Vectors and Hosts of *Rickettsia felis* in Europe

Subjects: Veterinary Sciences

Contributor: Constantina N. Tsokana , Ioanna Kapna , George Valiakos

Rickettsia felis in an obligate intracellular Gram negative bacterium and the causative agent of flea-borne spotted fever (FBSF). *Rickettsia felis* requires a vertebrate and invertebrate host to survive and reproduce. The cat flea (*Ctenocephalides felis*) is considered as the primary vector and the reservoir host of this pathogen.

Rickettsia felis rickettsiosis zoonosis

1. Introduction

Rickettsia felis requires a vertebrate and invertebrate host to survive and reproduce. The cat flea (*Ctenocephalides felis*) is considered as the primary vector and the reservoir host of this pathogen [1][2]. *Rickettsia felis* has been also identified in various flea species and there is a growing evidence of detection in other arthropods: ticks, mites, lice and mosquitoes. Similarly, the host range of *R. felis* is increasing; reports on infected humans, domestic and wild animals are coming from all over the world. However, the competency of the different arthropods and hosts as vectors and reservoirs, respectively, is yet to be demonstrated [2].

Rickettsia felis follows the distribution of its vector; it occurs on all continents except Antarctica [3]. The first human case was reported in Texas in 1994 [4] and the first autochthonous human case was reported in Europe in 2002 [5], suggesting that this pathogen was not restricted to USA and it had the potential for global distribution. The lack of specific diagnostics and the similarity of FBSF with the disease caused by *R. typhi* [Flea-borne (murine) typhus] or with other vector-borne diseases, potentially leads to the under-diagnosis of the disease caused by *R. felis.* Thus, the true number of *R. felis* cases may be under-estimated. Under-reporting may also be enhanced by the self-limiting nature of the disease [2].

Although originally considered a sporadic disease, febrile illness has recently been regularly associated with *R. felis* in sub-Saharan Africa; the monthly incidence of *R. felis* infection in humans was found to reach approximately 17% during spring [6][7]. The recent identification of *R. felis* in the literature, and the increasing number of human cases from different regions in parallel to the fast-growing reports of the worldwide detection of *R. felis* in different arthropod and host species, justify its designation as an emerging pathogen [2][8][9].

2. Vectors and Hosts of *R. felis* in Europe

2.1. Vectors

During 2017–2022, a total of 11 European countries reported the occurrence of *R. felis* in several vector species (**Figure 1**). The vectors found to be infected included flea, tick and mite species; the dominant flea and tick species were *C. felis* and *I. ricinus*, respectively. The baseline characteristics of the studies on vectors which were included in **Table 1**.

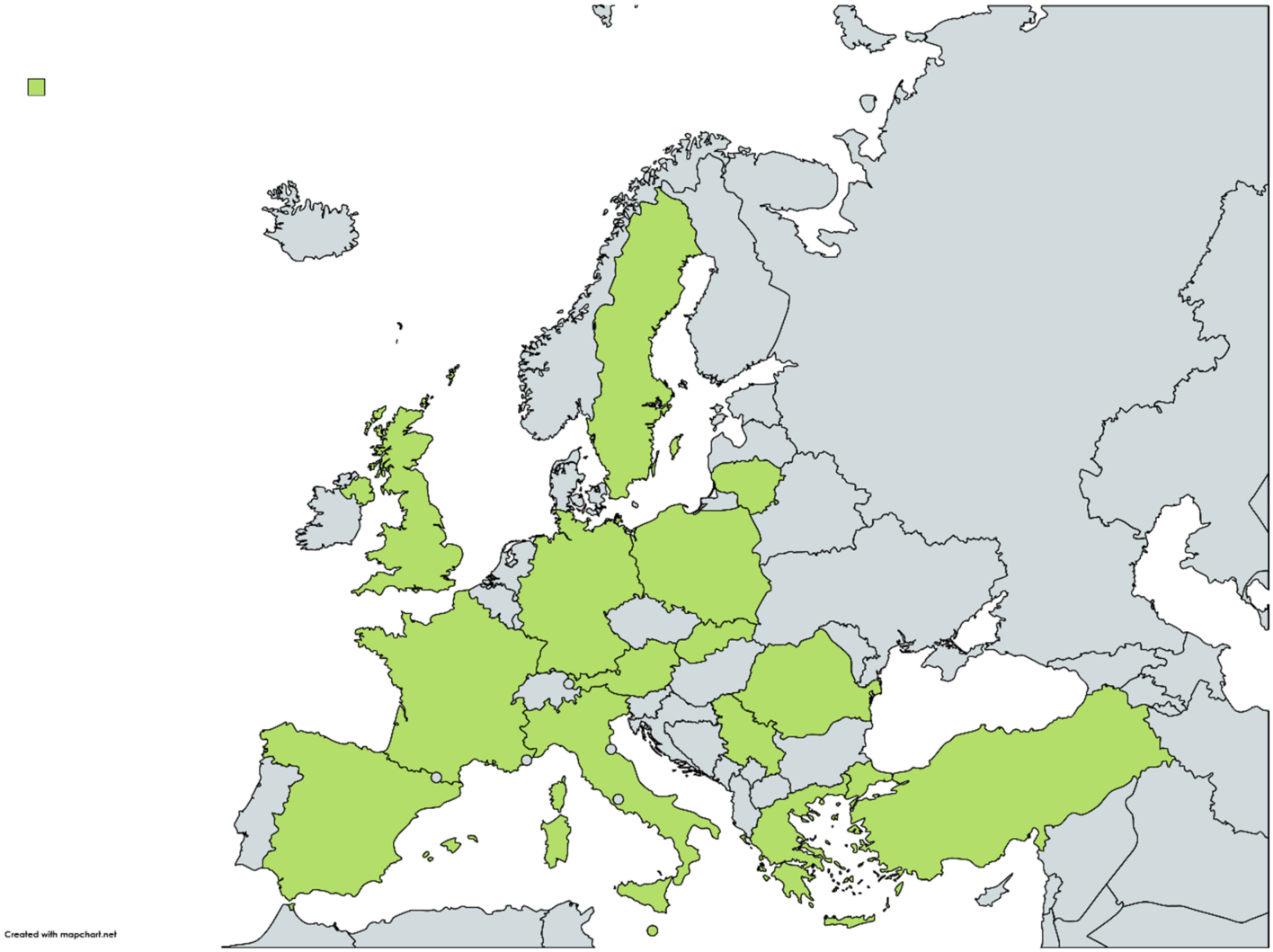

Figure 1. Map showing the European countries (in green) that reported the occurrence of *R. felis* during 2017–2022 in hosts and vectors (https://www.mapchart.net/europe.html, accessed on 12 November 2022).

Table 1. The reported occurrence of *R. felis* in different vectors in Europe (2017–2022).

Countries	Study Period	Vectors	Prevalence in Vector	Vector Hosts	Reference
Austria	2016	*C. felis*	Not defined (1/105)	Cats	[10]
France	2014–2017	*I. ricinus*	0.1% (1/998)	Environment	[11]

Countries	Study Period	Vectors	Prevalence in Vector	Vector Hosts	Reference
France	2017	*I. ricinus*	7% **	Environment	[12]
Greece	2013	*C. felis*	13% (3/23)	Cats	[13]
Greece	2016–2017	*C. felis*, *C. canis*, *P. irritans*	14% (14/100) *	Dogs and Cats	[14]
Italy	2013	*Rh. turanicus*	2.9% (1/34) *	Sheep	[15]
Italy	2014–2016	*I. hexagonus*	Not defined	Hedgehog and fox	[16]
Lithuania	2013–2014	*H. microti*, *L. agilis*, *Ct. agyrtes*, *H. talpae*	Not defined	Rodents	[17]
Malta	2017	*C. felis*	39.47% (15/38)	Cats	[18]
Malta	2017	*C. felis*	96.42% (54/56) *	Cats	[19]
Romania	2018	*I. ricinus*	Not defined (1/222)	Rodents, birds, hedgehogs	[20]
Serbia	2019	*I. ricinus*	3% (1/31)	Humans	[21]
Serbia	2020	Ticks	4.3%	Humans	[22]
Slovakia	2012–2014	*N. fasciatus*, *Ct. assimilis*	Not defined	Rodents	[23]
Slovakia	2014–2016	*Ct. solutus*	Not defined	Small mammals (*A. agrarius*)	[24]
Spain	2011–2018	*C. felis*	28.3% (15/53)	Dogs	[25]
		A. erinacei	33.3% (6/18)	Hedgehogs	
		Ct. b. boisseauorum	1.6% (1/60)	Rodents (*A. terrestris*)	
Spain	2015–2017	*I. ricinus*	0.46% (1/219)	Environment	[26]
Spain	2019–2020	*C. felis*	29.6% (38/128)	Dogs and Cats	[27]
UK	2018	*C. felis*, *C. canis*	5.7% (27/470) *	Dogs and Cats	[28]

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2. Yazid Abdad, M.; Stenos, J.; Graves, S. Rickettsia felis, an Emerging Flea-Transmitted Human Pathogen. Emerg. Health Threat. J. 2011, 4, 7168.

2.2. Hosts

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During 2017–2022, a total of nine European countries reported the occurrence of *R. felis* in different hosts (**Figure 1**). The hosts found to be infested by *R. felis* by molecular methods or exposed to *R. felis* by serology were humans, cats and small mammals. The baseline characteristics of the studies on hosts which were included in **Table 2**.

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Table 2. The occurrence of *R. felis* in different hosts in Europe (2017–2022).

Countries	Study Period	Host	Prevalence in Host	Reference
Germany	2008	Human	2.7% (15/559) *	[29]
Germany	2010–2014	Wild mammals (*A. amphibious*, *A. flavicollis*, *A. sylvaticus*)	Not defined	[30]
Germany	2012–2014	Small mammals (*A. flavicollis*)	Not defined	[31]
Greece	2013	Human	3.5% (8/223) *	[13]
Italy	2010–2016	Cats	8.04% (23/286) *	[32]
Italy	2018–2021	Cats	17.89% (17/95) *	[33]
Malta	2017	Cats	0%	[19]
Poland	2014	Small mammals (*A. flavicollis*)	Not defined	[34]
Serbia	2019	Human	3% (1/30)	[21]
Serbia	2020	Human	Not defined (1/85)	[22]
Slovakia	2014–2015	Small mammals (*A. flavicollis*)	1.1% (3/27)	[35]
Sweden	2015	Human	Not defined *	[36]
Turkey	2017–2021	Cats	26.3% (44/167)	[37]

* Serological methods (IFA/MIF).

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European countries reported the detection of *R. felis* in several arthropod and host species (fleas, ticks and mites, and cats, small mammals and humans, respectively). Several studies provided the first evidence of *R. felis* detection in some countries, vectors or animal species, such as in *Ct. agyrtes* and *H. talpae* fleas and *H. microti*

and *L. agilis* mites in Lithuania [17], fleas from cats in Malta [18], *Ct. b. boisseauorum* fleas in Spain [25], *Rh. turanicus* in Italy [15], cats in Turkey [37] and *A. flavicollis* in Slovakia [35]. In the studies conducted, *R. felis* positive fleas, ticks and mites were removed from different hosts: cats, dogs, hedgehogs, foxes, sheep, rodents, birds, small mammals *(A. agrarius*, *A. agrarius)* and humans, as well as from the environment (flagging) [14].

Among the flea species examined, *C. felis*, *C. canis*, *P. irritans*, *Ct. agyrtes*, *H. talpae*, *Ct. solutus*, *N. fasciatus*, *Ct. assimilis*, *A. erinacei* and *Ct. b. boisseauorum* were found to be infected with *R. felis*—with some of them being the first ever records [10][13][14][17][18][23][26][27][35]. Other flea species that have been found to be infected in previous studies include: *C. daensis*, *Anomiopsyllus nudata*, *Ctenophthalmus* sp., *X. cheopis*, *X. brasiliensis*, *Tunga penetrans*, *Ceratophyllus gallinae*, *Spilopsyllus cuniculi* and *Echidnophaga gallinacea* [9][38][39].

Although numerous flea species have been found to be infected by *R. felis*, the cat flea is deemed as the primary vector of *R. felis*. Furthermore, the pathogen has been identified in the mid-gut, ovaries and salivary glands of *C. felis* suggesting that infection is disseminated within the arthropod [40]. Moreover, *R. felis* is transmitted transovarially and transstadially in cat fleas and vertical transmission of *R. felis* persists in *C. felis* for at least 12 generations without the aid of any *R. felis*-infected blood meal [41][42].

Several host species, including cats, dogs, opossums, raccoons, rodents, and humans, were either seropositive or PCR positive for *R. felis* DNA. However, until now, a definitive host with appropriate clinical signs and bacteremia has not been identified [3][8][43]. The vertebrate hosts which were found to be *R. felis* infected or exposed during investigations in the last five years in Europe are cats (0–26.3%) [32][33][37], small mammals (1.1%) [35] and humans (2.7–3.5%) [13][21]. Free-roaming animals as well as the wild animals are of increased importance as they do not receive routine veterinary care as domestic cats and dogs do. Especially under certain circumstances that bring wildlife, free-roaming cats, and domestic animals in close proximity (e.g., when food is left outdoors), the potential for exchanging fleas and other ectoparasites increases [44].

Rickettsia felis is an emerging arthropod-borne pathogen which has been detected in a wide range of vectors and hosts worldwide. However, the role of the multiple arthropods that harbor the pathogen is still unclear; extensive field research, including of hosts and vectors close to the residences of *R. felis* human cases, would provide an insight into the components involved in the transmission chain. Clinicians should be aware of the epidemiology of the disease caused by *R. felis* and include it in the differential diagnosis of febrile disease with or without the presence of a rash. Additionally, clinicians should be well-informed about the possible arthropod species that could harbor *R. felis* and include information on exposure to these vectors during data collection of the clinical case history. As for pets, veterinarians should keep training pet owners on the need for effective year-round arthropod control, especially for fleas, on their pets and in the environment.

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