Tick-borne Relapsing Fever Caused by *Borrelia hermsii*, Montana

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Five persons contracted tick-borne relapsing fever after staying in a cabin in western Montana. *Borrelia hermsii* was isolated from the blood of two patients, and *Ornithodoros hermsi* ticks were collected from the cabin, the first demonstration of this bacterium and tick in Montana. Relapsing fever should be considered when patients who reside or have vacationed in western Montana exhibit a recurring febrile illness.

Tick-borne relapsing fever, caused by *Borrelia hermsii*, is endemic in the higher elevations and coniferous forests of the western United States and southern British Columbia, Canada (1). Although many multicase outbreaks of relapsing fever associated with *B. hermsii* and its tick vector, *Ornithodoros hermsi*, have been reported (2–6), none has been documented in Montana. Patients usually become ill after they have slept in cabins infested with spirochete-infected ticks that feed quickly during the night. The illness has an incubation period of 4 to ≥18 days and is characterized by recurring episodes of fever accompanied by a variety of other manifestations, including headache, myalgia, arthralgia, chills, vomiting, and abdominal pain (1). Relapsing fever is confirmed by the microscopic detection of spirochetes in the patient’s blood (Figure 1)(7).

In 1927, relapsing fever was diagnosed in a 33-year-old man in Walla Walla, Washington, although his possible site of exposure was Montana (8). A specific location was not given, however, and spirochetes causing the illness were not identified. *Ornithodoros parkeri*, another tick vector of relapsing fever spirochetes in western United States, was collected during 1936 in Beaverhead County in southwestern Montana, and an undisclosed number of these ticks transmitted *Borrelia parkeri* to one mouse in the laboratory (9). If relapsing fever were to occur in Montana, *B. parkeri* transmitted by *O. parkeri* was suspected as being the likely etiologic agent (9,10).

In summer 2002, a multicase outbreak of relapsing fever associated with a privately owned cabin occurred in western Montana. Spirochetes were isolated from two patients and identified as *B. hermsii*, and this spirochete’s tick vector, *O. hermsi*, was collected from the cabin where the patients slept. This is the first multicase outbreak of tick-borne relapsing fever in Montana and the first report of *B. hermsii* and *O. hermsi* in the state, thereby documenting the risk of this infection beyond the geographic range known previously within the United States.

The Study

From July 30 to August 20, 2002, a total of 5 persons in a group of 20 became ill with symptoms consistent with tick-borne relapsing fever during or following their visit to western Montana (Table). The common site of exposure was a cabin on the south shore of Wild Horse Island (47°50’30” N; 114°12’30” W) in southwest Flathead Lake, Lake County, Montana. The 875-hectare island became a state park in 1978, although 56 privately owned properties exist, many of which have cabins. No one lives permanently on the island, and camping overnight (by day visitors to the island) is not allowed. The island is approximately 4.6 km wide from east to west and 3.2 km wide from north to south; its elevation varies from 881 m at the shoreline to its highest point of 1,141 m. The island is separated from the mainland by 2.0 km to the south and 2.4 km to the north. The habitats include Ponderosa Pine and Douglas Fir forests, native grassland, and steep rocky outcroppings. Red squirrels (*Tamiasciurus hudsonicus*) and deer mice (*Peromyscus maniculatus*) are abundant.

On July 22, the first of four related families arrived at the cabin, and on July 25, a 54-year-old man (case 1, Table)
DISPATCHES

Table. Summary of relapsing fever patients exposed in western Montana during July–August, 2002

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Patient age (y)</th>
<th>Sex</th>
<th>Onset</th>
<th>Signs/Symptoms</th>
<th>Initial blood smear</th>
<th>Final laboratory results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>54</td>
<td>M</td>
<td>July 30</td>
<td>38.9°C–39.4°C temperature, rash, headache, myalgia, arthralgia</td>
<td>Spirochete negative</td>
<td>Seropositive by IFA and Western blot</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>F</td>
<td>August 10</td>
<td>40.6°C temperature, vomiting, diarrhea, headache, myalgia</td>
<td>Spirochete positive</td>
<td>Mouse inoculation positive; isolation of <em>Borrelia hermsii</em></td>
</tr>
<tr>
<td>3</td>
<td>43</td>
<td>M</td>
<td>August 16</td>
<td>Fever, headache, myalgia, arthralgia</td>
<td>Spirochete positive</td>
<td>Mouse inoculation positive; isolation of <em>B. hermsii</em></td>
</tr>
<tr>
<td>4</td>
<td>43</td>
<td>F</td>
<td>August 30</td>
<td>38.9°C–39.4°C temperature, vomiting, diarrhea, headache</td>
<td>Spirochete negative</td>
<td>Mouse inoculation negative; no isolation</td>
</tr>
<tr>
<td>5</td>
<td>13</td>
<td>M</td>
<td>August 11</td>
<td>40.6°C temperature, vomiting, diarrhea, headache</td>
<td>Spirochete positive</td>
<td>Mouse inoculation and isolation not attempted</td>
</tr>
</tbody>
</table>

*Confirmed cases with demonstration of spirochetes in blood; presumptive cases with appropriate manifestations but no spirochetes detected.

This patient relapsed on August 6.

IFA, immunofluorescence assay.

entered the east end of the attic and removed nest material that had accumulated there. He slept at night and napped during the day in one of two bedrooms located immediately under the area of the attic where the nest material had been partially removed. On July 30, he became ill with fever, headache, arthralgia, myalgia, and rash, and 2 days later he visited the emergency room of a local hospital but a diagnosis was not made. Over the next several days he improved, and on August 6, he and his family began driving back to their home in Seattle, Washington. During the trip, he relapsed with another febrile episode. That evening, he was taken to the emergency room of a Seattle hospital and admitted early the next morning. On the basis of his history, a diagnosis of relapsing fever was considered, although spirochetes were not detected in the blood.

Three additional families (17 persons) arrived at the cabin on July 31 and on August 5 and departed on August 8 and 9. One family of five returned to their home in Seattle, and three of them became ill on August 12, 17, and 20 (cases 2–4). Relapsing fever was suspected immediately, and spirochetes were detected in Wright-stained blood smears from two patients (cases 2, 3). On August 10, a family of six returned to St. Louis, Missouri, where a 13-year-old boy (case 5) became ill the next day. On August 12, he was taken to an emergency room and to his pediatrician the following day. His mother communicated with the family in Seattle, where a young girl (case 2) was ill, and spirochetes had been detected in her blood. This discovery led to the detection of spirochetes in a blood smear from the boy. All patients had fever and other clinical manifestations consistent with tick-borne relapsing fever (Table). They were all treated with doxycycline or erythromycin, and all recovered with no subsequent relapses.

Blood smears from three of the Seattle patients (cases 2–4) were prepared and stained separately with monoclonal antibodies H9724, which recognizes all known species of *Borrelia* (11), and H9826, which is specific for *B. hermsii* (12), and rabbit hyperimmune serum to *B. hermsii* (Figure 2A). Indirect immunofluorescence assays (IFA) and microscopic analysis demonstrated spirochetes from two patients (cases 2, 3) that were reactive with all antibodies, which identified these bacteria as *B. hermsii*. Blood from the third patient (case 4) was negative for spirochetes with all antibodies. EDTA-treated whole-blood samples from these patients were injected intraperitoneally into mice, and the two samples positive by microscopic examination also produced detectable levels of spirochetemia in mice. Whole blood obtained from the infected mice was injected into modified Kelly’s medium (BSK-H supplemented with 12% rabbit serum; Sigma-Aldrich Corp., St. Louis, MO), and spirochetes that originated from two patients were isolated.

A convalescent-phase serum sample from the first case-patient (case 1) was collected 55 days after the onset of his illness. This sample was examined by IFA with whole cells of *B. hermsii* (13) and by immunoblot with a whole-cell lysate of *B. hermsii* and recombinant GlpQ (13). The patient’s IFA titer to *B. hermsii* was positive at 1:1,024, and the sample was positive by immunoblot at 1:100 dilution.

The five persons with confirmed or presumptive relapsing fever slept in two adjacent bedrooms in the east end of the cabin under the attic where animal nest material had been partially removed. People who slept only on the outside porch or in other bedrooms did not become ill. On August 24, 2002, the two east bedrooms were examined for ticks, but none were found. The remaining nest material was collected from the attic and taken to Rocky Mountain Laboratories. During the next several weeks, the material was processed with two small Berlese extraction funnels, which separate live arthropods from nonliving debris. Fourteen *O. hermsi* were recovered, including 1 larva, 10 nymphs, 2 males, and 1 female (Figure 2B). The postlarval stages of *O. hermsi* are very similar to those of *O. sparnus*, which parasitizes woodrats and deer mice in Utah and Arizona, but the latter species is an incompetent vector of *B. hermsii* (14,15). The larva collected from the attic displayed morphologic characteristics consistent with *O. hermsi*. Voucher specimens (one nymph, one larva) of *O. hermsi* collected at the study site were deposited in the U.S. National Tick Collection, Georgia Southern.
University, under accession number RML 123385. The 12 remaining ticks were allowed to feed on a laboratory mouse to determine whether they were infectious. The blood of the mouse did not become spirochetal during the 10 days after tick bite. These ticks were not examined for infection by other methods and were kept alive to establish a laboratory colony.

On June 21, 2003, the attic, utility room, and bedrooms where the infected persons slept were treated with an over-the-counter insecticide-acaricide (Ortho Indoor Insect Fogger, The Ortho Group, Columbus, OH). Sentinel O. hermsi ticks (late stage nymphs and adults) from a laboratory colony were confined in open flasks in one treated room. Five of these ticks were killed immediately after treatment, and one tick was allowed to feed prior to treatment and then removed from its host. All 50 ticks that were fed were allowed to feed through the night and were then killed and examined for evidence of further investigation. A serologic survey of red squirrels (Sorex cinereus) in the attic material that had been removed on July 25. American robins (Turdus migratorius) had nested in the attic, and two dead robin chicks were found in the material collected from the attic on August 24. Recently, a B. hermsii–like spirochete was implicated in the death of a northern spotted owl (Strix occidentalis) in Kittitas County, Washington (18), and many years ago, 26 O. hermsi were collected from the nest of a bluebird (either Sialia mexicana or S. currucoides) in Summerland, British Columbia (19). The role of birds in perpetuating relapsing fever spirochetes and their tick vectors in nature is worthy of further investigation. A serologic survey of red squirrels and deer mice in the vicinity the cabin for immunologic evidence of exposure to B. hermsii might also help explain the enzootic involvement of these rodents.

This outbreak demonstrated for the first time that B. hermsii and its tick vector O. hermsi exist in Montana and caused multiple cases of relapsing fever. Owners of cabins in the vicinity where the outbreak occurred met with the Montana state epidemiologist and received information regarding the epidemiology and prevention of tick-borne relapsing fever. Although the outbreak was localized, a large area of western Montana has the appropriate ecologic parameters to support enzootic cycles that provide the potential for relapsing fever caused by B. hermsii to occur. A diagnosis of relapsing fever should therefore be considered when patients who have resided or vacationed in western Montana seek treatment for a recurrent febrile illness.

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References


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