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REVIEW

Infections in the natural environment of British Columbia, Canada

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Summary The Canadian province of British Columbia has a luxurious environment, complete with the multitude of wildlife and insects, and would at first glance appear to be suitable for the transmission of diseases in nature communicable to humans. Despite this potential, such diseases are relatively uncommon, although several have the potential for serious consequences. Attention has been recently focused on hantavirus infection, water-borne toxoplasmosis and parasitic diarrheal diseases, cryptococcosis on Vancouver Island, and rabies. West Nile virus has not yet caused endemic human infection in this province as of 2008. We review the cumulative science in this area.

Introduction

The abundance of forests in British Columbia (B.C.), Canada (Fig. 1) intermingled with both industry and public recreation would seem sufficient to ensure that people suffer from diseases acquired in nature. Such reports however are uncommon, although under-reporting is likely. Nevertheless, many such diseases have had considerable discussion given the potential for illness and given heightened awareness generated by media and other reports. For example, there are thousands of investigations requested yearly for Lyme disease even though the reported yearly cases can usually be counted on two hands [1].

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Figure 1 British Columbia is the western most province in Canada (highlighted in black). The large southwestern island is Vancouver Island.

Communicability

Infection in nature is spread to humans either directly from the infected or colonized source or through transmission by an insect (arthropod) vector (Table 1) [2—7]. Direct transmission may occur by ingestion of the microbe, direct contamination of skin (especially with an open wound) or mucous membranes, or by inhalation. Insect vectors may include ticks, fleas, mosquitoes, or lice. The latter vectors will usually act as an intermediary between humans and another mammal or a bird. In nature, the cycle of transmission will continue between insect and the non-human reservoir, sometimes causing a relatively asymptomatic infection while at other times causing morbidity or even death. Humans very rarely act to maintain this cycle of infectious burden in nature and rather become infected mostly as by-standers. An exception to the infectious characteristic is tick paralysis which is toxin mediated.

Whereas some diseases communicable to humans from nature have been cited for many decades (Table 2), others seem to have had an increasing frequency. The latter perception must be tempered by the understanding that some agents have been newly recognized and that, therefore, the epidemiological patterns are new observations.

Insect vectors of several types may be important intermediates. In B.C., the hard ticks *Ixodes pacificus* (Western black-legged) and *Dermacentor andersoni* (wood tick) are medically significant as is the soft tick *Ornithodoros hermsi* (Fig. 2) [3,6]. Mosquitoes could conceivably be carriers of Western equine encephalitis virus, West Nile virus, California encephalitis virus, and St. Louis encephalitis virus. Fleas can assist the transmission of plague, murine typhus, and cat scratch disease. Body lice (*Pediculus humanus*) are capable of transmitting *Bartonella quintana*.

Diseases in nature of concern

Anaplasmosis (ehrlichiosis)

Anaplasma spp. and *Ehrlichia* spp. closely resemble rickettsiae. These intracellular bacteria are tick-transmitted. Morshed cites three infections over 1993—1997 [1]. It is not clear whether such infections were imported. Infection with *A. equi* was documented in a horse from Vancouver Island [8]. Canine infection with *A. phagocytophilum* is detailed from Vancouver Island [9]. Such bacteria are believed to be carried by *Ixodes pacificus*. Deer, rodents, and other small mammals serve as reservoirs. Magnarelli et al. detected bacteria which were apparently similar to the above, although an exact characterization was not possible [10]. Among 20 female *Ixodes pacificus* ticks tested, 7 had evidence of rickettsia-like organisms.

Anthrax

Anthrax (*Bacillus anthracis*) is rare. Most infected animals in Canada are domestic cattle, and cattle vaccination programs have been initiated. One human skin infection was identified in B.C. although the source was uncertain [11,12]. A large domestic prairie outbreak in provinces east of B.C. affected cattle in 2006. In the wild, anthrax has been found among bison from Alberta and the former Northwest Territories and may have arisen as spread from domestic animals to wildlife [13].

Bartonellosis

In B.C., *Bartonella henselae* has been associated with cat scratch disease which is transmitted by felines or their fleas [14—16]. Infections are found on the Lower Mainland (southeast area close to Vancouver) and Vancouver Island. *Bartonella quintana* infection (systemic) has been rarely documented, and the major mode of transmission is from the body louse *Pediculus humanus* [15,17]. The potential role of other bartonellae in nature is also largely unexplored, but it is evident that many wildlife have unique bartonellae [18].