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COMPARATIVE CONSIDERATIONS ON THE EPIDEMIOLOGY OF LYME BORRELIOSIS AND TICK-BORNE ENCEPHALITIS IN SWITZERLAND

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INTRODUCTION

The broad-leaved tree forests with rich undergrowth represent the favourite biotopes for the tick *Ixodes ricinus* in Switzerland. This tick species is widespread in these forests under an altitude of 1000 meters (Aeschlimann 1972).

In Switzerland, the role of *I. ricinus* as a vector of diseases of man and animals is not negligible (Aeschlimann et al. 1979, Burgdorfer et al. 1983). Among the diseases, two concern human health: Lyme borreliosis (LB) and tick-borne encephalitis (TBE) which may cause serious pathogenic effects. The causative agent of LB is a spirochete, *Borrelia burgdorferi*. This disease is now recognized as a syndrome including dermatological, neurological, cardiac and rheumatological manifestations. TBE is a nervous system disorder caused by the western subtype of the TBE-virus complex, a RNA virus belonging to the *Flavivirus* group (Flaviviridae).

B. burgdorferi was discovered in *I. ricinus* from Switzerland in 1983 (Burgdorfer et al. 1983). Some months later, the occurrence of this bacterium in *I. ricinus* was assessed and these investigations showed that the distribution of spirochete infected *I. ricinus* is large and rather regular (Aeschlimann et al. 1986). *B. burgdorferi* has been detected in 5 to 50 % of this tick species and no population of *I. ricinus* devoid of infection has been observed in Switzerland to date. This means that *B. burgdorferi* is geographically well distributed in Switzerland.

The high frequency of *B. burgdorferi* infection in *I. ricinus* prompted other authors and us to investigate the Swiss population for antibodies against this bacterium (Satz et al. 1988, Gern et al. 1989, Miserez et al., 1991). These studies concerned patients entering 3 hospitals from 3 different regions of Switzerland. None of these patients presented any clinically active form of LB. The results have shown that the seroprevalence of antibodies against *B. burgdorferi* may be very high (27 %) in contrast to the low incidence of the disease.

Not only do these studies suggest that the exposition to *B. burgdorferi* infected *I. ricinus* must be frequent but they also reveal the presence of clusters of serologically positive populations in the Swiss territory, which is correlated with the increased risk of infection in small villages in regions heavily infested with ticks.

In addition, there is evidence that clinical cases of LB in Switzerland are strongly linked to the distribution of *I. ricinus* (Aeschlimann et al. 1986). Thus, this disorder seems to have a rather wide range in the Swiss territory.

In contrast to LB, clinical cases of TBE are concentrated in foci scattered in well delimited regions. Clinical evidence of this disease in humans in Switzerland was first obtained in 1969 (Krech et al. 1969, Spiess et al. 1969). Seroepidemiological studies have been conducted among humans and animals, and ticks were also investigated (Wyler and Matile 1984). In 1984, 12 different natural foci of TBE were recognized but they seem to be increasing in number. An average of 25 clinical cases per year are recorded by the Swiss Public Health Department.

Added to this, the infection prevalence of *I. ricinus* by TBE virus in the different foci is low since it occurs in less than 1 % of ticks (Matile 1982). This also contrasts with the high percentage of *B. burgdorferi* infected ticks.

Thus it appears that the epidemiology of these two tick-borne diseases is very different.

COMPARATIVE STUDY ON LB AND TBE

In order to obtain comparable data on both LB and TBE, we studied a population at risk (forestry workers) from different parts of the country (Fig. 1). We present here our first results.

The sera of 645 forestry workers were tested by ELISA for IgG using either a sonic extract of *B. burgdorferi* as antigen (Gern et al. 1989) or a purified virus antigen (Matile 1982). Sera from TBE-vaccinated persons were only tested against *B. burgdorferi*.

The prevalence of specific antibodies against both agents are reported in Fig. 1. A relatively high percentage of the studied population showed antibodies against *B. burgdorferi*. Some differences were observed from one region to another but they were strongly correlated with the abundance and the geographical distribution of the vector and especially with its preferred biotopes. Therefore, it is clear that the great majority of forestry workers in Switzerland are frequently exposed to *B. burgdorferi* infected *I. ricinus*.

On the other hand, the results obtained in the case of TBE virus revealed different epidemiological situations. Only a few forestry workers have been in contact with virus infected ticks. In the great majority of areas, the seroprevalence of positive individuals was 0 %. Two exceptions were observed in the canton of Grisons (9.1 %) where a focus has been active for many years and in the canton of Bern (4.4 %) where the presence of new foci is suspected.

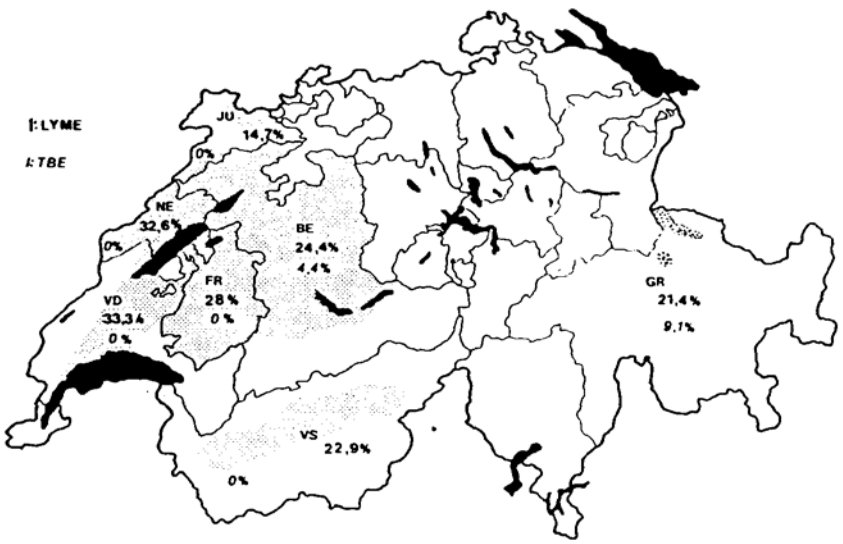

Figure 1. Prevalence of antibodies against *B. burgdorferi* and tick-borne encephalitis virus in forestry workers in Switzerland. origin of tested sera.

CONSIDERATIONS ON THE EPIDEMIOLOGY OF TBE AND LB

The most interesting result from this study is the discrepancy observed between the seroprevalence of antibodies against *B. burgdorferi* and TBE virus. The problem is how to explain why the seroepidemiological situations of LB and TBE are so different in humans.

The circulation of the spirochete and the virus in nature is independent of humans. In acquiring the infection, humans reveal the presence of a natural focus. The epidemiological features of the infections depend on the conditions under which the microorganisms circulate in nature. This raises questions about the discriminative infection rate of *I. ricinus* by the virus and the bacterium. Thus the origin of the observed discrepancy lies in the circulation of the organisms in the natural foci of the diseases.

Few will dispute the claim that the ecology and epizootiology of tick-borne disease foci are very complex. Nevertheless, it is clear today that both the virus and the spirochete can be transstadially and transovarially transmitted by the tick *I. ricinus* as suggested by the presence of these microorganisms in unfed field-collected ticks (Matile 1982, Aeschlimann et al. 1986, Zhioua et al. 1988, Miserez et al., 1991; (Fig. 2). However, the success of transovarial transmission is so low in nature that it can not ensure by itself

the maintenance of a focus. Thus, most larval ticks will have to feed on infected hosts to acquire the infection. Small mammals are recognized as important hosts for *I. ricinus* larvae (Aeschlimann 1972) (Fig. 2). What is the reservoir competence of these rodents for the spirochete and the virus?

In the case of TBE, the virus is present in the peripheral blood of small mammals only for a few days and then disappears from the blood and is no longer accessible to the ticks (Matile 1982).

Concerning the LB spirochete, much work has been devoted by us to the elucidation of the reservoir role of small mammals (Humair et al. 1990). By xenodiagnosis, we demonstrated their ability to remain infectious for *I. ricinus* for very long periods (over two years in rodents maintained in captivity). It seems that once infected with *B. burgdorferi*, small mammals remain infectious for ticks until they die. Thus, the reservoir competence of rodents for *B. burgdorferi* is important and of long duration.

The observed discrepancy between *B. burgdorferi* and TBE virus infection rates of *I. ricinus* can be explained by the difference in the rodents' ability to infect ticks with these microorganisms. The reservoir competence of rodents for TBE virus is low in comparison with their reservoir competence for *B. burgdorferi*. Thus, the conclusion

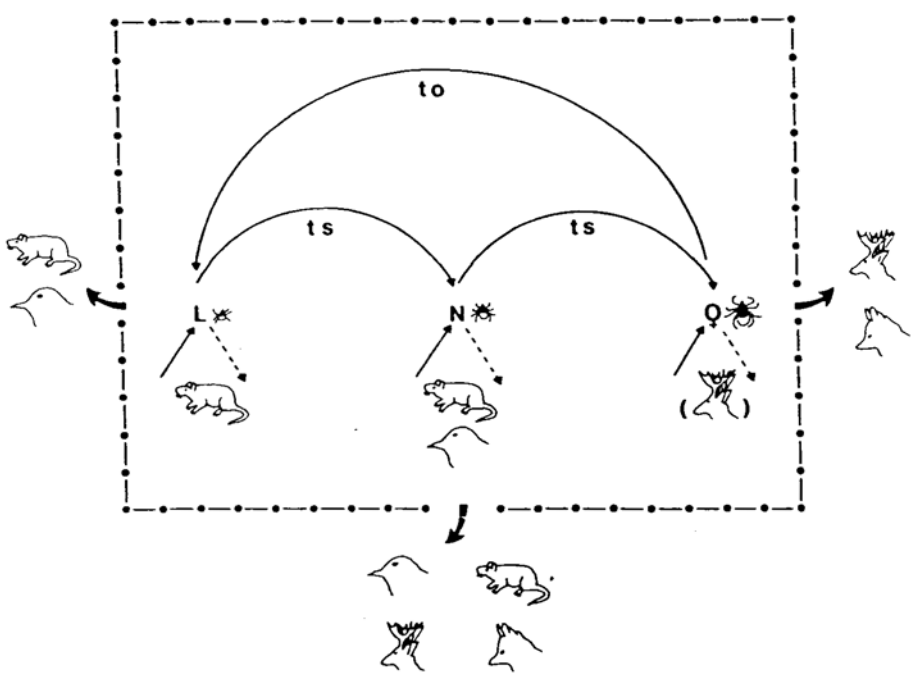

Figure 2. Scheme for the circulation of the microorganisms in nature. to: transovarial transmission; ts: transstadial transmission → : infecting blood meal ⇢ : infected blood meal —•— : natural focus ➘ : dispersal via infected ticks

which emerges from the previous considerations is that the epidemiological situation observed in humans reflects some aspects of the very complex circulation of the different organisms in natural foci.

SUMMARY

In Switzerland, the spirochete *Borrelia burgdorferi* and tick-borne encephalitis virus infect the human population. These infections may cause serious pathogenic effects to men and domestic animals. The tick *Ixodes ricinus* is the vector of both microorganisms. The distribution of the virus is concentrated in small foci scattered in some regions. In these areas, the infection occurs in less than 1 % of the ticks. The distribution of the spirochete is larger and more regular in the Swiss territory and *B. burgdorferi* is present in 5 to 50 % of *I. ricinus*. It is the aim of this paper to try to explain how both types of foci occur, considering especially the problem of small mammals as reservoirs for the bacterium and the virus.

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