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LYME BORRELIOSIS IN DOGS: DISTRIBUTION AND EPIDEMIOLOGY

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ABSTRACT

A review of the literature on canine Lyme borreliosis is performed. An emphasis is put on the distribution, the epizootic particularities and the newest contributions to the subject. Numerous data are cited with a special attention on the epidemiology of the disease in Bulgaria.

Key words: *Borrelia burgdorferi*, epidemiology, distribution, Bulgaria

Lyme borreliosis is a relatively new zoonosis. For the first time, it was described by the American rheumatologist Dr. Allen Steere in 1975 in men with arthritis in the town of Lyme, Connecticut, USA hence the origin of its name.

The Lyme borreliosis (LB) is caused by spirochetes from the *Borrelia* species, *Borrelia burgdorferi* sensu lato complex (0.2 x 30 μm) [1, 2]. Among the dogs in Europe and Asia, the species *B. burgdorferi* sensu stricto (group 1), *B. garinii* (group 2), *B. afzelii* (group 3) and *B. japonica* (group 4) are encountered [2, 3, 4, 5]. In the USA, only one species - *B. burgdorferi* sensu stricto is shown to be involved at this time.

In most dogs, the borreliosis has a latent course. When clinically manifested, the signs are non-specific – anorexia and general depression. The most distinctive sign of the disease is the intermittent lameness, due to the developed arthritis. Very often however, the arthritis could not be detected by radiography [6]. Some papers report development of a heart block [7], neurological disorders – seizures [8] and renal failure [9].

The therapy of the disease is performed with antibiotics. Tetracyclines (doxycycline), penicillins (amoxicillin and ceftriaxone) and macrolides (azithromycin) are shown to be the most effective. In not all affected dogs however, a microbiological healing is always achieved [10, 11]. The antibiotic therapy course includes always a 3- to 4-week therapeutic protocol. The prolonged treatment of LB is related to the slow generation time of the causative agent – the organisms need 12 hours for a 2-fold increase in their numbers. Positive serological titres may be present long after the cessation of the therapy [11]. Sometimes, corticosteroids and other anti-inflammatory drugs could be administered, but always combined with antibiotics. Some studies have shown that in some cases, the therapy with the corticosteroid prednisone in subclinical infections could result in clinical manifestation of arthritis [11].

PREVALENCE

Data about the seroprevalence of the infection have been reported from the following areas:

Europe: Croatia, The Czech Republic, Germany, Italy, Slovakia, Spain, Sweden and Bulgaria (Table 1). The data referring to Europe show the lowest prevalence in the Leon region, Spain – 2.1 %. The incidence of LB in Sweden is also low – 3.9%. The highest seroprevalence was established in Bulgaria – 74.5%, followed by Prague, the Czech Republic with 53.7%. The lack of seroreagents in Italy should be noted;

America: Bolivia, Brazil, Mexico and the USA. The data from Bolivia confirmed the lack of infection in this country. The lowest seroprevalence was found out in Brazil– 0.04%, and the highest one – in Mexico– 16.0%. The data about LB incidence in the USA are very interesting and various. From 19 studied states and regions, the lowest seroprevalence was observed in North

Carolina – 0.4%, and the highest – in the Hudson valley, New York (76.3 %).

Asia: Israel and Japan. The data about the Asia continent showed 10.0% prevalence for Israel and 27.3% for Japan.

Africa, Australia. For these continents, no literature data are available

Table 1. *Prevalence of anti-Borrelia antibodies in dogs from different parts of the world*

Country	County	Method of detection	Prevalence (%)	No. of sample (*n*)	Reference
Bulgaria	Plovdiv	IFA	74.5%	55	Angelov *et al.,* 1993 [12]
	Stara Zagora	IFA	22.64	106	Zarkov and Marinov, 2003 [13]
		IFA	6.7	46	Martinov *et al.,* 2006 [14]
		ELISA	6.2	16	Martinov *et al.,* 2006 [14]
	South Bulgaria	ELISA	2.0	100	Tsachev and Petrov, 2006 [41]
Germany	Berlin	ELISA	10.1	189	Kasbohrer and Schonberg, 1990[17]
	Berlin	IFA	5.8	189	Kasbohrer and Schonberg, 1990 [17]
	Bavaria	IFA	35.5	130	Weber *et al*., 1991 [46]
		ELISA	7.2	665	Witenbrink *et al*., 1996 [47]
Spain	Castilla y Leon	IFA	21.0	308	Delgado and Carmenes, 1995 [33]
	Soria	IFA	11.6	146	Merino *et al*., 2000 [39]
	Leon	IFA	2.10	95	Rojo Vazquez, 1997 [54]
Italy	Tyrrhenian cost	IFA	0.0	23	Mannelli *et al*., 1999 [49]
Slovakia	Kosice	ELISA	26.9	78	Stefancikova *et al*., 1996 [34]
	Kosice (hunting dogs)	ELISA	45.3	75	Stefancikova *et al*., 1998 [53]
	Kosice (service dogs)	ELISA	18.3	60	Stefancikova *et al*., 1998 [53]
	Kosice (pet dogs)	ELISA	17.6	68	Stefancikova *et al*., 1998 [53]
Czech Republic	Prague	IHA	53.7	169	Sykora *et al*., 1990 [45]
Netherlands	hunting dogs pet dogs	ELISA ELISA	18.0 17.0	448 75	Goossens *et al*., 2001 Goossens *et al*., 2001 [52]
Croatia	Gorski Kotar	ELISA	40.0	10	Poljak *et al*., 2000 [44]
Sweden		ELISA	3.9	588	Egenvall *et al*., 2000 [55]
Israel		WB	10.0	40	Beneth *et al*., 1998 [48]
Japan	Tokyo	ELISA	27.3	387	Arashima, 1991 [50]
Bolivia	Cordillera	ELISA	0.0	43	Ciceroni *et al*., 1997 [20]
Brazil	Cotia	ELISA	9.7	237	Joppert *et al*., 2001 [42]
		ELISA	0.04	2553	Labarthe *et al*.,2003 [43]
Mexico	Monterrey	IFA	16.0	850	Salinas- Melendez *et al*., 1999 [51]
USA	Rhode Island	ELISA	52.0	227	Hinrichsen *et al*., 2001 [56]
	Illinois	ELISA	56.9	1 077	Guerra *et al*., 2000 [57]
	Fort Detrick	ELISA	20.0	440	Sheets *et al*., 2000 [58]
	California	ELISA	2.3	917	Olson *et al*., 2000 [59]
	Alabama	IFA	1.70	579	Wright *et al*., 1997 [60]
	New York	ELISA	49.2	1 446	Falco *et al*., 1993 [26]
	Oklahoma	ELISA	11.7	223	Mukolwe *et al*., 1992 [61]
	Columbia	ELISA	24.3	37	Stockham *et al*., 1992 [
	Maine	ELISA	4.34	828	Rand *et al*., 1991 [63]
	Texas	IFA	5.5 2	409	Cohen *et al*., 1990 [35]
	Oklahoma	IFA	18.0	259	Rodgers *et al*., 1989 [64]
	Connecticut	IFA	66.5	155	Magnarelli *et al*., 1987 [36]
	Hudson Valley	IFA	76.3	114	Magnarelli *et al*., 1987 [36]
	New Jersey	IFA	34.7	423	Schulze *et al*., 1987 [65]
	Wisconsin	IFA	53.0	380	Burgess, 1986 [66]
	North Caroline	ELISA	0.4	987	Duncan et al., 2004 [67]
	Virginia	ELISA	8.7	472	Duncan et al., 2004 [67]
	Maryland	ELISA	14.4	167	Duncan et al., 2004 [67]
	Pensylvania	ELISA	25.0	40	Duncan et al., 2004 [67]

The investigations on the incidence of LB among dogs, performed and published in Bulgaria, are not plenty. The first study is that of Anguelov et al. (1993) [12]. They have assayed 55 canine blood sera from enzootic regions (not specified) and using the indirect immunofluorescence analysis (IFA), a seroprevalence of 74.5% is reported. The next studies using the same method (IFA) are made by Zarkov and Marinov in 2003 [13], observing a 22.74% seroprevalence among 106 dogs in the Stara Zagora region. The data of Martinov et al. from 2006 [14] (the areas are not specified) showed a relatively low incidence – 6.7 % (using IFA) and 6.2% (ELISA).

The studies of Tsachev and Petrov performed in 2006 [15] (C6 ELISA) also demonstrate a low prevalence of the infection– 2%. A total number of 100 samples from the regions of Stara Zagora (2 positive), Plovdiv, Burgas, Yambol and Blagoevgrad have been analyzed.

Until now, the seroprevalence of LB among dogs was assessed mainly by means of two serological tests: indirect immunofluorescence analysis (IFA) and ELISA. The antibodies against LB could be detected 4-6 weeks after the infection. False positive results could be also obtained (in cases when the dogs have been vaccinated against LB etc.). Recently, a new diagnostic test has appeared on the market – C6 ELISA /IDEXX Snap® 3DXTM. It is based upon the detection of the C6 peptide from the immunodominant region IR6. The specificity of the test for LB is 100%, and its sensitivity – 92%. The test does not allow cross-reacting with vaccinal strains ad other bacterial microbial agents [16].

EPIDEMIOLOGICAL FEATURES

Lyme disease is among the commonest vector borne diseases in Europe and North America. In Europe, it is described in many animal species having contact with humans [17, 18, 19, 20, 21, 22]. About 40 mammalian and avian species are registered as reservoirs of *Borrelia burgdorferi* (Bb) [23]. In dogs, *B. burgdorferi* sensu stricto is most frequently proved [24]. Many scientists select and investigate dogs as sentinel animals for detection of endemic areas of disease in men [25, 26, 27, 28].

Lyme borreliosis is transmitted to the host by a vector – a tick. The shedding of borrelia begins 24 to 48 hours after tick's attachment to the body of the human or animal host. Meanwhile, the infectious agents pass from the haemolymph to the salivary glands and infect the host via tick's saliva at the moment of the bite [29]. The replication occurs at the place of the bite, followed by migration into tissues. The interaction between the micro- and the macroorganism results in the release of immune regulation factors – proinflammatory cytokines; IL-8, polymorphonuclear neutrophils (PMNs), IL-1a, and IL-1b are shown to regulate the inflammation of synovial membranes in dogs, experimentally infected with *B. burgdorferi* [30, 31]

The screening of dogs is a good indicator of the presence of infection among people in a given area. The Lyme disease survey performed in Wisconsin, USA [32] showed a relationship between the prevalence of disease among dogs (0–40%) and the rate of parasitic infections with *Ixodes scapularis*.

Some epidemiological studies have shown that:

- The seroprevalence of the Lyme disease was not related to either the gender or the season [33].
- There is an age-dependent prevalence, evidenced in Slovakia [34], Spain [27] and North America [25, 35].
- A correlation with the genophenotypic traits of the dogs was investigated. Thus, in dogs with hard hair, Merino *et al*., 2000 [27] have observed a higher incidence of antibodies against Bb.
- There was not a significant difference between the size of dogs and their gender [27, 33, 36].
- The dogs living at a higher altitude exhibited a relatively lower seroprevalence than those living at a lower one [25].
- The high seroprevalence of borreliosis among cats (33%) does not exclude them from the risk group in the epidemiology of the disease [21].

In Europe and Asia, vectors of the diseases are the ticks from the *Ixodes* gender - *I. ricinus* and *I. persulcatus* that transmit borrelia to mammals, birds and reptiles.

The epidemiological peculiarities of LB among people in **Bulgaria** showed clearly the leading role of *Ixodes Ricinus* in the vector borne mechanisms of the disease. The average rate of infection of *I.Ricinus* with borrelia in our country, determined by Hristova et al. (2003)

was 3% [37]. The commonest species were *B. afzelii , B. burgdorferi* sensu stricto and *B. garinii.*

Active natural foci of Lyme disease in people exist in some regions of the country. The Stara Zagora region is the most affected, followed by the regions of Burgas, Varna, Shoumen, Veliko Tarnovo etc.

In the period 1995 – 2004, 258 cases of LB are registered in the region of Stara Zagora, the average morbidity rate for the region being 5.97 $^{0}/_{0000}$. The lowest morbidity rate was found out in 1997 (0.54 $^{0}/_{0000}$), the highest one – in 2004 (23.18 $^{0}/_{000}$, almost 4 times higher than the average annual rate) [38]. The territorial analysis showed the highest incidence for the studied decade in the municipality of Opan – 28.03 $^{0}/_{0000}$, followed by the municipality of Galabovo – 18.9 $^{0}/_{0000}$. During the last year of the survey however, the first place is occupied by the municipality of Galabovo with morbidity rates five times higher than the average for the region (126.2 $^{0}/_{0000}$ and 23.18 $^{0}/_{0000}$ respectively) [38]. In 26 districts in Bulgaria, there were 3261 cases of Lyme disease from 1990 to 2002 [39].

Two clinical cases of Lyme disease in dogs from Bulgaria are reported. The first one was in an 8-year-old Boxer from Sofia with erythematous form of LB [40]. The second case was in a %-year old German Shepherd from Stara Zagora – coinfection with *Ehrlichia Canis* and *Borrelia burgdorferi* [41].

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