RESERVOIR HOSTS OF THE TBE VIRUS

Background

About 500 arboviruses have been described. The main factor for the circulation of any arbovirus is the interplay between the arthropod vector and its reservoir hosts. In order to effectively transmit the virus, a sufficient number of susceptible hosts have to be present in a given region to achieve virus amplification. The TBE virus remains restricted to natural foci, with strict borders drawn under factors that are yet widely unknown. Among at least 22 tick species which have been shown to be able to carry the virus, the most important tick vector in Europe is *Ixodes ricinus*, whereas in Asia, it is *I. persulcatus*. In Asia, *Haemaphysalis concinna* also seems to play a major role. *Dermacentor reticulatus*, which rarely attacks humans, also leads to a potential circulation of the TBE virus.

Results

Small mammals such as rodents and insectivores are suspected as the main reservoir hosts for the TBE virus. Each tick stage has a certain range of target animals, such as adult ticks mainly targeting large animals (e.g. roe deer, *Capreolus capreolus*), while nymphs and larvae prefer small and medium-sized animals, including birds. The latter may translocate ticks over long distances, also to new endemic regions. A route of TBE virus dissemination within the tick population is the consumption of blood from a viremic host by a naïve tick. The other route is co-feeding: Through the simultaneous feeding of an infected tick, as well as an uninfected (naïve) tick in close proximity on the same host, the TBE virus can be transferred from one tick to another, even without viremia of the host. In the latter case, ticks may be considered to be their own virus reservoir and the animal used for transmission of the virus can just be regarded as a bridge (vehicle) for the transmission of the virus.

Small rodents of the genus *Myodes* and *Apodemus* are perfect virus amplification reservoirs, because they can easily be infected and can maintain the virus for a long time without suffering from the viral infection. The yellow-necked mouse *Apodemus flavicollis* seems to be the most adapted species for TBE virus and to *Ixodes ricinus* ticks. Other important reservoirs are the bank vole *Myodes glareolus* and the two European hedgehog species *Erinaceus roumanicus* and *Erinaceus europaeus*. In Russia, a high prevalence of TBE virus has been observed in the striped field mouse *Apodemus agrarius*, the northern red-backed vole *Myodes rutilus* and the grey red-backed vole *Myodes rufocans* as well as the common shrew *Sorex araneus* and the Northern birch mouse *Sicista betulina*. In Japan, surveillance studies show the importance of the large Japanese field mouse *Apodemus speciosus* and the small field mouse *Apodemus aregenteus*. Closely related species seem to be able to take over the role as the main reservoir host in the absence of the original host.

To create a suitable environment for TBE virus circulation, multiple factors play a role, e. g. certain botanical, zoological, climatic and geo-ecological conditions. A temperature level of more than 7 degrees and a relative humidity of over 80% for most of the time create a suitable tick environment. In contrast to the tick-borne pathogen *Borrelia burgdorferi* s.l., the TBE virus is not found evenly spread among the tick population but is clustered to certain areas from about a few square meters to several kilometers in size, the so-called natural foci. From an endemic area of only 2500 square meter - a microfocus - TBE virus infected ticks may be carried over an area of about one kilometer in diameter around this microfocus by medium- and large-sized animals leading to a macrofocus.

Discussion

There are only a few scientific data about virus titers of viremia in a potential reservoir host needed for efficient virus transmission. By experimental infection of rodents, high titers of TBE virus have been found in various organs for a long time. More infection studies, also in natural environments, may be useful because standardized laboratory conditions may not reflect the true conditions in nature. Although there is a classic view of small animals being the major reservoir hosts for TBE virus circulation, one may argue that ticks themselves represent a reservoir, circulating the virus within their population mainly through trans-stadial transmission over long time periods.

In the context of ticks, their hosts and their microbiota, another article may be of interest discussing the phylogenetic association between ticks and their microbial communities: Diaz-Sánchez et al., Evolutionary insights into the tick hologenome. *Trends Parasitol*. 2019, in press, doi.org/10.1016/j.pt.2019-06-014.

Literature

Michelitsch et al.
Exploring the reservoir hosts of tick-borne encephalitis virus,
Viruses 2019, 11, 669; doi:10.3390/v11070669

Author: Dr. Michael Bröker

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