

***Mycobacterium avium* subsp. *paratuberculosis* in Lake Catchments, in River Water Abstracted for Domestic Use, and in Effluent from Domestic Sewage Treatment Works: Diverse Opportunities for Environmental Cycling and Human Exposure**

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Abstract

Mycobacterium avium subsp. *paratuberculosis* from infected animals enters surface waters and rivers in runoff from contaminated pastures. We studied the River Tywi in South Wales, United Kingdom, whose catchment comprises 1,100 km² containing more than a million dairy and beef cattle and more than 1.3 million sheep. The River Tywi is abstracted for the domestic water supply. Between August 2002 and April 2003, 48 of 70 (68.8%) twice-weekly river water samples tested positive by IS900 PCR. In river water, the organisms were associated with a suspended solid which was depleted by the water treatment process. Disposal of contaminated slurry back onto the land established a cycle of environmental persistence. A concentrate from 100 liters of finished water tested negative, but 1 of 54 domestic cold water tanks tested positive, indicating the potential for these pathogens to access domestic outlets. In the separate English Lake District region, with hills up to 980 m, tests for *M. avium* subsp. *paratuberculosis* in the high hill lakes and sediments were usually negative, but streams and sediments became positive lower down the catchment. Sediments from 9 of 10 major lakes receiving inflow from these catchments were positive, with sediment cores indicating deposition over at least 40 to 50 years. Two of 12 monthly 1-liter samples of effluent and a single 100-liter sample from the Ambleside sewage treatment works were positive for *M. avium* subsp. *paratuberculosis*. Since Lake Ambleside discharges into Lake Windermere, which is available for domestic supply, there is a potential for these organisms to cycle within human populations

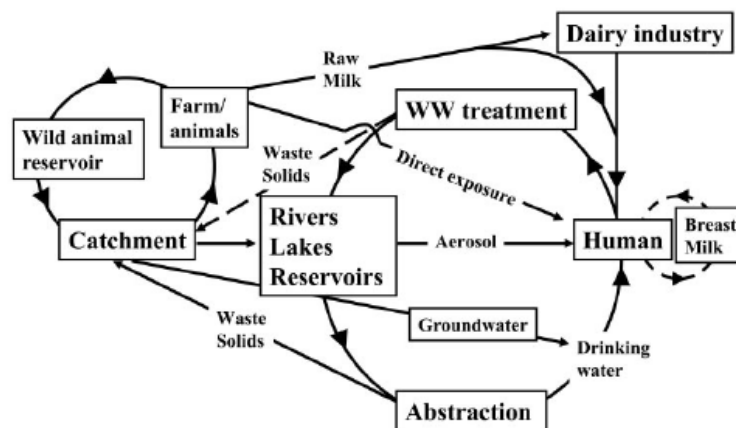


FIG. 4. Model of sources and sinks of *M. avium* subsp. *paratuberculosis* in the environment with respect to human exposure. This model incorporates the established route of transmission of this pathogen to humans via dairy products, especially milk, as well as hypothetical routes of transmission. It also incorporates the catchment cycle, which receives inputs from domestic livestock and wildlife reservoirs as well as agricultural practices such as slurry spreading. *M. avium* subsp. *paratuberculosis* enters water through runoff from the catchment, with aerosols from contaminated rivers and abstraction for domestic supply as potential sources of human exposure. Disposal of waste from water treatment onto catchments and the entry of effluent from sewage treatment works into sources of domestic supply constitute environmental cycles with opportunities for microbial evolution and enhanced pathogenicity.

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