

Relation of Arthropods to the Epidemiology of Virus Encephalitis in Kern County, Calif.

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SANITARIAN (R) *

Kern County is situated at the southern end of the San Joaquin Valley, in the central valley area of California. The valley portion of the county, about 2,000 square miles in area, is relatively flat and has an average elevation of 490 feet above sea level. It is bordered on the south, west, and east by mountain ranges. The climate of this section of the county is characterized in the summer by high daytime temperatures and low humidities, and by comparatively cool nights; in the winter, the temperatures remain relatively low. Precipitation occurs chiefly during the spring months and seldom totals more than 8 inches per year. The chief industries in the valley are agriculture and petroleum. All crops are irrigated, the water being obtained from the Kern River through a system of canals and in many areas from deep wells. The population of Kern County for the census year 1940 was 135,124; that of 1948 has been estimated as between 214,000 and 220,000, of which approximately 121,000 live in or close to Bakersfield, the county seat.

Outbreaks of encephalitis in horses have been recognized in Kern County at least since 1930, and in man since 1938. Cases are reported each year, usually during the period from late June or early July until the end of September, or occasionally into October. In some years the cases have appeared in epidemic proportions; in other years there have been only sporadic cases.

Three encephalitis viruses are known to occur in this area; the Western equine virus appears to be the most important; the St. Louis encephalitis virus apparently is equally prevalent but does not affect horses; and the California virus. The latter virus first was isolated from mosquitoes, and later was

found to have caused a severe case of encephalitis in a child and to have produced specific serum antibodies in a number of apparently normal persons, horses, and rodents. Relatively little is known as yet about the California virus, and it will not be considered in this discussion.

Studies on arthropods and their relation to encephalitis in Kern County were started in 1943 by Drs. W. McD. Hammon and W. C. Reeves of the Hooper Foundation. In 1945, The U. S. Public Health Service began the cooperative program of research with the Hooper Foundation which has continued up to the present. This study has been conducted under the direction of Dr. Hammon, with Dr. Reeves in charge of the field studies.

Since 1943, studies have been carried on each summer in Kern County. Our primary purpose is to establish with certainty the infection chain of encephalitis as it occurs in that endemic area. When such knowledge is obtained, it theoretically would be possible to determine the weakest link of the chain, attack it at that point, and thus control the disease. To obtain such knowledge, however, it is necessary to determine the answers to the following questions: (1) What species of hematophagous arthropods are naturally infected with the encephalitis viruses? (2) Are these arthropods capable of transmitting the viruses after they become infected? (3) Do these arthropods normally feed on susceptible vertebrate hosts? (4) Are these arthropods abundant in the area during the time when encephalitis is known to be transmitted? (5) Which, if any, of the susceptible vertebrate hosts can serve as reservoirs of the viruses; that is, do any of these hosts exhibit viremia over relatively long periods of time, or do they have recurrent

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viremias? (6) If they do not have recurrent viremias, what animal does serve as a reservoir for the virus?

It appears from our present knowledge that only one species of mosquito, *Culex tarsalis*, and one species of mite, *Liponyssus sylviarum*, are commonly associated with the encephalitis viruses in Kern County. Two other mosquitoes, *Culex stigmatosoma* and *Aedes dorsalis*, occasionally have been found infected, but not with the frequency or regularity of *C. tarsalis*. Both *C. tarsalis* and *A. dorsalis* are proven vectors of the Western equine type of virus, and the former mosquito species is capable of transmitting the St. Louis virus. Transmission experiments with *C. stigmatosoma* have not been conclusive, due to the technical difficulty of inducing it to feed on experimental animals. Experiments designed to test the ability of *A. dorsalis* to transmit the St. Louis virus were conducted last summer, but the results have been inconclusive, and they must be repeated. In the case of the mite *L. sylviarum*, technical difficulties have been encountered in our attempts to effect transmission through the agency of this arthropod, since it does not lend itself readily to laboratory manipulation. Our latest attempt to transmit virus by means of *L. sylviarum* were undertaken last summer under simulated natural conditions; however, the results are not yet available.

By precipitin tests of blood meals, it has been shown that *C. tarsalis* feeds primarily on birds, but frequently feeds also on large domestic mammals, as well as on man. In addition, studies on the epidemiology of avian malaria in Kern County have proved that *C. tarsalis* feeds very frequently on wild birds — a fact that could not be ascertained by the precipitin test. In our malaria studies we found that *C. tarsalis* is the chief vector of avian *Plasmodium*, a very common parasite in the blood of wild birds in Kern County. On the other hand, *A. dorsalis* obtains its blood chiefly from large domestic animals and occasionally from man, but only infrequently from birds. In Kern County, *L. sylviarum* has been found to be specifically parasitic on wild birds. Although this mite

occurs on domestic fowl in other parts of the United States, we have secured no evidence that it will attack domestic birds in Kern County; nor is there evidence that it attacks man or other mammals under natural conditions.

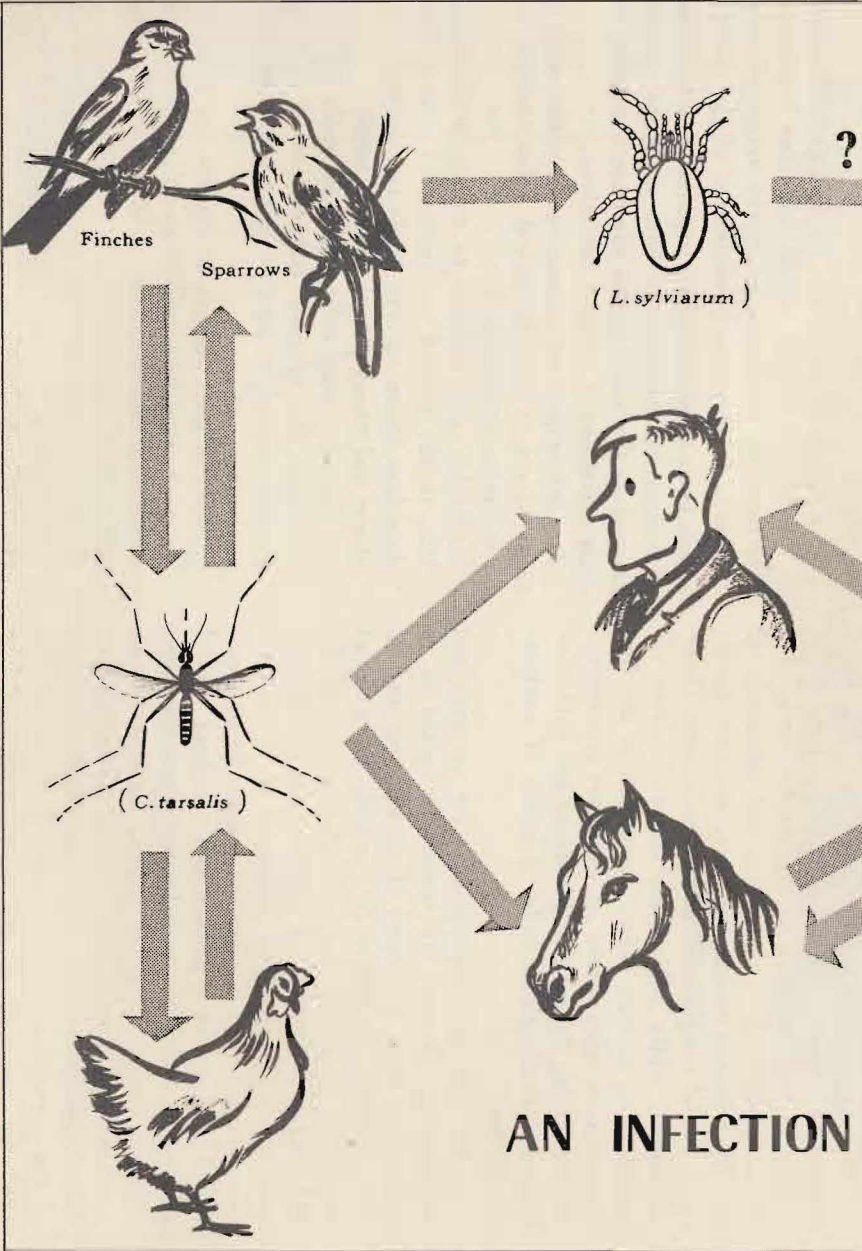
Extensive biological studies have been carried out both on *C. tarsalis* and on *L. sylviarum*, and it has been found that both of these arthropods are at their peak of abundance during the period when the encephalitis viruses are most active; that is, from June to September.

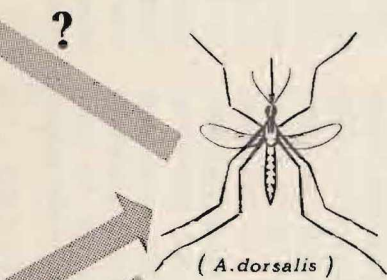
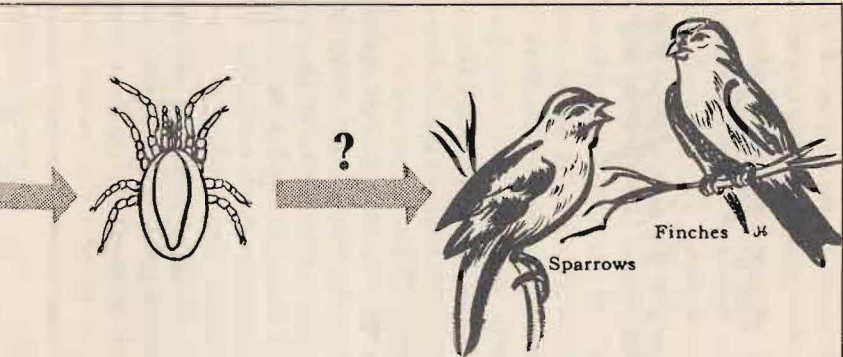
Results of experiments conducted in the Hooper Foundation laboratories indicate that infected domestic and wild birds are better sources of virus for arthropods than are susceptible mammalian hosts. However, avian hosts cannot be considered true reservoirs of the virus since they contain circulating virus for only a few days, and they are not known to have recurrent viremias. Apparently the immunity developed after an initial infection is sufficient to control the virus thereafter. Thus we must look elsewhere for the reservoir. At present, our best lead is the mite, *L. sylviarum*, which acquires the virus by feeding on an infected bird during the short period of viremia.

It is entirely possible that this mite could transmit the virus by the transovarian route to its offspring, as has been shown for other mite-borne diseases, and later the offspring could transmit it to another susceptible bird. However, additional research is necessary to prove this point definitely.

In 1946, control operations directed specifically against *C. tarsalis* were started by the Kern Mosquito Abatement District in an attempt to break the infection chain. Sufficient time has not elapsed as yet to determine the effect of such control on the over-all incidence of encephalitis.

The writer has attempted in the above discussion to point out the known, as well as the unknown, in the infection chain of encephalitis in Kern County, in as brief a manner as possible. The infection chain may be presented graphically as follows, the unknown links being indicated by question marks:





CHAIN OF ENCEPHALITIS