

Colorado Tick Fever In Rocky Mountain NP

Editor's Note: The management implications stemming from a recent study, by U.S. Forest Service scientist Andrew B. Carey, are so well presented and follow so logically from the research, that Dr. Carey's presentation (somewhat different from Park Science style) are here set forth as submitted.

By Andrew B. Carey

The Disease: Colorado tick fever (CTF; historically referred to as "mountain fever" or "American mountain fever") is a viral disease acquired through the bite of a tick. The disease may be mild and go unnoticed but usually has an abrupt onset three to six days after a tick bite, with symptoms being chilly sensations, high fever, severe headache, sensitivity to light, lethargy, and muscle-ache. The fever lasts two to three days, subsides for one or two days, and then recurs for two or three days. In rare cases, primarily in children, the disease may be worse, with encephalitis or bleeding. A rash may develop and the disease is often misdiagnosed as Rocky Mountain spotted fever (a bacterial tick-borne disease).

Diagnosis: Tick bite and symptoms may suggest CTF, but confirmation rests on isolation of the virus from the blood by inoculating red blood cells into newborn mice or tissue culture. If the mice or the cells die, fluorescent antibody staining is used to identify the virus. Tests for antibody specific to CTF may be used also.

Treatment: There is no specific treatment; in other words "take two aspirin and go to bed." Rest, general supportive care, and medicine to reduce fever and pain generally serve to ameliorate the symptoms. Recovery is usually rapid.

Causative Agent: CTF is caused by a virus in the genus *Orbivirus*. A related virus (*Eyach*) has been found in ticks in Europe. CTF virus infects red blood cells, where it is protected from antibody and other body-defense mechanisms. CTF virus is unrelated to the rickettsia that causes Rocky Mountain spotted fever.

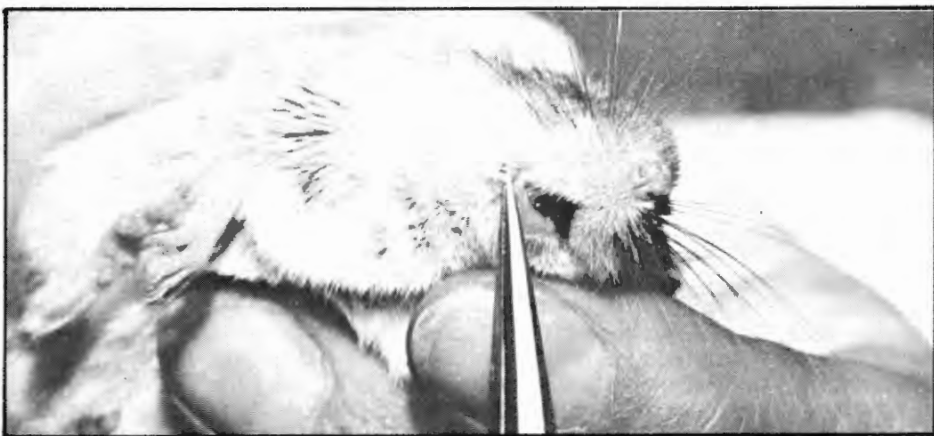
Vector: CTF virus is carried and transmitted primarily by the Rocky Mountain wood tick (*Dermacentor andersoni*). The wood tick also transmits Rocky Mountain spotted fever and causes a disease called "tick paralysis."

The wood tick has four stages in its life cycle: egg, larvae, nymph, adult. The tick increases in size with each stage. Each stage feeds once. Males feed lightly until they are attracted to a feeding female by her chemical signals. Males impregnate the partially engorged, feeding females. Larvae, nymphs, and females feed until they are engorged with blood. After feeding, these ticks drop off the host and seek shelter. The larvae molt to nymphs; nymphs molt to adults; females lay eggs and die. Each stage feeds on successively larger mammals; for example, larvae feed on mice (*Peromyscus*) and chipmunks (*Eutamias*), nymphs on chipmunks and ground squirrels (*Spermophilus*), and adults on porcupines (*Erethizon dorsatum*).

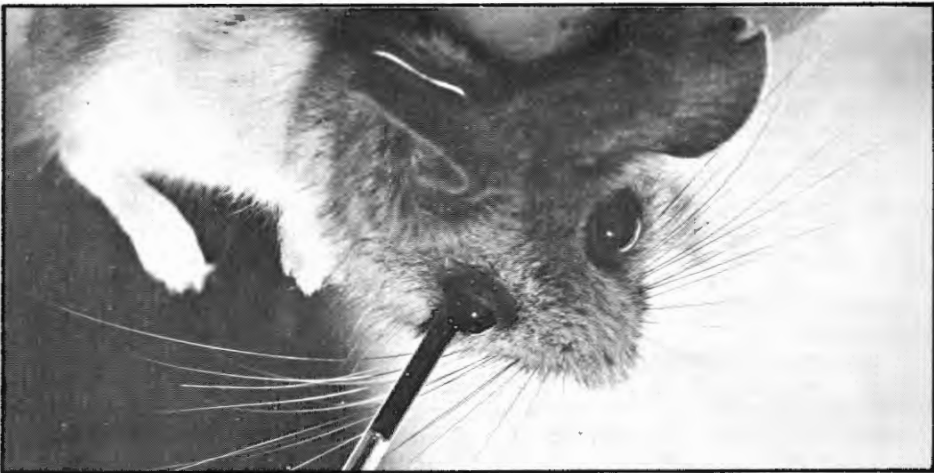
Distribution: People become infected with CTF virus throughout the mountainous regions of the western United States and Canada. Distribution of the disease is correlated with that of the wood tick, however it is certain the virus occurs outside the range of the wood tick. Eight other species of ticks have been found

infected with the virus. The actual incidence of the disease is unknown because the disease frequently is misdiagnosed and underreported. Colorado reported 77 percent of the 1,767 cases reported during 1956-1965. During 1970-1977, Colorado reported an average of 174 cases/year. A large proportion (46 percent) of these cases were in the two-county area encompassing Rocky Mountain NP. An independent study by the Vector-borne Diseases Division of the Centers for Disease Control (CDC, U.S. Public Health Service) estimated that as many as 391 cases of CTF may have been contracted in one campground in Rocky Mountain NP in one year. The risk of infection was calculated to be 1 case/346 camper-days.

Natural Cycles of Infection: Nymphal wood ticks carry the virus through the winter and infect small mammals the next summer; the small mammals then infect larval wood ticks, which molt to nymphs and carry the virus through the winter. Thus, circulation of the virus is maintained among the larvae, nymphs, and small



Larval wood tick is shown (above) at the end of a jeweler's forceps, being removed from a deer mouse — the same genus as the white-footed mouse. In the photo below, Carey draws blood efficiently and harmlessly from a deer mouse's post-orbital capillary. Both methods were used in Carey's studies *Ixodes dammini* (vector of Lyme disease) and *Dermacentor andersoni* (vector of Colorado tick fever.)



mammals. Nymphs become adults, and although adults are a "dead-end" for the virus because they feed on larger hosts than the nymphs and larvae, it is the adults that transmit the virus to humans.

Research In Rocky Mountain National Park: The CDC, under the direction of Bob McLean, began an investigation of the CTF natural cycle in Rocky Mountain NP in 1974. The first step was to determine where the virus and ticks occurred altitudinally. Small mammals were trapped at sites 8,000 to 11,400 feet in elevation. McLean found that the least chipmunk (*E. minimus*) and the golden-mantled ground squirrel (*S. lateralis*) were the most frequently infected small mammals and that they had the greatest infestations of immature wood ticks. It also was apparent that the ticks were most abundant at the lower elevations (the upper montane zone) and on rocky, south-facing slopes.

Armed with this knowledge, the CDC launched an investigation to determine more precisely where the natural cycle was maintained and, more importantly, why the cycle was localized in the landscape. Two study areas were chosen to encompass all the plant communities found on south-facing slopes in the upper montane region of the Park.

Intensive studies of flora, fauna, and environmental structure over a two-year period developed a clear picture of the CTF cycle in the Park. The south-facing slopes in the upper montane were characterized by major ecological gradients of soil depth and soil moisture. Wood ticks were confined to areas of shallow soil, steep slope, exposed rock, and rock crevices by their physiological tolerances for soil temperature and soil moisture. Solar radiation must be great enough to warm the soil sufficiently for egg development in the summer. The warm period of summer must be long enough for larvae and nymphs to emerge, find a host, feed, and molt before winter. But, winter soil temperatures must be sufficiently cold to physiologically release the adults from the diapause that prevents them from feeding in the fall. These low soil temperatures also prevent the immature ticks from attempting to feed at the wrong time of the year. Soil relative humidities must be high enough to prevent desiccation of eggs and ticks. Thus, suitable conditions for tick survival depend on latitude, altitude, aspect, vegetative cover, and litter.

Another requirement of the ticks must be met — they must have hosts to feed upon. Golden-mantled ground squirrels, least chipmunks, and porcupines were abundant on the rocky slopes, where they found all their requisite food and cover. The influence of environmental structure was so pervasive that equations (discriminant functions) could be developed to predict where the ticks and virus occurred. These equations were

based on easily measured environmental variables such as soil depth, amount of shallow soil (less than two inches), degree of slope, shrub cover, and amount of grass litter. Unfortunately, research funds were too limited to evaluate these equations in new areas and only a statistical validation was performed.

Applicability of the Research: The descriptions of the environment amenable to virus and ticks (and the discriminant functions if they were fully validated) could be used to locate recreational facilities and activities to minimize human exposure to the virus. The tick discriminate function could be used in the application of acaricides (pesticides).

The research provided information on other problems. For example, Richardson's ground squirrel is a reservoir for plague (*Yersinia pestis*). Results of the study suggested that if Richardson's ground squirrels were controlled (killed) to minimize human exposure to plague in Moraine Park Campground (such an effort was instituted in 1976 and 1977), they would be replaced by golden-mantled ground squirrels, a major carrier of CTF. However, this would not increase the risk of human exposure to CTF virus because the golden-mantled ground squirrels would have moved out of the area that was climatically suited for ticks.

Prevention of CTF: CTF is best prevented by being aware of the danger posed by the adult ticks. In Rocky Mountain NP, adult ticks are most active during May and June and are most abundant on rocky, south-facing slopes between 7,900 and 8,900 feet. People should be encouraged to avoid spending too much time in these areas in the spring. Also, people should be encouraged to assist one another in detecting and removing ticks from their clothing and bodies. Light-colored clothing make the dark ticks more apparent. "Blousing," or tucking pant legs into boots or socks, prevents the ticks from quickly becoming concealed beneath the trousers. Personal examination after a hike or other recreational activity (concentrating on the groin, belt line, and hair line on the neck — ticks respond to tight places in determining where to feed) can often detect ticks before they complete attachment and begin to feed.

Further Information: More detail on CTF in Rocky Mountain NP can be found in the following reports: Carey, A.B. 1979. Discriminant analysis: a method of identifying foci of vector-borne diseases. *American Journal of Tropical Medicine and Hygiene* 28 (4): 750-755; Carey et al. 1980. The structure of a Colorado tick fever ecosystem. *Ecological Monographs* 50 (2): 131-151; and McLean et al. 1981. The ecology of Colorado tick fever in Rocky Mountain National Park in 1974. *American Journal of Tropical Medicine and Hygiene* 30(2): 483-489.