

The central ganglion of the tick is not as hospitable to *B. turicatae* as it is to *B. duttonii*.

Brumpt and Brumpt (124) and Mazzotti (483) demonstrated that mice, rats, guinea pigs, cotton rats, rabbits, pigs, dogs, cats, and foxes can be infected with *B. turicatae* in the laboratory but not hedgehogs and dormice. The virulence for guinea pigs is low.

O. turicata cannot transmit *B. duttonii*, *B. venezolensis* (118), or *B. dugesi* Mazzotti 1949 (228).

Ornithodoros parkeri and *Borrelia parkeri*

Ornithodoros parkeri Cooley 1936 transmits *Borrelia parkeri* Davis 1942. It lives in the western region of Canada and the United States but not in Mexico, in caves and burrows inhabited by ground squirrels, prairie dogs, and burrowing owls (384). It only infrequently encounters man. The infection is transmitted by the bite of the tick because coxal fluid is excreted only after feeding. Rafyi *et al.* (593) described a variant of *O. parkeri* that was found on the Hastings Reservation in Monterey County, California. The *Borrelia* harbored by this variant differed antigenically from the type strain.

O. parkeri can be infested with *B. turicatae* but not with *B. venezolensis* in the laboratory (485).

Ornithodoros hermsi and *Borrelia hermsi*

Ornithodoros hermsi Wheeler, Herms, and Meyer 1935 was described in 1935, together with the *Borrelia* strain carried by it (730). It was found in the Californian mountains at an altitude between 5,000 and 8,000 ft, but human cases of borreliosis were discovered also at 3,000 ft. It is a disease acquired by persons entering newly opened wooden summer cottages which are frequented (when empty) by wild rodents such as *Tamiasciurus douglasii* and *Eutamias* that often carry this tick in their fur (358).

B. hermsi has been studied extensively by Wheeler (727, 728, 729). It is transmitted with the eggs but less than 2% of them are infested. *O. hermsi* does not extrude feces or coxal fluid during feeding. Its bite is infective. When mammalian blood is not available, *O. hermsi* may feed on other ticks. Mice and monkeys can be infected with *B. hermsi* (727). Three days after a meal on an infected rodent or man, the celomic cavity becomes invaded, and

the central ganglion by the 10th day (728, 729). Longenecker (458) found *O. hermsi* in dead trees ("snags") at an altitude of 6,000 to 8,000 ft. Of 39 batches of *O. hermsi*, 18 infected mice, rats, and chipmunks.

Ornithodoros talaje and its *Borreliae*

Ornithodoros talaje Guérin-Méneville 1848 probably has substrains. It is principally a Central and South American tick, found on the West Coast of the Americas and in Argentina. Bates *et al.* (68) observed *O. talaje* in the Arriján area of Panama. Human infections were present there. Rats, mice, and *Macaca mulatta* monkeys could be infected by the bite of *O. talaje*. Dunn and Clark (248) described natural infections in marmoset monkeys (*Saguinus Geoffroyi*), *Cebus capucinus*, opossums (*Didelphis marsupialis etensis*), armadillos (*Dasybus novemcinctus fessstrans*), cattle, and in a horse. *O. talaje* transfers borreliæ rather from animal to animal than from animal to man (182, 222) even though it often appears near human habitats (89). It attaches itself to opossums and other animals that prowl around horses and cattle tied to bush fence posts in which *O. talaje* then finds a home. It may also crawl under houses.

Vampire bats and *Tritatoma* bugs may acquire this *Borrelia* but do not transmit it to other animals. Some strains of *O. talaje* do not bite man (222, 577). The *Borrelia* transmitted by *O. talaje* has not yet been named because it was believed that it is identical to that from *O. ruidis*. Matters became complicated when Calero (137) stated that *B. neotropicalls* is a variety of *B. recurrentis* carried by *O. venezolensis* (synonym: *O. ruidis*) as well as by *O. talaje*. Mazzotti (484, 485) found incongruities between the bionomics of *O. venezolensis* and *O. talaje* on one hand, and *B. venezolensis* on the other hand. Davis (225) stated that *O. dugesi* is a possible alternate host of *B. talaje*, and described *B. mazzottii* sp. nov. from *O. talaje* from Mexico and Guatemala that transmitted this *Borrelia* regularly, and *O. dugesi* weakly and in a fleeting way. *O. talaje* from other areas (Panama) did not transmit *B. mazzottii*, nor did *O. venezolensis*. *O. turicata* from Mexico, and some other ticks. There was no transovarian passage in *O. talaje* carrying this *Borrelia*. Guinea pigs and young rabbits were refractory to it. Considering

further that *B. venezolensis* (synonyms: *B. venezuelensis* Brumpt 1924, *B. neotropicis* Bates and Saint John 1922) is present in *O. rufus* Karsch 1880 (synonyms: *O. venezuelensis* Brumpt 1921 and *O. venezolensis*) in approximately the same area, and that the differentiation of borreliæ by immunologic and serologic means is most difficult, one could assume that *O. talaje* carried *B. maz-zotti* and in addition a hitherto unnamed *Borreliæ*, the vector being perhaps a subspecies of *O. talaje*. Further investigation of this problem is certainly indicated and, until such studies are carried out, one has to keep an open mind.

Ornithodoros venezolensis and *Borreliæ venezolensis*

The synonyms were discussed under *O. talaje*, which is said to be able to carry also *B. venezolensis*. Pifano (573) found this tick in Venezuela and in Mérida on the Yucatán (Mexico). A "related" tick was discovered in Yayaquy. The tick acquired the habits of a bed-bug, and became domesticated. Rats and mice on which the tick was fed developed borreliemia. The *Borreliæ* was neurotropic. No animal reservoir was found. The ticks appeared to feed only on man, as shown by precipitin tests with sera against various animal blood. Osorno Mesa (558) found *O. venezolensis* in Santander, Colombia, and suspected that human cases may exist there. Anduze (18) collected *O. venezolensis* in the Mérida area of Venezuela at an elevation between 1,600 to 5,000 feet. The human relapsing fever caused by its bite was severe. León and León (443) found the vector in Esmeraldas, Colombia, and varying clinical pictures of the disease. They suspected birds and wild rodents as the reservoir. Mazzotti (484) believed that *B. venezolensis* is the causative agent of relapsing fever in Panama, Colombia, and Venezuela, that *O. talaje* and *O. venezolensis* carry it, but perhaps that the strains are different.

Other *Borreliæ*

Ornithodoros brasiliensis Argão-Beaurepaire 1923 carries *Borreliæ brasiliensis* Davis 1952 (224). This tick has one larval and 4 to 7 nymph stages before the adult emerges. It is able to feed two days after moulting. Davis was the first to rear these ticks in the laboratory. Little information is available about the disease

caused by *B. brasiliensis* and the ecology of the ticks. It appears, however, that *B. brasiliensis* can be transmitted to mice and guinea pigs.

Heisch (345) described *Ornithodoros graingeri*, the vector of *B. graingeri* Heisch 1953 in Kenya. It caused disease in man, with slight neurotropism. The illness was mild in rats and mice. Guinea pigs, young rabbits, and monkeys were not susceptible.

Garnham (293) reported a *Borreliæ* from a grivet monkey.

Carley and Pope (144) described *Borreliæ queenslandica* from *Rattus villosus* in Australia. It caused relapses in mice and rats. Guinea pigs and chickens were not susceptible. This *Borreliæ* could be carried in the laboratory in fertilized chick embryos. It was not transmitted by *O. gurneyi*, the only *Ornithodoros* species in the area where the organism was isolated.

Further data are not available on these borreliæ.

Other *Ornithodoros*

Ornithodoros coniceps Canestrini 1890 was considered a possible vector of borreliæ but Chagin and Diatlov (151) demonstrated that it is not infected in nature. However, about 2 to 3% of these ticks will take up *B. persica* when fed on infected animals, and will transmit this *Borreliæ* to about 10% of the guinea pigs on which they are fed at a later date. Ovarian transmission has also been observed.

Ornithodoros lahorensis Neumann 1908, which was said to be a vector, was unable to transmit Central Asian borreliæ in the hands of Pavlovskii and Kuzina (567). *O. lahorensis* is common in the stone walls of old caravanserais, in cracks of wooden buildings, and in sheep stalls. Perhaps it lives also with rodents in their burrows (584).

Ornithodoros toleyi Parot 1928 (synonym: *O. franchinii*) was considered a vector of *B. hispanica* in Lybia where two war-time louse-borne epidemics raged. Colas-Belcour and Yervent (191) were unable to prove that it plays a role in the propagation of relapsing fever.

Ornithodoros savignyi Audouin 1827 has been observed from Timbuktoo to Ceylon. It has never been found to be infected in nature although it takes up *B. duttonii* and *B. hispanica* in the

