Chrarda - Béni Hssen	Kénitra	0	
Morocco	Grand Casablanca	Mohammedia	0	
Morocco	Meknès - Tafilalet	Ifrane	0	
Morocco	Meknès - Tafilalet	Khénifra	0	
Morocco	Meknès - Tafilalet	Meknès	0	
Portugal	Évora	Montemor-o-Novo	0	
Portugal	Lisboa		1143	
Portugal	Santarém	Coruche	0	
Portugal	Setúbal		1143	
Portugal	Setúbal	Alcácer do Sal	0	2
Portugal	Setúbal	Grândola	0	
Romania	Timis		177	5
Serbia	Macvanski	Ljubovija	0	
Serbia	Pcinjski	Surdulica	0	
Serbia	Toplicki	Prokuplje	0	
Slovakia	Kosicky		140	
Spain	Andalucía	Cádiz	0	5
Spain	Andalucía	Córdoba	0	
Spain	Andalucía	Granada	0	
Spain	Andalucía	Huelva	0	3
Spain	Andalucía	Jaén	0	2
Spain	Andalucía	Jaén	611	
Spain	Aragón	Huesca	0	7
Spain	Aragón	Teruel	0	
Spain	Aragón	Zaragoza	0	3
Spain	Cantabria	Cantabria	0	2
Spain	Castilla y León	Burgos	0	2
Spain	Castilla y León	Burgos	821	2
Spain	Castilla y León	Soria	0	
Spain	Cataluña	Girona	0	3
Spain	Cataluña	Lleida	0	3
Spain	Cataluña	Tarragona	0	
Spain	Comunidad Foral de Navarra	Navarra	0	6
Spain	Extremadura	Badajoz	0	
Spain	Extremadura	Cáceres	0	3
Spain	Islas Baleares	Baleares	1345	2
Spain	La Rioja	La Rioja	0	4
Spain	País Vasco		77	

Country	Admin 1	Admin 2	Reference	Number of entries*
Spain	País Vasco	Álava	0	25
Spain	País Vasco	Guipúzcoa	0	14
Spain	País Vasco	Vizcaya	0	15
Spain	Principado de Asturias		821	
Sweden	Blekinge		1339	
Sweden	Gotland		1339	
Sweden	Kalmar		1339	
Sweden	Västra Götaland		1339	
Switzerland	Ticino		435	
Switzerland	Ticino		435	
Tunisia	Ariana	Kalaat El Andalous	0	
Tunisia	Béja	Béja Nord	0	
Tunisia	Béja	Nefza	0	2
Tunisia	Béja	Téboursouk	0	2
Tunisia	Bizerte	Bizerte Sud	0	
Tunisia	Bizerte	Mateur	0	2
Tunisia	Bizerte	Sejnane	0	3
Tunisia	Jendouba	Aïn Draham	0	
Tunisia	Jendouba	Ghardimaou	0	
Tunisia	Le Kef	Nebeur	0	
Tunisia	Nabeul	Haouaria	0	
Tunisia	Nabeul	Menzel Temime	0	
Tunisia	Zaghouan	Zriba	0	2
Turkey	Aksaray		1353	
Turkey	Ankara		0	8
Turkey	Ankara		1353	
Turkey	Elazig		0	

(*) If more than one.

Appendix M: Table of geographic data of *Haemaphysalis concinna*

Table 20: ***Haemaphysalis concinna*** **geographic distribution data.**
See appendix R for the related complete reference.

Country	Admin 1	Admin 2	Reference
Spain	País Vasco		77
Spain	Principado de Asturias		821
France	Midi-Pyrénées	Ariège	1280
France	Centre	Indre	1280
France	Centre	Indre-Et-Loire	1280
France	Aquitaine	Landes	1280
France	Picardie	Oise	1280
France	Aquitaine	Pyrénées-Atlantiques	1280
France	Île-de-France	Seine-Et-Marne	1280
France	Île-de-France	Seine-Maritime	1280
France	Poitou-Charentes	Vienne	1280
France	Limousin	Haute-Vienne	1280
Romania	Timis		177
Slovakia	Bratislavsky		1349
Slovakia	Banskobystricky		140
Slovakia	Bratislavsky		1349
Slovakia	Trenciansky		1349
Slovakia	Trnavsky		900
Slovakia	Nitriansky		1349
Czech Republic	Jihomoravsky		490
Hungary	Fejer		1417
Hungary	Nograd		1417
Hungary	Baranya		1417
Hungary	Somogy		1417
Hungary	Csongrad		1417
Hungary	Bacs-Kiskun		1417
Hungary	Zala		1417

(*) If more than one.

Appendix N: Table of geographic data of *Haemaphysalis inermis*

Table 21: *Haemaphysalis inermis*, geographic distribution data.
See appendix R for the related complete reference.

Country	Admin 1	Admin 2	Reference
Bulgaria	Smolyan		884
Bulgaria	Yuzhen tsentralen		
France	Centre	Indre	1280
France	Centre	Indre-Et-Loire	1280
France	Languedoc-Roussillon	Pyrénées-Orientales	1280
France	Île-de-France	Seine-Et-Marne	1280
France	Poitou-Charentes	Vienne	1280
France	Limousin	Haute-Vienne	1280
Hungary	Fejer		1417
Hungary	Borsod-Abauj-Zemplen		1417
Hungary	Heves		1417
Italy	Campania		802
Portugal	Lisboa		1143
Slovakia	Bratislavsky		1349
Slovakia	Banskobystricky		140
Slovakia	Trenciansky		1349
Slovakia	Kosicky		1349
Slovakia	Zilinsky		1349
Spain	País Vasco		77

(*) If more than one.

Appendix O: Table of geographic data of *Rhipicephalus sanguineus* group

Table 22: *Rhipicephalus sanguineus* group (*R. sanguineus* and *R turanicus*), geographic distribution data.
See appendix R for the related complete reference.

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus sanguineus	Algeria	Alger		110	
Rhipicephalus sanguineus	Algeria	El Tarf	El Tarf	110	
Rhipicephalus sanguineus	Bulgaria	Stara Zagora	Haskovo	69	2
Rhipicephalus sanguineus	Egypt	Al Jizah		1101	
Rhipicephalus sanguineus	Egypt	Al Wadi al Jadid		595	
Rhipicephalus sanguineus	France	Aquitaine	Dordogne	1280	
Rhipicephalus sanguineus	France	Aquitaine	Gironde	1280	
Rhipicephalus sanguineus	France	Aquitaine	Landes	1280	
Rhipicephalus sanguineus	France	Aquitaine	Lot-Et-Garonne	1280	
Rhipicephalus sanguineus	France	Auvergne	Allier	1280	
Rhipicephalus sanguineus	France	Bourgogne	Côte-d'Or	1280	
Rhipicephalus sanguineus	France	Corse		1280	
Rhipicephalus sanguineus	France	Corse	Corse-Du-Sud	1306	4
Rhipicephalus sanguineus	France	Île-de-France	Seine-Saint-Denis	1280	
Rhipicephalus sanguineus	France	Île-de-France	Ville de Paris	1280	
Rhipicephalus sanguineus	France	Provence-Alpes-Côte-d'Azur	Alpes-Maritimes	1280	
Rhipicephalus sanguineus	France	Provence-Alpes-Côte-d'Azur	Bouches-Du-Rhône	1280	
Rhipicephalus sanguineus	France	Provence-Alpes-Côte-d'Azur	Var	1280	
Rhipicephalus sanguineus	France	Rhône-Alpes	Isère	1280	
Rhipicephalus sanguineus	Greece	Dytiki Makedonia		735	2
Rhipicephalus sanguineus	Greece	Kentriki Makedonia		735	
Rhipicephalus sanguineus	Greece	Kentriki Makedonia		735	
Rhipicephalus sanguineus	Greece	Kentriki Makedonia	Khalkidiki	1303	
Rhipicephalus sanguineus	Greece	Stereá Ellháda	Fokis	778	
Rhipicephalus sanguineus	Hungary	Nógrád		445	

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus sanguineus	Hungary	Nógrád		829	
Rhipicephalus sanguineus	Italy	Sicily	Palermo	242	
Rhipicephalus sanguineus	Italy	Sicily	Palermo	998	
Rhipicephalus sanguineus	Italy	Toscana		1331	
Rhipicephalus sanguineus	Kosovo	Kosovska Mitrovica	Kosovska Mitrovica	346	
Rhipicephalus sanguineus	Kosovo	Kosovska Mitrovica	Kosovska Mitrovica	346	
Rhipicephalus sanguineus	Romania	Timis		177	
Rhipicephalus sanguineus	Spain	Andalucía	Jaén	611	
Rhipicephalus sanguineus	Spain	Andalucía	Sevilla	614	
Rhipicephalus sanguineus	Spain	Castilla-La Mancha	Toledo	989	2
Rhipicephalus sanguineus	Spain	Islas Baleares	Baleares	1345	2
Rhipicephalus sanguineus	Spain	País Vasco		77	
Rhipicephalus sanguineus	Spain	Región de Murcia	Murcia	616	
Rhipicephalus sanguineus	Sweden	Östergötland		1339	
Rhipicephalus sanguineus	Sweden	Södermanland		1339	
Rhipicephalus sanguineus	Sweden	Stockholm		1339	
Rhipicephalus sanguineus	Sweden	Uppsala		1339	
Rhipicephalus sanguineus	Sweden	Västernorrland		1339	
Rhipicephalus sanguineus	Sweden	Västmanland		1339	
Rhipicephalus sanguineus	Turkey	Afyon		186	
Rhipicephalus sanguineus	Turkey	Elazig		22	
Rhipicephalus sanguineus	Turkey	Erzurum		32	
Rhipicephalus sanguineus	Turkey	Istanbul		145	
Rhipicephalus sanguineus	Turkey	Sanliurfa		303	
Rhipicephalus sanguineus group	Albania	Durrës	Durrësit	0	
Rhipicephalus sanguineus group	Albania	Elbasan	Librazhdit	0	2
Rhipicephalus sanguineus group	Albania	Gjirokastër	Përmetit	0	
Rhipicephalus sanguineus group	Albania	Korçë	Korçës	0	
Rhipicephalus sanguineus group	Albania	Lezhë	Lezhës	0	2
Rhipicephalus sanguineus group	Albania	Shkodër	Shkodrës	0	

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus sanguineus group	Albania	Tiranë	Tiranës	0	2
Rhipicephalus sanguineus group	Albania	Vlorë	Sarandës	0	2
Rhipicephalus sanguineus group	Albania	Vlorë	Vlorës	0	2
Rhipicephalus sanguineus group	Algeria	Aïn Témouchent	Oued Sebbah	0	
Rhipicephalus sanguineus group	Algeria	Alger	Ain Benian	0	
Rhipicephalus sanguineus group	Algeria	Alger	Bouzareah	0	
Rhipicephalus sanguineus group	Algeria	Alger	Ouled Chebel	0	
Rhipicephalus sanguineus group	Algeria	Batna	Ain Touta	0	
Rhipicephalus sanguineus group	Algeria	Batna	Chemora	0	
Rhipicephalus sanguineus group	Algeria	Batna	Ras El Aioun	0	
Rhipicephalus sanguineus group	Algeria	Béchar	Beni Abbes	0	2
Rhipicephalus sanguineus group	Algeria	Blida	Blida	0	
Rhipicephalus sanguineus group	Algeria	Blida	Boufarik	0	
Rhipicephalus sanguineus group	Algeria	Bouira	Ain Turk	0	
Rhipicephalus sanguineus group	Algeria	Bouira	Guerrouma	0	2
Rhipicephalus sanguineus group	Algeria	Bouira	Lakhdaria	0	
Rhipicephalus sanguineus group	Algeria	Bouira	Sour El Ghouzlane	0	
Rhipicephalus sanguineus group	Algeria	Chlef	Chlef	0	
Rhipicephalus sanguineus group	Algeria	El Bayadh	Boualem	0	
Rhipicephalus sanguineus group	Algeria	El Bayadh	Bougtoub	0	
Rhipicephalus sanguineus group	Algeria	El Bayadh	El Bayadh	0	3
Rhipicephalus sanguineus group	Algeria	El Bayadh	Stitten	0	
Rhipicephalus sanguineus group	Algeria	Guelma	Hammam Debagh	0	
Rhipicephalus sanguineus group	Algeria	Jijel	Chekfa	0	
Rhipicephalus sanguineus group	Algeria	Laghouat	Hassi R'Mel	0	
Rhipicephalus sanguineus group	Algeria	Laghouat	Laghouat	0	
Rhipicephalus sanguineus group	Algeria	M'Sila	Sidi M'Hamed	0	2
Rhipicephalus sanguineus group	Algeria	Mascara	Mascara	0	
Rhipicephalus sanguineus group	Algeria	Mostaganem	Mostaganem	0	
Rhipicephalus sanguineus group	Algeria	Oran	Oran	0	2

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus sanguineus group	Algeria	Relizane	Sidi M'Hamed Benaouda	0	
Rhipicephalus sanguineus group	Algeria	Sétif	Ain Arnat	0	
Rhipicephalus sanguineus group	Algeria	Sétif	Setif	0	
Rhipicephalus sanguineus group	Algeria	Sidi Bel Abbès	Dhaya	0	
Rhipicephalus sanguineus group	Algeria	Souk Ahras	Ouled Moumen	0	
Rhipicephalus sanguineus group	Algeria	Tiaret	Meghila	0	
Rhipicephalus sanguineus group	Algeria	Tindouf	Tindouf	0	3
Rhipicephalus sanguineus group	Algeria	Tissemsilt	Theniet El Had	0	
Rhipicephalus sanguineus group	Algeria	Tizi Ouzou	Ain-El-Hammam	0	
Rhipicephalus sanguineus group	Bulgaria	Burgas	Burgas	0	6
Rhipicephalus sanguineus group	Bulgaria	Burgas	Malko Tarnovo	0	3
Rhipicephalus sanguineus group	Bulgaria	Burgas	Primorsko	0	
Rhipicephalus sanguineus group	Bulgaria	Kardzhali	Ardino	0	
Rhipicephalus sanguineus group	Bulgaria	Kardzhali	Momchilgrad	0	4
Rhipicephalus sanguineus group	Bulgaria	Shumen	Shumen	0	3
Rhipicephalus sanguineus group	Bulgaria	Smolyan	Dospat	0	
Rhipicephalus sanguineus group	Bulgaria	Sofia	Ihtiman	0	
Rhipicephalus sanguineus group	Bulgaria	Sofia	Zlatitsa	0	2
Rhipicephalus sanguineus group	Croatia	Dubrovacko-Neretvanska		0	3
Rhipicephalus sanguineus group	Croatia	Istarska		0	
Rhipicephalus sanguineus group	Croatia	Splitsko-Dalmatinska		0	2
Rhipicephalus sanguineus group	Croatia	Zadarska		0	4
Rhipicephalus sanguineus group	Cyprus	Famagusta		0	4
Rhipicephalus sanguineus group	Cyprus	Larnaca		0	
Rhipicephalus sanguineus group	Cyprus	Limassol		0	
Rhipicephalus sanguineus group	Cyprus	Nicosia		0	2
Rhipicephalus sanguineus group	Cyprus	Paphos		0	3
Rhipicephalus sanguineus group	Egypt	Al Bahr al Ahmar		0	3
Rhipicephalus sanguineus group	Egypt	Al Iskandariyah		0	
Rhipicephalus sanguineus group	Egypt	Al Jizah		0	4

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus sanguineus group	Egypt	Al Minufiyah		0	9
Rhipicephalus sanguineus group	Egypt	Al Minya		0	
Rhipicephalus sanguineus group	Egypt	Aswan		0	3
Rhipicephalus sanguineus group	Egypt	Bani Suwayf		0	2
Rhipicephalus sanguineus group	Egypt	Janub Sina'		0	6
Rhipicephalus sanguineus group	France	Alsace	Bas-Rhin	0	4
Rhipicephalus sanguineus group	France	Aquitaine	Dordogne	0	
Rhipicephalus sanguineus group	France	Aquitaine	Gironde	0	2
Rhipicephalus sanguineus group	France	Aquitaine	Lot-Et-Garonne	0	2
Rhipicephalus sanguineus group	France	Aquitaine	Pyrénées-Atlantiques	0	
Rhipicephalus sanguineus group	France	Auvergne	Allier	0	2
Rhipicephalus sanguineus group	France	Auvergne	Cantal	0	
Rhipicephalus sanguineus group	France	Auvergne	Puy-De-Dôme	0	
Rhipicephalus sanguineus group	France	Basse-Normandie	Calvados	0	
Rhipicephalus sanguineus group	France	Basse-Normandie	Orne	0	
Rhipicephalus sanguineus group	France	Centre	Indre	0	
Rhipicephalus sanguineus group	France	Centre	Indre-Et-Loire	0	
Rhipicephalus sanguineus group	France	Champagne-Ardenne	Ardennes	0	
Rhipicephalus sanguineus group	France	Champagne-Ardenne	Marne	0	2
Rhipicephalus sanguineus group	France	Corse	Corse-Du-Sud	0	8
Rhipicephalus sanguineus group	France	Corse	Haute-Corse	0	4
Rhipicephalus sanguineus group	France	Franche-Comté	Doubs	0	
Rhipicephalus sanguineus group	France	Île-de-France	Hauts-De-Seine	0	
Rhipicephalus sanguineus group	France	Île-de-France	Seine-Et-Marne	0	2
Rhipicephalus sanguineus group	France	Île-de-France	Seine-Saint-Denis	0	
Rhipicephalus sanguineus group	France	Île-de-France	Val-De-Marne	0	5
Rhipicephalus sanguineus group	France	Île-de-France	Ville de Paris	0	3
Rhipicephalus sanguineus group	France	Île-de-France	Yvelines	0	2
Rhipicephalus sanguineus group	France	Languedoc-Roussillon	Aude	0	2
Rhipicephalus sanguineus group	France	Languedoc-Roussillon	Gard	0	8

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus sanguineus group	France	Languedoc-Roussillon	Hérault	0	3
Rhipicephalus sanguineus group	France	Languedoc-Roussillon	Pyrénées-Orientales	0	10
Rhipicephalus sanguineus group	France	Lorraine	Meurthe-Et-Moselle	0	
Rhipicephalus sanguineus group	France	Midi-Pyrénées	Ariège	0	2
Rhipicephalus sanguineus group	France	Midi-Pyrénées	Aveyron	0	2
Rhipicephalus sanguineus group	France	Midi-Pyrénées	Haute-Garonne	0	
Rhipicephalus sanguineus group	France	Midi-Pyrénées	Lot	0	2
Rhipicephalus sanguineus group	France	Midi-Pyrénées	Tarn	0	
Rhipicephalus sanguineus group	France	Midi-Pyrénées	Tarn-Et-Garonne	0	
Rhipicephalus sanguineus group	France	Pays de la Loire	Vendée	0	
Rhipicephalus sanguineus group	France	Picardie	Somme	0	
Rhipicephalus sanguineus group	France	Provence-Alpes-Côte-d'Azur	Alpes-De-Haute-Provence	0	8
Rhipicephalus sanguineus group	France	Provence-Alpes-Côte-d'Azur	Alpes-Maritimes	0	11
Rhipicephalus sanguineus group	France	Provence-Alpes-Côte-d'Azur	Bouches-Du-Rhône	0	35
Rhipicephalus sanguineus group	France	Provence-Alpes-Côte-d'Azur	Var	0	26
Rhipicephalus sanguineus group	France	Provence-Alpes-Côte-d'Azur	Vaucluse	0	24
Rhipicephalus sanguineus group	France	Rhône-Alpes	Ain	0	
Rhipicephalus sanguineus group	France	Rhône-Alpes	Ardèche	0	11
Rhipicephalus sanguineus group	France	Rhône-Alpes	Drôme	0	5
Rhipicephalus sanguineus group	France	Rhône-Alpes	Isère	0	2
Rhipicephalus sanguineus group	France	Rhône-Alpes	Loire	0	
Rhipicephalus sanguineus group	France	Rhône-Alpes	Rhône	0	
Rhipicephalus sanguineus group	Greece	Anatoliki Makedonia kai Thraki	Drama	0	2
Rhipicephalus sanguineus group	Greece	Anatoliki Makedonia kai Thraki	Evros	0	4
Rhipicephalus sanguineus group	Greece	Anatoliki Makedonia kai Thraki	Kavala	0	5
Rhipicephalus sanguineus group	Greece	Attiki	Attica	0	
Rhipicephalus sanguineus group	Greece	Dytiki Makedonia	Grevena	0	
Rhipicephalus sanguineus group	Greece	Dytiki Makedonia	Kastoria	0	3
Rhipicephalus sanguineus group	Greece	Ionioi Nisoi	Corfu	0	
Rhipicephalus sanguineus group	Greece	Ionioi Nisoi	Kefallinia	0	2

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus sanguineus group	Greece	Ipeiros	Ioannina	0	2
Rhipicephalus sanguineus group	Greece	Kentriki Makedonia	Imathia	0	
Rhipicephalus sanguineus group	Greece	Kentriki Makedonia	Khalkidiki	0	10
Rhipicephalus sanguineus group	Greece	Kentriki Makedonia	Kilkis	0	5
Rhipicephalus sanguineus group	Greece	Kentriki Makedonia	Pella	0	
Rhipicephalus sanguineus group	Greece	Kentriki Makedonia	Pieria	0	8
Rhipicephalus sanguineus group	Greece	Kentriki Makedonia	Serrai	0	2
Rhipicephalus sanguineus group	Greece	Kentriki Makedonia	Thessaloniki	0	13
Rhipicephalus sanguineus group	Greece	Notio Aigaio	Cyclades	0	
Rhipicephalus sanguineus group	Greece	Peloponnisos	Arcadia	0	
Rhipicephalus sanguineus group	Greece	Peloponnisos	Messinia	0	
Rhipicephalus sanguineus group	Greece	Stereá Elláda	Boeotia	0	
Rhipicephalus sanguineus group	Greece	Thessalia	Larisa	0	
Rhipicephalus sanguineus group	Greece	Thessalia	Magnesia	0	
Rhipicephalus sanguineus group	Greece	Voreio Aigaio	Lesvos	0	4
Rhipicephalus sanguineus group	Italy	Abruzzo	L'Aquila	0	
Rhipicephalus sanguineus group	Italy	Abruzzo	Teramo	0	6
Rhipicephalus sanguineus group	Italy	Apulia	Bari	0	29
Rhipicephalus sanguineus group	Italy	Apulia	Barletta-Andria-Trani	0	4
Rhipicephalus sanguineus group	Italy	Apulia	Brindisi	0	20
Rhipicephalus sanguineus group	Italy	Apulia	Foggia	0	49
Rhipicephalus sanguineus group	Italy	Apulia	Lecce	0	11
Rhipicephalus sanguineus group	Italy	Apulia	Taranto	0	8
Rhipicephalus sanguineus group	Italy	Basilicata	Matera	0	18
Rhipicephalus sanguineus group	Italy	Basilicata	Potenza	0	
Rhipicephalus sanguineus group	Italy	Calabria	Cosenza	0	12
Rhipicephalus sanguineus group	Italy	Calabria	Reggio Di Calabria	0	10
Rhipicephalus sanguineus group	Italy	Campania		802	
Rhipicephalus sanguineus group	Italy	Campania	Avellino	0	2
Rhipicephalus sanguineus group	Italy	Campania	Caserta	0	2

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus sanguineus group	Italy	Emilia-Romagna	Forli' - Cesena	0	2
Rhipicephalus sanguineus group	Italy	Emilia-Romagna	Modena	0	
Rhipicephalus sanguineus group	Italy	Emilia-Romagna	Parma	0	
Rhipicephalus sanguineus group	Italy	Emilia-Romagna	Ravenna	0	3
Rhipicephalus sanguineus group	Italy	Emilia-Romagna	Reggio Nell'Emilia	0	
Rhipicephalus sanguineus group	Italy	Friuli-Venezia Giulia	Udine	0	
Rhipicephalus sanguineus group	Italy	Lazio	Latina	0	4
Rhipicephalus sanguineus group	Italy	Lazio	Rieti	0	2
Rhipicephalus sanguineus group	Italy	Lazio	Roma	0	14
Rhipicephalus sanguineus group	Italy	Lazio	Viterbo	0	3
Rhipicephalus sanguineus group	Italy	Liguria	Genova	0	3
Rhipicephalus sanguineus group	Italy	Liguria	Imperia	0	2
Rhipicephalus sanguineus group	Italy	Marche	Ascoli Piceno	0	2
Rhipicephalus sanguineus group	Italy	Molise	Campobasso	0	15
Rhipicephalus sanguineus group	Italy	Piemonte	Cuneo	0	
Rhipicephalus sanguineus group	Italy	Sardegna	Cagliari	0	
Rhipicephalus sanguineus group	Italy	Sardegna	Carbonia-Iglesias	0	2
Rhipicephalus sanguineus group	Italy	Sardegna	Nuoro	0	
Rhipicephalus sanguineus group	Italy	Sardegna	Ogliastra	0	
Rhipicephalus sanguineus group	Italy	Sardegna	Olbia-Tempio	0	3
Rhipicephalus sanguineus group	Italy	Sardegna	Oristano	0	
Rhipicephalus sanguineus group	Italy	Sardegna	Sassari	0	
Rhipicephalus sanguineus group	Italy	Sicily	Agrigento	0	8
Rhipicephalus sanguineus group	Italy	Sicily	Catania	0	
Rhipicephalus sanguineus group	Italy	Sicily	Enna	0	
Rhipicephalus sanguineus group	Italy	Sicily	Palermo	0	17
Rhipicephalus sanguineus group	Italy	Sicily	Trapani	0	6
Rhipicephalus sanguineus group	Italy	Toscana	Florence	0	2
Rhipicephalus sanguineus group	Italy	Toscana	Grosseto	0	5
Rhipicephalus sanguineus group	Italy	Toscana	Livorno	0	

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus sanguineus group	Italy	Toscana	Pisa	0	
Rhipicephalus sanguineus group	Italy	Umbria	Perugia	0	
Rhipicephalus sanguineus group	Italy	Umbria	Terni	0	2
Rhipicephalus sanguineus group	Italy	Veneto	Belluno	0	
Rhipicephalus sanguineus group	Italy	Veneto	Verona	0	2
Rhipicephalus sanguineus group	Libya	Ajdabiya		0	
Rhipicephalus sanguineus group	Libya	Al Butnan		0	3
Rhipicephalus sanguineus group	Libya	Al Hizam Al Akhdar		0	13
Rhipicephalus sanguineus group	Libya	Al Jabal al Akhdar		0	
Rhipicephalus sanguineus group	Libya	Al Jabal al Akhdar		0	3
Rhipicephalus sanguineus group	Libya	Al Kufrah		0	2
Rhipicephalus sanguineus group	Libya	Al Marj		0	3
Rhipicephalus sanguineus group	Libya	Al Marqab		0	
Rhipicephalus sanguineus group	Libya	Al Qubbah		0	3
Rhipicephalus sanguineus group	Libya	Al Wahah		0	2
Rhipicephalus sanguineus group	Libya	An Nuqat al Khams		0	
Rhipicephalus sanguineus group	Libya	Ghadamis		0	2
Rhipicephalus sanguineus group	Libya	Gharyan		0	
Rhipicephalus sanguineus group	Libya	Misratah		0	5
Rhipicephalus sanguineus group	Libya	Nalut		0	3
Rhipicephalus sanguineus group	Libya	Surt		0	2
Rhipicephalus sanguineus group	Libya	Tajura' wa an Nawahi al Arba		0	
Rhipicephalus sanguineus group	Libya	Tarabulus		0	2
Rhipicephalus sanguineus group	Libya	Tarhunah-Masallatah		0	
Rhipicephalus sanguineus group	Libya	Yafran-Jadu		0	2
Rhipicephalus sanguineus group	Monaco	Monaco		0	
Rhipicephalus sanguineus group	Morocco	Chaouia - Ouardigha	Ben Slimane	0	3
Rhipicephalus sanguineus group	Morocco	Chaouia - Ouardigha	Settat	0	4
Rhipicephalus sanguineus group	Morocco	Fès - Boulemane	Zouagha-Moulay Yacoub	0	2
Rhipicephalus sanguineus group	Morocco	Gharb - Chrarda - Béni Hssen	Kénitra	0	4

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus sanguineus group	Morocco	Gharb - Chrarda - BÈni Hssen	Sidi Kacem	0	
Rhipicephalus sanguineus group	Morocco	Grand Casablanca	Mohammedia	0	2
Rhipicephalus sanguineus group	Morocco	Guelmim - Es-Semara	Assa-Zag	0	2
Rhipicephalus sanguineus group	Morocco	Guelmim - Es-Semara	Guelmim	0	4
Rhipicephalus sanguineus group	Morocco	Marrakech - Tensift - Al Haouz	Al Haouz	0	2
Rhipicephalus sanguineus group	Morocco	Marrakech - Tensift - Al Haouz	El Kela, des Sraghna	0	4
Rhipicephalus sanguineus group	Morocco	Marrakech - Tensift - Al Haouz	Essaouira	0	
Rhipicephalus sanguineus group	Morocco	Marrakech - Tensift - Al Haouz	Marrakech	0	5
Rhipicephalus sanguineus group	Morocco	Meknès - Tafilalet	Ifrane	0	2
Rhipicephalus sanguineus group	Morocco	Meknès - Tafilalet	Khénifra	0	
Rhipicephalus sanguineus group	Morocco	Meknès - Tafilalet	Meknès	0	4
Rhipicephalus sanguineus group	Morocco	Oriental	Oujda Angad	0	
Rhipicephalus sanguineus group	Morocco	Rabat - Salé - Zemmour - Zaer	Khémisset	0	4
Rhipicephalus sanguineus group	Morocco	Rabat - Salé - Zemmour - Zaer	Skhirate-Témara	0	3
Rhipicephalus sanguineus group	Morocco	Souss - Massa - Draâ	Agadir-Ida ou Tanane	0	4
Rhipicephalus sanguineus group	Morocco	Souss - Massa - Draâ	Chtouka-Aït Baha	0	
Rhipicephalus sanguineus group	Morocco	Souss - Massa - Draâ	Ouarzazate	0	
Rhipicephalus sanguineus group	Morocco	Souss - Massa - Draâ	Taroudannt	0	
Rhipicephalus sanguineus group	Morocco	Souss - Massa - Draâ	Zagora	0	
Rhipicephalus sanguineus group	Morocco	Tadla - Azilal	Azilal	0	3
Rhipicephalus sanguineus group	Morocco	Tadla - Azilal	Béni Mellal	0	
Rhipicephalus sanguineus group	Morocco	Tanger - Tétouan	Chefchaouen	0	2
Rhipicephalus sanguineus group	Morocco	Tanger - Tétouan	Larache	0	
Rhipicephalus sanguineus group	Morocco	Tanger - Tétouan	Tanger-Assilah	0	
Rhipicephalus sanguineus group	Morocco	Taza - Al Hoceima - Taounate	Taounate	0	3
Rhipicephalus sanguineus group	Portugal	Beja	Beja	0	
Rhipicephalus sanguineus group	Portugal	Beja	Ferreira do Alentejo	0	2
Rhipicephalus sanguineus group	Portugal	Beja	Mértola	0	7
Rhipicephalus sanguineus group	Portugal	Beja	Odemira	0	
Rhipicephalus sanguineus group	Portugal	Braga	Cabeceiras de Basto	0	3

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus sanguineus group	Portugal	Bragança		1143	
Rhipicephalus sanguineus group	Portugal	Castelo Branco	Idanha-a-Nova	0	
Rhipicephalus sanguineus group	Portugal	Évora	Montemor-o-Novo	0	
Rhipicephalus sanguineus group	Portugal	Évora	Portel	0	
Rhipicephalus sanguineus group	Portugal	Faro	Lagos	0	3
Rhipicephalus sanguineus group	Portugal	Faro	Loulé	0	
Rhipicephalus sanguineus group	Portugal	Faro	Monchique	0	
Rhipicephalus sanguineus group	Portugal	Faro	Vila do Bispo	0	3
Rhipicephalus sanguineus group	Portugal	Faro	Vila Real de Santo António	0	
Rhipicephalus sanguineus group	Portugal	Guarda	Guarda	0	2
Rhipicephalus sanguineus group	Portugal	Leiria		1143	
Rhipicephalus sanguineus group	Portugal	Leiria	Ansi„o	0	
Rhipicephalus sanguineus group	Portugal	Leiria	Ansião	0	
Rhipicephalus sanguineus group	Portugal	Leiria	Pombal	0	2
Rhipicephalus sanguineus group	Portugal	Lisboa	Sintra	0	
Rhipicephalus sanguineus group	Portugal	Lisboa	Sobral de Monte Agraço	0	2
Rhipicephalus sanguineus group	Portugal	Lisboa	Torres Vedras	0	
Rhipicephalus sanguineus group	Portugal	Portalegre		1143	
Rhipicephalus sanguineus group	Portugal	Portalegre	Marvão	0	3
Rhipicephalus sanguineus group	Portugal	Portalegre	Ponte de Súr	0	
Rhipicephalus sanguineus group	Portugal	Porto	Matosinhos	0	
Rhipicephalus sanguineus group	Portugal	Santarém		1143	
Rhipicephalus sanguineus group	Portugal	Santarém	Benavente	0	3
Rhipicephalus sanguineus group	Portugal	Santarém	Coruche	0	
Rhipicephalus sanguineus group	Portugal	Santarém	Santarém	0	
Rhipicephalus sanguineus group	Portugal	Setúbal		1143	
Rhipicephalus sanguineus group	Portugal	Setúbal	Alcácer do Sal	0	12
Rhipicephalus sanguineus group	Portugal	Setúbal	Almada	0	2
Rhipicephalus sanguineus group	Portugal	Setúbal	Barreiro	0	2
Rhipicephalus sanguineus group	Portugal	Setúbal	Grândola	0	7

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus sanguineus group	Portugal	Setúbal	Moita	0	
Rhipicephalus sanguineus group	Portugal	Setúbal	Palmela	0	18
Rhipicephalus sanguineus group	Portugal	Setúbal	Seixal	0	5
Rhipicephalus sanguineus group	Portugal	Setúbal	Set˙bal	0	3
Rhipicephalus sanguineus group	Portugal	Setúbal	Sines	0	
Rhipicephalus sanguineus group	Portugal	Viana do Castelo	Melgaço	0	2
Rhipicephalus sanguineus group	Portugal	Viana do Castelo	Ponte da Barca	0	
Rhipicephalus sanguineus group	Romania	Constanta		0	4
Rhipicephalus sanguineus group	Romania	Dolj		0	2
Rhipicephalus sanguineus group	Romania	Timis		0	2
Rhipicephalus sanguineus group	Slovenia	Obalno-kra ka	Piran	0	
Rhipicephalus sanguineus group	Slovenia	Osrednjeslovenska	Ljubljana	0	
Rhipicephalus sanguineus group	Spain	Andalucía	Almería	0	
Rhipicephalus sanguineus group	Spain	Andalucía	Cádiz	0	
Rhipicephalus sanguineus group	Spain	Andalucía	Granada	0	18
Rhipicephalus sanguineus group	Spain	Andalucía	Huelva	0	3
Rhipicephalus sanguineus group	Spain	Andalucía	Jaén	0	4
Rhipicephalus sanguineus group	Spain	Andalucía	Málaga	0	
Rhipicephalus sanguineus group	Spain	Andalucía	Sevilla	0	3
Rhipicephalus sanguineus group	Spain	Aragón	Zaragoza	0	2
Rhipicephalus sanguineus group	Spain	Castilla y León	Soria	0	
Rhipicephalus sanguineus group	Spain	Castilla y León	Valladolid	0	
Rhipicephalus sanguineus group	Spain	Castilla y León	Zamora	0	
Rhipicephalus sanguineus group	Spain	Castilla-La Mancha	Guadalajara	0	
Rhipicephalus sanguineus group	Spain	Cataluña	Barcelona	0	5
Rhipicephalus sanguineus group	Spain	Cataluña	Girona	0	12
Rhipicephalus sanguineus group	Spain	Cataluña	Lleida	0	2
Rhipicephalus sanguineus group	Spain	Cataluña	Lleida	0	
Rhipicephalus sanguineus group	Spain	Cataluña	Tarragona	0	8
Rhipicephalus sanguineus group	Spain	Extremadura	Badajoz	0	8

Species	**Pais**	**Admin 1**	**Admin 2**	**Reference**	**Number of entries***
Rhipicephalus sanguineus group	Spain	Extremadura	Cáceres	0	46
Rhipicephalus sanguineus group	Spain	País Vasco	Álava	0	3
Rhipicephalus sanguineus group	Spain	País Vasco	Vizcaya	0	3
Rhipicephalus sanguineus group	Tunisia	Ariana	Sidi Thabet	0	2
Rhipicephalus sanguineus group	Tunisia	Béja	Amdoun	0	
Rhipicephalus sanguineus group	Tunisia	Béja	Béja Nord	0	
Rhipicephalus sanguineus group	Tunisia	Béja	Mejez El Bab	0	
Rhipicephalus sanguineus group	Tunisia	Ben Arous (Tunis Sud)	Fouchana	0	
Rhipicephalus sanguineus group	Tunisia	Bizerte	Bizerte Sud	0	
Rhipicephalus sanguineus group	Tunisia	Bizerte	Ghar El Melh	0	2
Rhipicephalus sanguineus group	Tunisia	Bizerte	Sejnane	0	
Rhipicephalus sanguineus group	Tunisia	Gabès	Gabès Médina	0	
Rhipicephalus sanguineus group	Tunisia	Gabès	Gabès Ouest	0	
Rhipicephalus sanguineus group	Tunisia	Gabès	Hamma	0	3
Rhipicephalus sanguineus group	Tunisia	Gabès	Matmata	0	3
Rhipicephalus sanguineus group	Tunisia	Gafsa	Ksar	0	2
Rhipicephalus sanguineus group	Tunisia	Gafsa	Metlaoui	0	2
Rhipicephalus sanguineus group	Tunisia	Jendouba	Aïn Draham	0	
Rhipicephalus sanguineus group	Tunisia	Jendouba	Tabarka	0	
Rhipicephalus sanguineus group	Tunisia	Kairouan	Bouhajla	0	
Rhipicephalus sanguineus group	Tunisia	Kairouan	Kairouan Sud	0	2
Rhipicephalus sanguineus group	Tunisia	Kairouan	Sbikha	0	
Rhipicephalus sanguineus group	Tunisia	Kebili	Faouar	0	
Rhipicephalus sanguineus group	Tunisia	Kebili	Kebili Nord	0	
Rhipicephalus sanguineus group	Tunisia	Le Kef	Kef Ouest	0	
Rhipicephalus sanguineus group	Tunisia	Médenine	Houmt Souk	0	
Rhipicephalus sanguineus group	Tunisia	Nabeul	Menzel Temime	0	
Rhipicephalus sanguineus group	Tunisia	Nabeul	Soliman	0	
Rhipicephalus sanguineus group	Tunisia	Nabeul	Takelsa	0	3
Rhipicephalus sanguineus group	Tunisia	Sfax	Sfax Sud	0	2

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus sanguineus group	Tunisia	Sidi Bou Zid	Meknassi	0	2
Rhipicephalus sanguineus group	Tunisia	Siliana	Siliana Nord	0	
Rhipicephalus sanguineus group	Tunisia	Tataouine	Tataouine Nord	0	
Rhipicephalus sanguineus group	Tunisia	Tozeur	Tamaghza	0	
Rhipicephalus sanguineus group	Tunisia	Tozeur	Tozeur	0	2
Rhipicephalus sanguineus group	Tunisia	Tunis	Carthage	0	
Rhipicephalus sanguineus group	Tunisia	Tunis	La Goulette	0	
Rhipicephalus sanguineus group	Tunisia	Tunis	Sidi El Béchir	0	7
Rhipicephalus sanguineus group	Turkey	Ankara		0	21
Rhipicephalus sanguineus group	Turkey	Burdur		0	14
Rhipicephalus sanguineus group	Turkey	Çorum		0	2
Rhipicephalus sanguineus group	Turkey	Edirne		0	3
Rhipicephalus sanguineus group	Turkey	Elazig		0	14
Rhipicephalus sanguineus group	Turkey	Erzincan		0	
Rhipicephalus sanguineus group	Turkey	Kayseri		0	4
Rhipicephalus sanguineus group	Turkey	Kirklareli		0	3
Rhipicephalus sanguineus group	Turkey	Samsun		0	
Rhipicephalus sanguineus group	Turkey	Sivas		0	4
Rhipicephalus sanguineus group	Turkey	Tokat		0	4
Rhipicephalus sanguineus group	Turkey	Van		0	8
Rhipicephalus sanguineus group	Turkey	Yozgat		0	
Rhipicephalus turanicus	Algeria	Tizi Ouzou	Tizi Ouzou	110	
Rhipicephalus turanicus	Bulgaria	Stara Zagora	Haskovo	69	2
Rhipicephalus turanicus	Croatia	Splitsko-Dalmatinska		277	
Rhipicephalus turanicus	Egypt	Al Isma`iliyah		595	
Rhipicephalus turanicus	France	Provence-Alpes-Côte-d'Azur	Bouches-Du-Rhône	1280	
Rhipicephalus turanicus	Greece	Anatoliki Makedonia kai Thraki		735	2
Rhipicephalus turanicus	Greece	Kentriki Makedonia		735	
Rhipicephalus turanicus	Greece	Kentriki Makedonia	Khalkidiki	1303	3
Rhipicephalus turanicus	Greece	Stereá Elláda	Fokis	778	

Species	Pais	Admin 1	Admin 2	Reference	Number of entries*
Rhipicephalus turanicus	Israel	Jerusalem		1071	
Rhipicephalus turanicus	Italy	Sicily	Palermo	242	2
Rhipicephalus turanicus	Spain	Andalucía	Jaén	611	2
Rhipicephalus turanicus	Spain	Andalucía	Jaén	611	
Rhipicephalus turanicus	Spain	Islas Baleares	Baleares	1345	2
Rhipicephalus turanicus	Turkey	Afyon		186	
Rhipicephalus turanicus	Turkey	Aksaray		1353	
Rhipicephalus turanicus	Turkey	Ankara		1353	2
Rhipicephalus turanicus	Turkey	Sanliurfa		303	

(*) If more than one.

Appendix P: Table of geographic data of *Rhipicephalus (Boophilus) annulatus*

Table 23: *Rhipicephalus (Boophilus) annulatus* geographic distribution data.
See appendix R for the related complete reference.

Country	Admin 1	Admin 2	Reference	Number of entries*
Albania	Tiranë	Tiranës	0	
Algeria	Alger	Ain Benian	0	
Algeria	Guelma	Hammam Debagh	0	
Algeria	Mascara	Mascara	0	
Algeria	Sidi Bel Abbès	Sidi Bel Abbes	0	
Algeria	Tiaret		129	
Bulgaria	Montana	Montana	0	
Bulgaria	Vratsa	Vratsa	0	
Egypt	Al Iskandariyah		0	
Egypt	Al Iskandariyah		595	
Egypt	Al Isma`iliyah		1039	2
Egypt	Al Isma`iliyah		595	
Egypt	Al Jizah		0	
Egypt	Al Jizah		1101	
Egypt	Al Minufiyah		0	3
Egypt	Al Minya		0	
Egypt	Bur Sa`id		595	
France	Corse		1280	
Greece	Anatoliki Makedonia kai Thraki	Drama	0	3
Greece	Anatoliki Makedonia kai Thraki	Kavala	0	4
Greece	Kentriki Makedonia		735	2
Greece	Kentriki Makedonia	Khalkidiki	0	
Greece	Kentriki Makedonia	Khalkidiki	1303	2
Greece	Kentriki Makedonia	Kilkis	0	2
Greece	Kentriki Makedonia	Serrai	0	2
Greece	Kentriki Makedonia	Thessaloniki	0	
Greece	Thessalia	Larisa	0	
Italy	Sicily	Palermo	366	2
Libya	Al Butnan		0	
Libya	Al Hizam Al Akhdar		0	2
Libya	Al Jifarah		0	
Libya	Al Wahah		0	
Morocco	Chaouia - Ouardigha	Ben Slimane	0	2
Morocco	Gharb - Chrarda - Béni Hssen	Kénitra	0	
Morocco	Grand Casablanca	Mohammedia	0	2
Morocco	Marrakech - Tensift - Al Haouz	El Kela, des Sraghna	0	3
Morocco	Marrakech - Tensift - Al Haouz	Marrakech	0	
Morocco	Meknès - Tafilalet	Meknès	0	3
Morocco	Rabat - Salé - Zemmour - Zaer	Khémisset	0	
Morocco	Tanger - Tétouan	Larache	0	
Morocco	Tanger - Tétouan	Tanger-Assilah	0	
Morocco	Taza - Al Hoceima - Taounate	Taounate	0	2
Morocco	Taza - Al Hoceima - Taounate	Taza	0	
Romania	Tulcea		769	

Country	Admin 1	Admin 2	Reference	Number of entries*
Spain	Andalucía	Cádiz	0	9
Spain	Andalucía	Cádiz	241	
Spain	Andalucía	Cádiz	821	
Spain	Andalucía	Huelva	0	2
Spain	Andalucía	Sevilla	0	
Tunisia	Bizerte	Sejnane	0	2
Tunisia	Jendouba	Fernana	0	
Tunisia	Jendouba	Tabarka	0	
Tunisia	Le Kef	Nebeur	0	
Tunisia	Nabeul	Takelsa	0	
Tunisia	Tozeur	Tozeur	0	
Tunisia	Tunis	Sidi El Béchir	0	
Tunisia	Zaghouan	Zriba	0	
Turkey	Ankara		0	3
Turkey	Artvin		0	
Turkey	Burdur		0	3
Turkey	Çorum		0	2
Turkey	Edirne		0	
Turkey	Elazig		0	4
Turkey	Elazig		22	
Turkey	Erzurum		0	
Turkey	Erzurum		22	
Turkey	Kayseri		0	7
Turkey	Kirklareli		0	
Turkey	Mus		22	
Turkey	Samsun		0	
Turkey	Sivas		0	95
Turkey	Tokat		0	7

(*) If more than one.

Appendix Q: Table of geographic data of *Dermacentor reticulatus*

Table 24: *Dermacentor reticulatus* geographic distribution data.
See appendix R for the related complete reference.

Country	Admin 1	Admin 2	Reference	Number of entries*
Czech Republic	Jihomoravsky		427	3
France	Alsace	Bas-Rhin	1280	
France	Aquitaine	Dordogne	1280	
France	Aquitaine	Gironde	1280	
France	Aquitaine	Landes	1280	
France	Aquitaine	Lot-Et-Garonne	1280	
France	Aquitaine	Pyrénées-Atlantiques	1280	
France	Auvergne	Allier	1280	
France	Auvergne	Haute-Loire	1280	
France	Bourgogne	Côte-d'Or	1280	
France	Bourgogne	Nièvre	1280	
France	Bourgogne	Saône-et-Loire	1280	
France	Bourgogne	Yonne	1280	
France	Bretagne	Côtes-d'Armor	1280	
France	Bretagne	Finistère	1280	
France	Bretagne	Ille-Et-Vilaine	1280	
France	Centre	Indre	1280	
France	Centre	Indre-Et-Loire	1280	
France	Haute-Normandie	Eure	1280	
France	Île-de-France	Essonne	1280	
France	Île-de-France	Hauts-De-Seine	1280	
France	Île-de-France	Seine-Et-Marne	1280	
France	Île-de-France	Seine-Saint-Denis	1280	
France	Île-de-France	Val-D'Oise	1280	
France	Île-de-France	Val-De-Marne	1280	
France	Île-de-France	Ville de Paris	1280	
France	Île-de-France	Yvelines	1280	
France	Limousin	Corrèze	1280	
France	Limousin	Haute-Vienne	1280	
France	Lorraine	Moselle	1280	
France	Midi-Pyrénées	Ariège	1280	
France	Midi-Pyrénées	Aveyron	1280	
France	Midi-Pyrénées	Gers	1280	
France	Midi-Pyrénées	Haute-Garonne	1280	
France	Midi-Pyrénées	Hautes-Pyrénées	1280	
France	Midi-Pyrénées	Tarn-Et-Garonne	1280	
France	Nord-Pas-de-Calais	Pas-De-Calais	1280	
France	Pays de la Loire	Loire-Atlantique	1280	
France	Pays de la Loire	Maine-Et-Loire	1280	
France	Pays de la Loire	Sarthe	1280	
France	Poitou-Charentes	Charente	1280	
France	Poitou-Charentes	Charente-Maritime	1280	
France	Poitou-Charentes	Vienne	1280	

Country	Admin 1	Admin 2	Reference	Number of entries*
France	Rhône-Alpes	Ain	1280	
France	Rhône-Alpes	Drôme	1280	
France	Rhône-Alpes	Isère	1280	
France	Rhône-Alpes	Loire	1280	
France	Rhône-Alpes	Rhône	1280	
Germany	Baden-Württemberg		576	
Germany	Bayern		236	3
Germany	Bayern	Oberpfalz	1075	3
Germany	Berlin		236	4
Germany	Brandenburg		236	
Germany	Hessen		236	3
Germany	Sachsen		236	4
Germany	Sachsen-Anhalt		236	4
Germany	Thüringen		576	
Hungary	Bács-Kiskun		341	
Hungary	Baranya		322	2
Hungary	Borsod-Abaúj-Zemplén		341	2
Hungary	Budapest		322	3
Hungary	Csongrád		341	
Hungary	Fejér		322	2
Hungary	Fejér		341	
Hungary	Gyor-Moson-Sopron		322	
Hungary	Gyor-Moson-Sopron		341	
Hungary	Komárom-Esztergom		341	
Hungary	Somogy		341	
Hungary	Szabolcs-Szatmár-Bereg		341	
Hungary	Vas		341	
Hungary	Veszprém		341	
Moldova	Anenii Noi		667	
Moldova	Calarasi		667	
Moldova	Chisinau		667	
Moldova	Criuleni		667	
Moldova	Hîncesti		667	
Moldova	Ialoveni		667	
Moldova	Nisporeni		667	
Moldova	Orhei		667	
Moldova	Straseni		667	
Moldova	Ungheni		667	
Netherlands	Zeeland		686	
Netherlands	Zuid-Holland		686	
Poland	Lublin		103	
Poland	Lublin		105	2
Poland	Lublin		1282	
Poland	Masovian	Warsaw	1099	
Poland	Podlachian		1282	
Poland	Podlachian		464	
Poland	Podlachian	Hajnówka	385	
Poland	Warmian-Masurian	Gizycko	118	

Country	Admin 1	Admin 2	Reference	Number of entries*
Poland	Warmian-Masurian	Gizycko	120	3
Portugal	Bragança		1143	
Romania	Buzau		769	
Romania	Caras-Severin		769	
Romania	Gorj		769	
Romania	Mures		769	
Romania	Tulcea		769	
Slovakia	Banskobystricky		140	12
Slovakia	Kosicky		140	29
Slovakia	Trenciansky		140	5
Slovakia	Trnavsk		140	5
Slovakia	Zilinsky		140	4
Spain	País Vasco		77	
Spain	Principado de Asturias		821	

(*) If more than one.

Appendix R: scientific papers from which the data was extracted

List of the scientific papers that were considered appropriate for the systematic review and data extraction, sorted by their reference identificiation number.

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Appendix S: Photograps of some species of hard ticks and soft ticks.

These photographs have been kindly provided by Dr. M. Madder.

HARD TICKS (IXODIDAE)

Ixodes ricinus Linnaeus, 1758

Male dorsal (left) and ventral (right)

Female dorsal (left) and ventral (right)

Ixodes hexagonus Leach, 1815

Male dorsal (left) and ventral (right)

Female dorsal (left) and ventral (right)

Ixodes canisuga Johnston, 1849

Female dorsal (left) and ventral (right)

Ixodes uriae White, 1852

Male dorsal (left) and ventral (right)

Female dorsal (left) and ventral (right)

Haemaphysalis punctata Canestrini & Fanzago, 1878

female dorsal (left) and ventral (right)

Haemaphysalis concinna Koch 1844

Male dorsal (left) and ventral (right)

Haemaphysalis inermis Birula, 1895

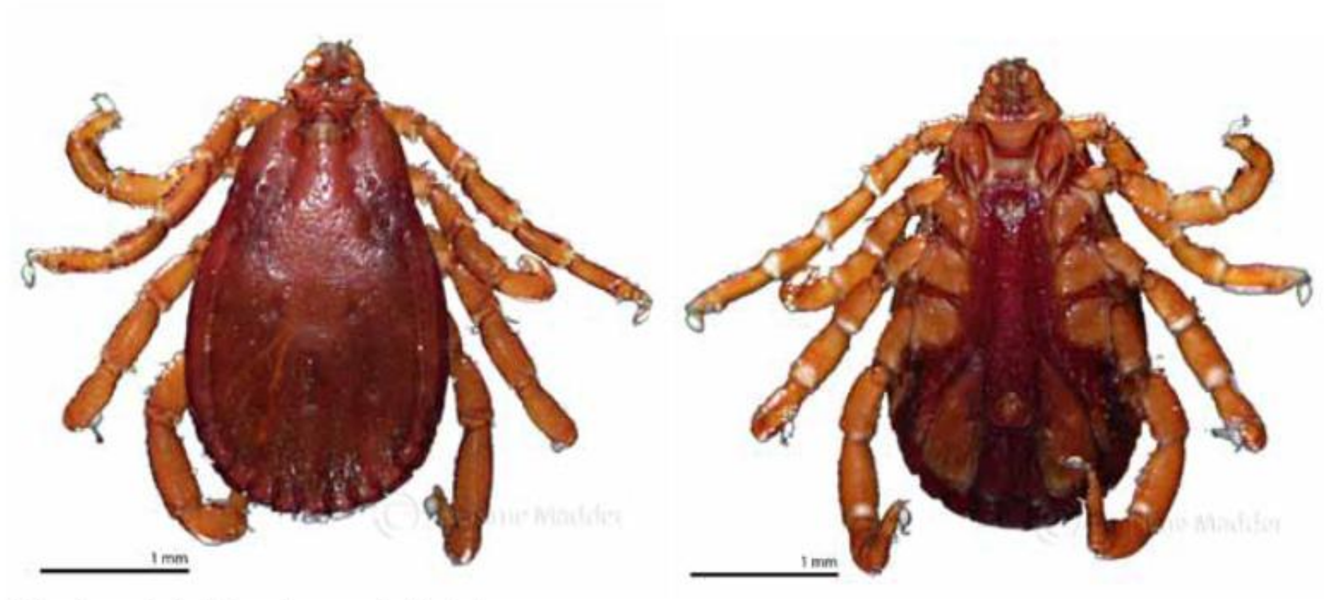
Male dorsal (left) and ventral (right)

Rhipicephalus bursa Canastrini & Fanzago, 1878

Male dorsal (left) and ventral (right)

Female dorsal (left) and ventral (right)

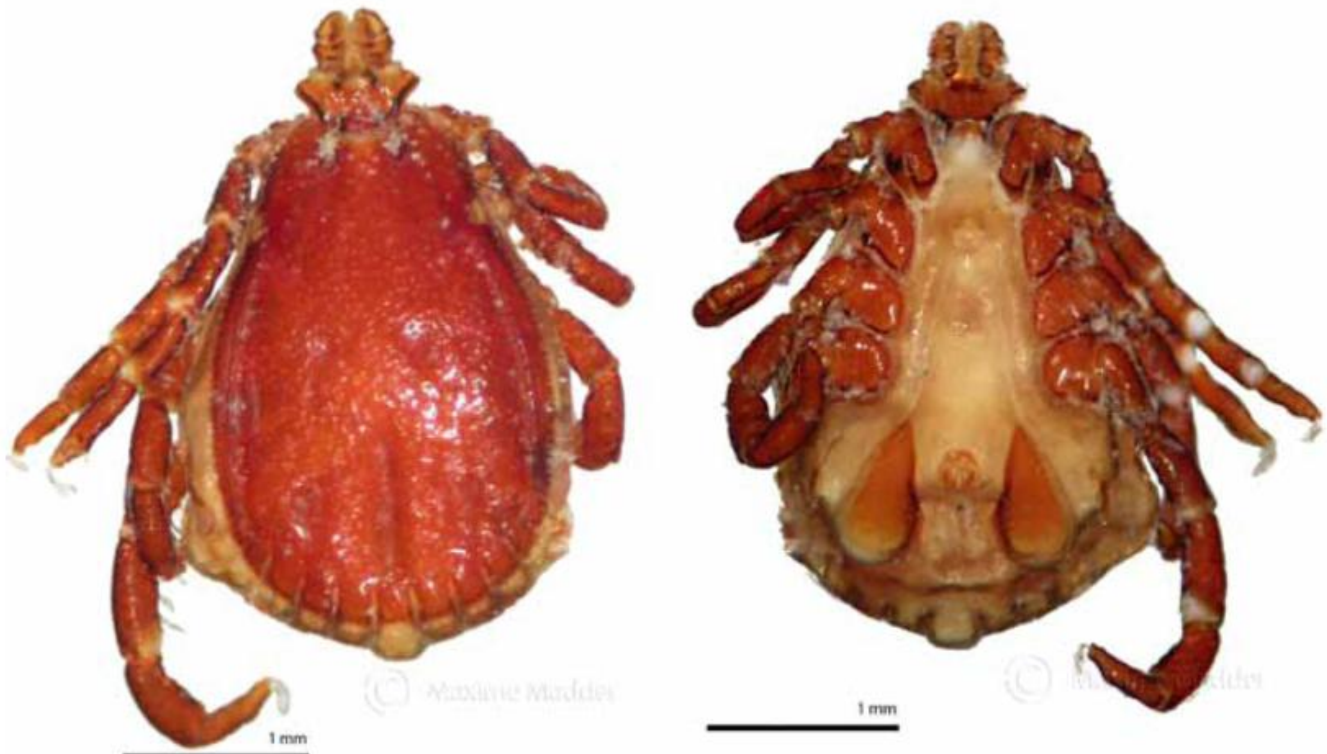
Rhipicephalus sanguineus Latreille, 1806



Male dorsal (left) and ventral (right)

Female dorsal (left) and ventral (right)

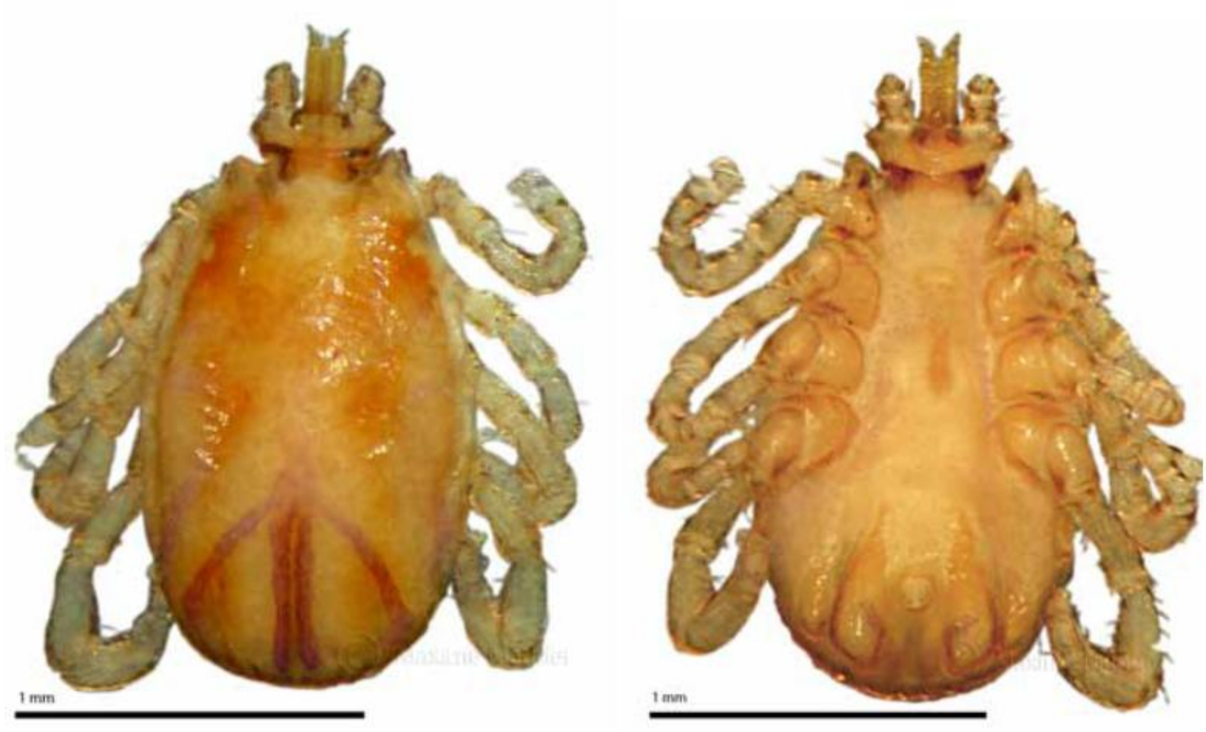
Rhipicephalus turanicus Pomerantsev 1936



Male dorsal (left) and ventral (right)

Female dorsal (left) and ventral (right)

Rhipicephalus (Boophilus) annulatus Say, 1821



Male dorsal (left) and ventral (right)

Female dorsal (left) and ventral (right)

Hyalomma marginatum Koch, 1844

Male, ventral view

Male dorsal (left) and ventral (right)

Female dorsal (left) and ventral (right)

Hyalomma scupense Schultze, 1919

Male dorsal (left) and ventral (right)

Female dorsal (left) and ventral (right)

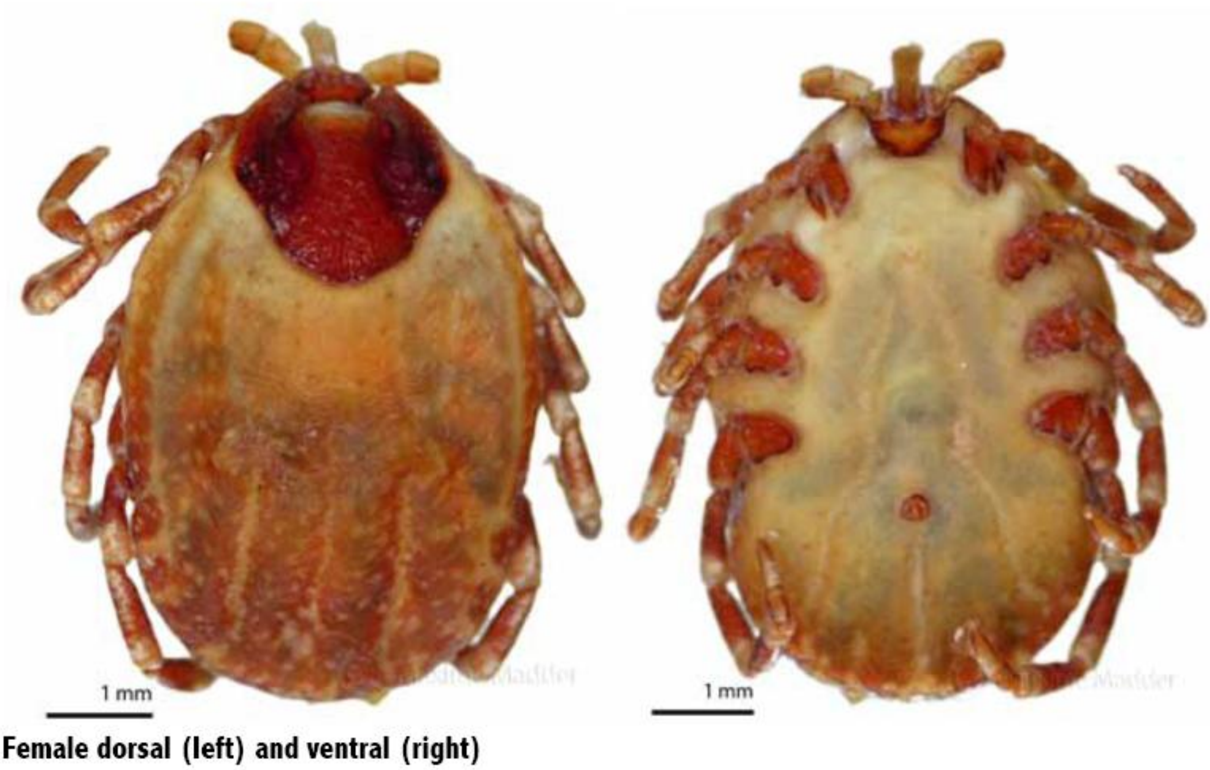
Hyalomma excavatum Koch, 1844

Male dorsal (left) and ventral (right)

Female dorsal (left) and ventral (right)

Hyalomma lusitanicum Koch, 1844

Male dorsal (left) and ventral (right)



Female dorsal (left) and ventral (right)

Dermacentor marginatus Sultzer, 1776

Male dorsal (left) and ventral (right)

Female dorsal (left) and ventral (right)

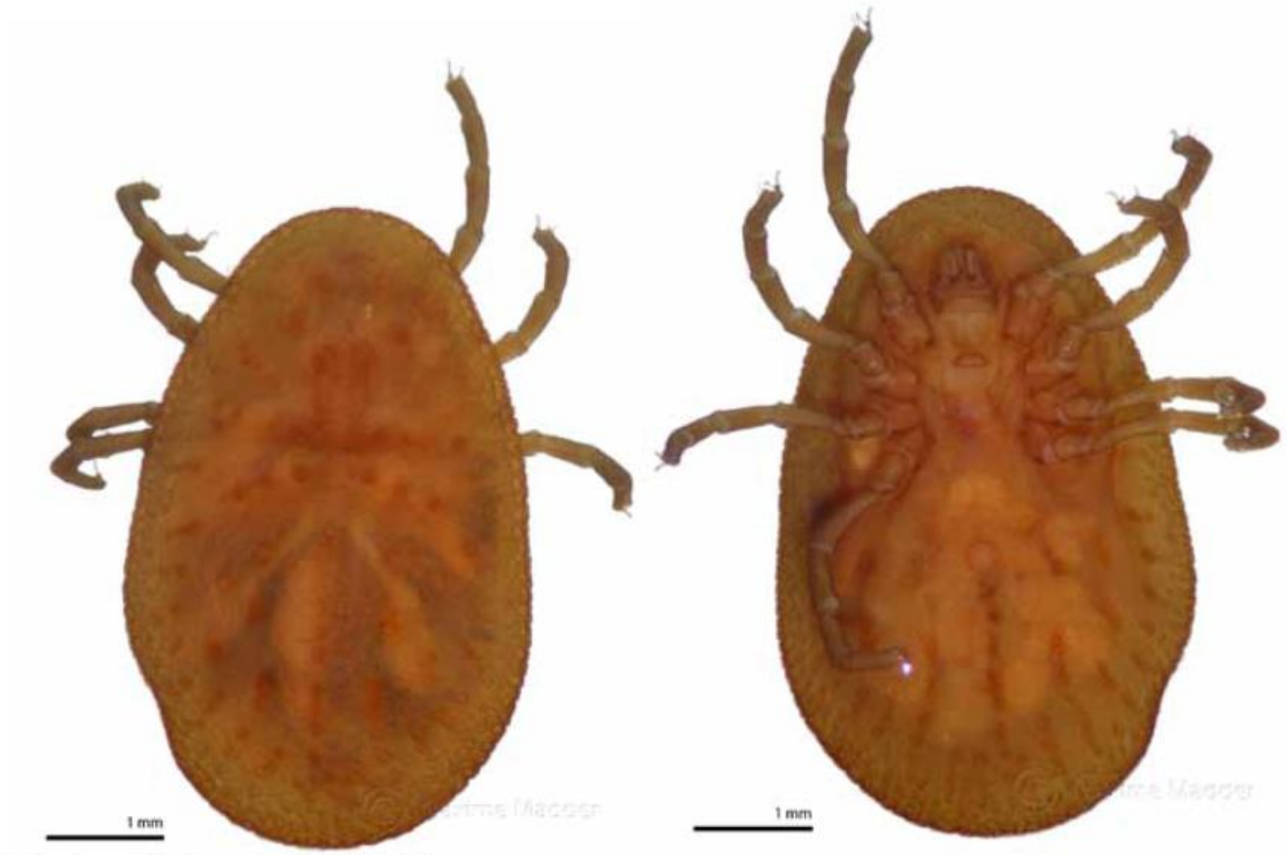
Dermacentor reticulatus Fabricius, 1794

Male dorsal (left) and ventral (right)

Female dorsal (left) and ventral (right)

SOFT TICKS (ARGASIDAE)

Argas periscus Oken, 1818



Male dorsal (left) and ventral (right)

Argas reflexus Fabricius, 1794

Male dorsal (left) and ventral (right)

Ornithodoros erraticus (Lucas, 1849)

Male dorsal (left) and ventral (right)

Sample kindly provided by Dr. Laurence Vial (CIRAD BIOS, France)