

Bat Transmitted Rabies

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Up to a few years ago, all the information one needed for a full understanding of rabies as a disease seemed to be readily available in most text-books. The rapidity with which changes in our concepts of this disease are now taking place, and the multiplicity of publications dealing with this disease both make frequent reviews desirable. Actually, bat-transmitted rabies created problems long before it was even recognized. A paralytic disease of epizootic proportions in horses, mules, and cattle in Brazil in 1908 was not even identified as rabies until three years after the outbreak started. Mass killing of dogs did not control the disease, but evidence to show that bats were the vectors was not obtained for several more years. A fatal bulbar paralysis of cattle in Trinidad in 1925 did not assume the ascending spinal paralysis form more typical of rabies until 1930. By this time, paralytic bovine rabies had spread to Paraguay, Uruguay, Argentina, Bolivia, British Guiana, and Venezuela. The first human case of acute ascending myelitis occurred in Trinidad in

1929, sixteen other cases being reported before the vampire bat was suggested as the possible vector in 1931. Later studies incriminated fruit-eating bats as well as vampire bats.

In 1952, serious cattle losses occurred in Honduras from rabies, and in 1953, nine miners in British Guiana died from rabies. Although derriengue, a disease of cattle in Mexico, has been prevalent since about 1910, it was not shown conclusively to be rabies until Johnson's 1944 field work, when the virus was recovered from both a paralyzed cow and vampire bats captured nearby. Since 1951 a number of human deaths from vampire bat-transmitted rabies have been reported in Mexico.

In the areas where vampire bats are normally found, control of the disease in cattle is a problem. Eliminating the bats is difficult if not impossible, leaving only the possible immunization of the cattle against the virus as a control. In areas where the vampire bat is not present, the problem is mainly one of human protection. Rabies in insect-eating bats has been reported from Germany, Yugoslavia, British Columbia, and a large part of the United States.

The first state in the United States to report the detection of rabies in a bat was Florida in 1953. Thirty-five states have since reported the finding of at least one

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occurrence of this disease in a bat. The states and vernacular names of the bat species involved are presented in the following list. This list is up-to-date but does not purport to be all-inclusive. The records are too widely scattered in the literature or remain unpublished.

Alabama: Red bat, Seminole bat.
 Arizona: Big brown bat, Pallid bat, Hoary bat, Mexican free-tailed bat.
 Arkansas: Species not listed.
 California: Little brown myotis, California myotis, Long-eared myotis, Western pipistrelle, Hoary bat, Mexican free-tailed bat, Silver-haired bat, California leaf-nosed bat.
 Colorado: Little brown myotis, Silver-haired bat.
 Connecticut: Species not listed.
 Florida: Grey myotis, Southeastern myotis, Eastern pipistrelle, Florida yellow bat, Red bat, Seminole bat, Florida free-tailed bat.
 Georgia: Red bat, Seminole bat, Florida free-tailed bat.
 Illinois: Big brown bat (?).
 Indiana: Red bat.
 Iowa: Hoary bat.
 Kansas: Hoary bat (?).
 Kentucky: Species not listed.
 Louisiana: Species not listed.
 Maryland: Hoary bat.
 Massachusetts: Little brown myotis.
 Michigan: Big brown bat.
 Minnesota: Big brown bat.
 Missouri: Hoary bat, Red bat.
 Montana: Big brown bat, California myotis, Long-eared myotis, Long-legged myotis.
 Nebraska: Little brown myotis, Red bat.
 New Jersey: Little brown myotis, Hoary bat.
 New Mexico: Hoary bat, Mexican free-tailed bat, Florida free-tailed bat, Big free-tailed bat.
 New York: Big brown bat.
 Ohio: Big brown bat.
 Oklahoma: Hoary bat, Mexican free-tailed bat.
 Oregon: Species not listed.
 Pennsylvania: Little brown myotis, Hoary bat.
 South Dakota: Hoary bat.
 Tennessee: Red bat.
 Texas: Cave myotis, Pallid bat, Florida yellow bat, Mexican free-tailed bat.
 Utah: Pallid bat, Red bat.
 Virginia: Species not listed.
 Washington: Species not listed, as undetermined.
 West Virginia: Species not listed.
 Wisconsin: Little brown myotis, Big brown bat.

Although this list does give some idea of the present known distribution of the disease in bats in the United States, no indication of prevalence can be given. For general distribution without regard to species or quantitative factors, take a United States map and fill in the states where

present. The apparent recent expansion of the disease in bats in the United States may to a large extent be attributed to a greater awareness and consequent increase in testing. However, the gradual extension northward from South America of records of bat rabies noted in the last 50 years, and the recording of cases in Europe give an indication that the disease in bats has been spreading. It has been this writer's opinion that rabies is probably already well established in United States bat populations and that more intensive testing will result in its being recorded from every continental state. Transmission involved in this type of spreading is from bat to bat, and is apparently more easily accomplished than from a bat to another mammal.

New Aspects of the Disease

As a description of "typical" rabies, its symptoms, and its characteristics can be readily found in reference works, the information here will be restricted to that showing the contrast between bat rabies and "typical" rabies. Up to comparatively recent times, one of the main concepts concerning the disease was that it was invariably fatal once symptoms became apparent. As vampire bats have exhibited a full range of symptoms, including the ability to transmit the virus, and then recovered, the presence of rabies neutralizing antibodies in the serum of large numbers of cave-dwelling bats in the United States may be considered at least indicative of survival following exposure. Large numbers of insectivorous bats have been found to possess the rabies neutralizing antibodies, and there has been almost complete failure in effecting transmission by bite of naturally infected bats to other adult mammals. Because of this, the strain of rabies present in most bats might be considered modified to a high infectivity and lowered virulence for bats. This does *not* mean that there is no danger of transmission of the virus to other mammals or that other mammals would necessarily survive. On the contrary, at least five human deaths in the United States have been attributed to bat rabies, and other mammals are known to have contracted the disease from bats.

Although many bats found to have the disease are moribund or are taken under unusual conditions, there is often no outwardly visible evidence of the disease in insectivorous bats. They may appear to be absolutely normal in behavior.

As there may be reduction in or absence of formation of Negri bodies, cytoplasm inclusions characteristic of the disease, one of the oldest and fastest methods of laboratory diagnosis has lessened value. The presence of the virus in the brown hibernating fat while absent in the central nervous system and salivary glands further complicates the pictures. Recent work by Constantine with Mexican free-tailed bats at Carlsbad Caverns has shown that contact with the bat is not necessary for transmission to occur between a bat and another mammal. This latest finding is rather disconcerting to both bat workers and rabies workers, especially the latter, who may wonder whether this type of transmission is restricted to bat rabies strains alone. The medium of transmission, egested materials, excrement, or even exhaled vapor must now be identified and studied. For a disease known since the time of Aristotle, we still have much to learn.

Effects of the New Aspects

Although we have serum neutralization tests, complement fixation tests, and fluorescent antibody methods for identifying the virus in addition to Negri body staining and animal inoculation, the virus may be present in tissues other than those normally tested. The presence of the virus in the brown hibernating fat of bats while absent or undetectable in the central nervous system or salivary glands, for example, has led to pathogenicity and metabolic effect studies.

Prevention of the disease by elimination of the insectivorous bat vectors would be extremely difficult even if the bats were not extremely valuable in their food habits. Transmission of rabies from bats to wildlife has not been demonstrated so far, the casualties thus far being humans. The vaccination of cattle and other mammals has not been suggested for the United States as the problem of livestock rabies is

a remote one due to the non-hematophagous characteristics of the United States bat species. Prevention through immunization is desirable for humans likely to be exposed to the disease, and all workers subject to exposure should undergo pre-exposure vaccination. The Communicable Disease Center Rabies Laboratory can perform neutralization tests on paired pre-vaccinal and post-booster serum samples routed through the appropriate state health department to see if the vaccinations have caused the production of rabies neutralizing antibodies in the serum.

Sources

As anyone working with bat rabies soon discovers, published information is widely scattered in the literature and much information remains unpublished. As an indication of the quantity available, full documentation for a short generalized report such as this would require several pages extra. Information concerning current rabies cases in the United States may be obtained from the monthly "CDC Veterinary Public Health Newsletter" available from the Bureau of State Services, Communicable Disease Center, Atlanta 22, Georgia, or from the "Weekly Morbidity and Mortality Reports" from the same source. To bring together information in this field, a two day conference on research in bat rabies was held July 10-11, 1959 at the National Institutes of Health in Bethesda, Maryland, with other such meetings to be held in the future if possible. For a history of bat rabies from South America to the United States, Enright's 1956 paper is excellent, and a paper by Martin (1959) traces the history of bat rabies to 1959 in the United States. A complete assemblage of all published work on Trinidad bat rabies forms volume 21, numbers 1-4, 1959, of the *Caribbean Medical Journal*, available for \$3.50 from the editor, 24 Coblentz Avenue, Cascade, Trinidad, B. W. I. Diseases of wildlife are covered in the journal of the Wildlife Disease Association, *Wildlife Disease*, published on 3" x 5" microcards. Annual dues for this association are \$4.00. Information on the activities of bats and bat banders is available in *Bat Banding News*, compiled by Dr. Wayne H.

Davis, Biology Department, Middlebury College, Middlebury, Vermont, and sent at a cost of \$1.00 for two years. Members of the Cave Research Association, with headquarters at the University of Illinois, and Cave Research Associates, Inc., of California, are active in cave biology studies, and a Cave Research Center at Mammoth Cave National Park is presently being proposed. Both the University of Kentucky and the University of Texas have faculty members hired for cave biology work. The National Speleological Society also has many members interested in biological research. The coverage of information and assistance sources here has necessarily been rather brief, but should give some idea of the range of assistance available to those interested in bat rabies work.

Suggestions

From this abbreviated treatment of the subject, it can be seen that there is much to do in this new field and that there are many problems to be faced. As a bat bander, one of many supplied with bird bands by the United States Fish and Wild-

life Service in hopes of learning more of distributional and migratory patterns in the many species of bats, I would like to stress one important point. Valuable information on distribution and prevalence of rabies in bats is lost if the bat species is not identified. Even such basic information as whether the bat was a cave-dwelling or a tree-dwelling form is thus lost. Non-mammalogists frequently call bats "cave bats," "brown bats," "bull bats," and other such names which give no clue to the actual species involved. It is like saying, "brown carnivore," leaving us to guess whether it is a wildcat, wolf, or raccoon. The body and jaws should be turned over to a mammalogist for positive identification.

The author will be happy to communicate with anyone interested in bat rabies work.

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