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RODENT DISEASE IMPLICATIONS ASSOCIATED WITH CAMPGROUNDS AND PUBLIC USE AREAS IN CALIFORNIA

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ABSTRACT: Rodents, both commensal and wild, serve as reservoirs for a variety of diseases in nature communicable to man. Forty-six percent of the 30 human plague cases in the past two decades in California are associated with campgrounds and public use recreational sites. In addition, human cases of tularemia, giardiasis, relapsing fever, Rocky Mountain spotted fever, Colorado tick fever, and Lyme disease have been associated with recreational activities. Commingling of humans, wild rodents and ectoparasites in disease endemic areas places the public at risk from the above-mentioned diseases. Construction of recreational sites without knowledge of wild rodent and disease ecology may enhance rodent and ectoparasite densities and increase disease potential. Cooperation between vertebrate pest specialists, vector ecologists, and public landuse and recreation specialists is needed in the development and management of campground and public use recreational areas. Knowledge of disease awareness and management technology would result in improved disease prevention and better public health protection.

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INTRODUCTION

Rodents, both commensal and wild, serve as reservoirs for a variety of diseases in nature communicable to man. These diseases are caused by bacteria, viruses, rickettsial organisms, and protozoans. This brief review concentrates on the wild rodents, and diseases associated with these animals and their ectoparasites, in campgrounds and public use areas in California.

The diseases involving wild rodents as reservoirs most familiar to those in vertebrate pest control include: bubonic plague, tularemia, giardiasis, relapsing fever, Rocky Mountain spotted fever, Colorado tick fever, Q-fever, and Lyme disease. An arthropod vector serves as the prime transmitter of most but not all of these diseases. Plague is associated with both commensal rats and wild rodents and is vectored by fleas. Additional routes of plague transmission include direct contact with infected animal tissue, or aerosol route from an infected rodent, carnivore, or human. Giardiasis is primarily a waterborne illness, and involves man, beaver, and other wild and domestic animals as reservoirs. Tularemia may be waterborne, or may involve vector ticks or deerflies, or direct contamination from infected tissue of wild rodents or rabbits. Argasid ticks serve as vectors of relapsing fever, while Ixodid ticks vector Rocky Mountain spotted fever, Colorado tick fever, Q-fever, and Lyme disease.

DISEASE ASSOCIATED WITH RODENTS AND CERTAIN OTHER MAMMALIAN WILDLIFE

A review of human plague cases in California reveals that 46% (14/30) of the cases since 1970 have been directly associated with campgrounds and public use recreational sites (Smith and Lusk 1990). Types of recreational activities associated with human cases included fishing, hunting, camping or hiking, but primarily camping while sleeping in tents or on the ground. One case (1984) was contracted in a national park campground, two in California state parks (1970,1976), four at established campgrounds operated by the U.S. Forest Service (1977, 1984, 1986, 1988), and two in private camps (1979, 1986). One case proved fatal for a 3-year-old girl from San Diego who camped with her family in the vicinity of Lake Tahoe in the summer of 1977.

Seven of the 14 plague cases were associated with fleabite transmission and epizootic die-off among California or Beechey ground squirrel, *Spermophilus beecheyi.* Three cases involved association with epizootics in chipmunks of at least two species, *Tamas senex,* the shadow chipmunk, and *Tandas speciosus,* the lodgepole pine chipmunk. One case was directly associated with an epizootic among golden-mantled ground squirrels, *Spermophilus lateralis.* Certain flea species found on both these rodent generally are proven vectors of plague to humans.

Epizootics of plague in wild rodents have been rather extensive in the mountainous recreational areas of California in the past two decades. These animal epidemics have occurred in the Sierra Nevada mountains, the Cascades of Northern California, the northern and southern Coast ranges (north and south of San Francisco), and the Tehachapi, San Gabriel, San Bernardino, and San Jacinto mountains of Southern California (Smith 1985).

Positive plague in wild rodents is reported by laboratory confirmation by the California Department of Health Services at campgrounds and public use areas under the following jurisdictions: 7 National Parks, 15 National Forests, 14 State Parks, 5 county parks, 4 city parks or city operated camps, 2 Girl Scout camps, 3 Boy Scout camps, 2 Campfire Girls camps, one YMCA camp, 2 church camps, one historical site picnic ground, one state-operated fishing area, 4 ski resorts, and 10 private resorts or developments. Plague epizootics forced temporary closure of many of these locations while vector fleas were controlled with insecticide to lessen the disease transmission potential to recreational site users.

Lyme Disease

Over 1,100 human cases of Lyme disease have been reported in California by the California Department of Health Services since the disease was first documented in the state in 1985. Many of these cases involved tickbite in recreational and public use areas. Cases have been associated with hunting, fishing, hiking, camping, and other outdoor activities.

The tick vector of Lyme disease in the West, *Ixodes pacificus,* the Pacific black-legged tick, is reported to occur in 53 of the state's 58 counties. Human cases of Lyme disease

have been reported in 47 of 58 counties. The Lyme disease spirochete has been isolated from ticks in 33 of the 58 counties (California Department of Health Services records). This tick prefers areas of some humidity and occurs in many of our lower mountainous regions and foothills. The dusky-footed woodrat, *Neotoma fuscipes,* which has a distribution much like that of the tick, is implicated as a reservoir of the Lyme disease organism in California.

Ticks positive for the Lyme disease spirochete are reported from at least 3 national parks and 7 state parks in California. The chances of encountering this tick in many of our state's public use areas is apparently quite high, especially in habitat with oaks, some humidity, and the presence of rodent and deer hosts.

Q-fever

Q-fever, caused by a rickettsial organism, has been isolated from the following wild rodent genera in nature: *Spermophilus, Tamias, Dipodomys, Neotoma, Peromyscus, Perognathus, Reithrodontomys, Onychomys,* and *Erethizon.* Despite this widespread distribution in wild hosts, the majority of human cases which occur are associated with contact with domestic animals such as cattle, sheep, and goats. Mode of transmission is primarily by airborne dissemination of rickettsia in dust in premises contaminated with animal tissue or excreta of infected animals. Raw milk from infected cattle or goats is another source of infection, as are ticks from infected animals.

Tularemia

Cases of tularemia, a bacterial disease, have been recorded each year in California since the 1930's. From 1981 to 1991 a total of 41 cases have occurred in the state. Cases occurred in 22 different counties, with Los Angeles county having the most cases (6). In 52% of cases the most probable source of infection was handling and skinning rabbits. Two percent of cases were from skinning deer, and 43% of cases involved bites of infected blood-sucking insects. Tularemia infections occur during all months of the year, but the incidence rate in adults is usually higher during winter when rabbits are hunted, and higher in summer in children when ticks and deerflies are more abundant.

Rocky Mountain Spotted Fever

Rocky Mountain spotted fever, caused by a rickettsia, and Colorado tick fever, a virus disease, involve wild rodent reservoirs, and ticks in the genus *Dermacentor* as both reservoirs and vectors. Wild rodents such as ground squirrels, chipmunks, woodrats and deermice are proven disease reservoirs. Colorado tick fever is closely associated with the tick, *Dermacentor andersoni,* which occurs in several western United States. In California, this tick occurs only in the northeastern counties of Great Basin habitat. Cases occur in that region of the state each year, but since the disease is not a reportable disease in California, accurate records are not available.

Wild rodents and rabbits are important reservoirs of Rocky Mountain spotted fever in nature. *Dermacentor andersoni* is the classic tick vector of the disease; however, *D. variabilis* and the rabbit tick, *Haemaphysalis leporispalustris,* have been found naturally infected in California. The former is the prime vector species of the disease in the southeastern states. In California, scattered, sporadic cases of Rocky Mountain spotted fever continue to occur, but in low numbers.

Dermacentor spp. ticks are prevalent in many of our campgrounds and public use areas. Even in the absence of disease, a tickbite from one of these large ticks can be painful and cause secondary infection. In a survey of recreational sites in the Cascade Range, at one campground over 100 of these ticks were flagged from campsite vegetation in less than 30 minutes' sampling time. This particular campground is heavily used during the fishing season on the Klamath River.

Relapsing Fever

Relapsing fever is caused by a spirochete bacteria. The disease is reservoired among wild rodents and transmitted by Argasid ticks, or soft ticks as they are commonly called. In California, golden-mantled ground squirrel, chipmunk, pine squirrel, flying squirrel, deermouse and woodrats are implicated as reservoirs, along with Argasid ticks in the genus *Ornithodorous.*

Onithodorous spp. ticks are nest ticks of wild rodents and closely associated with the nest environment. When normal rodent hosts are disturbed by man, predators, or disease, these ticks may seek an alternative host in the immediate vicinity. Unlike the hardback Ixodid ticks, soft ticks feed at night for a short time, then drop off and return to the vicinity of the rodent nest.

Due to the propensity of soft ticks for rodent nests, the majority of human cases of relapsing fever involve non-rodent-proofed cabins or structures where nests may be built in walls, crawl spaces, cupboards, or attics. An occasional case has involved wood cutting when hollow snags containing rodent nests were brought into campsites or cabins adjacent to where people slept.

Cases of relapsing fever continue to occur in our mountainous recreational areas primarily involving cabins or structures closed in winter allowing rodent access, then reopened again in summer for human occupancy. There have been 28 cases of relapsing fever in California in the past 3 years. Cases have occurred in three national parks among staff occupying seasonal cabins, and most recently at Yosemite National Park involving a ski hut. In addition, cases have occurred at several other public use areas in California including: Lake Almanor, Eagle Lake, the Marble Mountains, Big Bear Lake, Ebbets Pass, Lake Tahoe, Huntington Lake, and Hume Lake.

DESIGNING FOR DISEASE MANAGEMENT

California is very much a recreation-oriented state. An extensive system of campgrounds and other recreational facilities has been developed throughout the entire length and width of the Golden State. These facilities are operated privately, by large corporations, and by local, state, and federal public lands agencies.

Populations of ground squirrels, pine squirrels, chipmunks, woodrats, marmots, deermice, or meadow mice may be present in any particular habitat where recreation sites are constructed. Ectoparasites, such as ticks and fleas, are associated with these rodents and are present in the same habitat in nests, in rodent burrows, or near rodent burrows. The commingling of humans, rodents and ectoparasites in disease-endemic areas places the public at risk from the above-mentioned diseases at many recreational sites. Control of these diseases integrates education, arthropod vector con-

trol, and rodent management. One aspect of rodent management incorporates knowledge of rodent behavior with planning and development of recreation sites to make campground habitat less attractive to rodents.

Construction of a campground or other public use facility in a natural habitat invokes habitat changes due to the necessary modifications made to accommodate visitors. These modifications may disrupt larger natural predators of wild rodents and cause a decline in predator numbers. These same modifications make the habitat more attractive to certain wild rodent species, and are conducive to increases in populations of these animals (Marsh et al. 1981).

Improper campground construction creates improved burrowing sites for rodents under concrete pads, fire pits, paved roads and road embankments, rock piles, stumps, and rock or log traffic barriers. Extra water is an added attraction, as is extra food, mostly in the form of camper food. Proper construction techniques to help alleviate rodent burrowing from recreation sites is discussed in detail in Marsh et al. (1981).

Thinning of the forest canopy to allow for roads and campsites opens up areas and makes them more attractive to certain species of ground squirrels and chipmunks. Lower vegetation below the tree canopy may be left clumped around campsites or close to trail edges. Many campsites are purposely placed in these clumped vegetative areas, or built directly into rock outcroppings. Logs and rocks are hauled in as barriers and generally placed directly on top of the ground. In many cases large bushy areas are left on exposed slopes at edges of campgrounds, and vegetation comes into direct contact with the backsides of campsites.

Recreation site construction without thought of wild rodent and disease ecology may result in creation of more favorable habitat for many of our wild rodent species. Campgrounds and recreational sites may support as much as a fourfold or greater density of ground squirrels and chipmunks than natural habitat in the same region.

Clumping of brush, or leaving brush or grasses untrimmed close to trail edges, creates perfect questing sites for tick vectors of disease. Cabins in recreational areas where relapsing fever is endemic should be rodent-proofed to discourage rodent occupancy. If rodents do have access, tick control of nesting areas should be considered prior to human occupancy.

Close cooperation between vertebrate pest specialists, vectorborne disease management specialists, and public landuse and recreational specialists is needed in development and management of campground and public use recreational areas. Developmental planning and cooperative management would result in better prevention of diseases associated with wild rodents and their ectoparasites at recreation sites and public use areas in California in the future.

LITERATURE CITED

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