RABIES IN INSECTIVOROUS BATS OF WESTERN CANADA, 1979 TO 1983

Author: Pybus, M. J.

Source: Journal of Wildlife Diseases, 22(3) : 307-313

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-22.3.307

Journal of Wildlife Diseases, 22(3), 1986, pp. 307–313

RABIES IN INSECTIVOROUS BATS OF WESTERN CANADA, 1979 TO 1983

M. J. Pybus
Alberta Fish and Wildlife, O. S. Longman Building, 6909 - 116th Street,
Edmonton, Alberta T6H 4P2, Canada

ABSTRACT: A total of 1,745, 362, and 536 bats collected in Alberta, British Columbia, and Saskatchewan, respectively, was tested for rabies virus between 1979 and 1983. Only one (0.1%) of 769 bats collected at random from buildings was infected with rabies virus in contrast to 95 (5%) of 1,874 symptomatic, rabies-suspect bats submitted for testing. The pattern of infection in the rabies-suspect bats was similar in Alberta and Saskatchewan, but differed in British Columbia. Rabies was diagnosed in four species of bats in each of Alberta and Saskatchewan, but in seven species in British Columbia. Annual prevalence in rabies-suspect bats was similar in colonial species within each province. Rabies was found rarely in suspect little brown bats (*Myotis lucifugus*) (<1%). In suspect big brown bats (*Eptesicus fuscus*), the prevalence was low in Saskatchewan (3%), moderate in Alberta (10%), and high in British Columbia (25%). Big brown bats accounted for over 55% of the rabid bats detected in each province. Annual prevalence reported in silver-haired bats (*Lasionycteris noctivagans*) and hoary bats (*Lasiurus cinereus*) was variable in all three provinces. Rabies is enzootic in northern insectivorous bats.

INTRODUCTION

Rabies virus is known throughout the world as a major disease agent in terrestrial mammals. In addition, the virus is spread widely in vampire bats (*Desmodus rotundus*) and has been reported sporadically in non-hematophagous insectivorous bats. Rabies has been detected in 30 of 39 species of bats considered resident in North America (Constantine, 1979). In Canada, rabies has been diagnosed in insectivorous bats in all provinces excluding the maritimes (see reviews by Beauregard, 1969; Tabel et al., 1974; Centers for Disease Control, 1983). As part of an ongoing effort to understand and control rabies in Alberta, Schowalter (1980) summarized information concerning rabies in bats collected in Alberta from 1973 to 1978. The present paper summarizes the rabies data from bats submitted from western Canada from 1979 to 1983. Partial results (Alberta data, in part) were presented in Rosatte (1985).

Received for publication 26 March 1985.

MATERIALS AND METHODS

Information was summarized by the author from files at the Animal Diseases Research Institute (ADRI) of Agriculture Canada in Lethbridge, Alberta. All bats from British Columbia and Saskatchewan were collected by the public and submitted for rabies testing. These bats usually were submitted because they were symptomatic or suspected of being diseased or injured. Bats from Alberta were collected by the public (=suspect bats) and also by personnel of the Alberta Fish and Wildlife Division as part of a rabies control program to monitor the level of rabies infection in little brown bats (*Myotis lucifugus*) and big brown bats (*Eptesicus fuscus*) (=survey bats). The latter specimens were collected in surveys throughout the central and southern regions of the province. The age and sex of bats collected in Alberta was determined. Unless indicated otherwise, data and analyses include only suspect bats collected by the public.

All specimens received in acceptable condition were tested for rabies antigen with the fluorescent antibody test on impression smears of brain tissue (Beauregard et al., 1965) at ADRI. In cases involving human exposure, the mouse inoculation test (Abelseth, 1966) also was conducted. Data were summarized using the TWOWAY correlation program of the Michigan Interactive Data Analysis System (MIDAS) and analyzed using a χ^2-test of 2 × 2 contingency tables where applicable. Probabilities equal to or less than 0.5% were considered sig-

TABLE 1. Annual prevalence of infection by rabies virus in some species of rabies-suspect bats submitted from western Canada.

	1979	1980	1981	1982	1983	Total
Alberta						
Sample size	109	255	158	190	181	893
Little brown bat	2 (66)[a]	0 (115)	0 (84)	0 (99)	1 (103)	0.4 (467)
Big brown bat	21 (26)	10 (74)	14 (42)	8 (37)	5 (44)	11 (223)
Silver-haired bat	18 (17)	6 (66)	0.3 (32)	4 (54)	6 (34)	6 (203)
British Columbia						
Sample size	28	61	58	93	96	336
Little brown bat	15 (13)	0 (19)	0 (16)	0 (42)	0 (29)	1 (119)
Big brown bat	3 of 7[b]	29 (17)	21 (19)	30 (20)	17 (24)	25 (87)
Silver-haired bat	0 of 2	0 of 3	1 of 4	0 of 5	18 (11)	12 (25)
Other	0 of 6	18 (22)	5 (19)	0 (26)	6 (32)	7 (105)[c]
Saskatchewan						
Sample size	82	77	95	147	72	473
Little brown bat	0 of 10	0 of 9	1 of 10	0 (23)	0 (11)	2 (63)
Big brown bat	5 (58)	5 (60)	0 (57)	2 (87)	2 (50)	3 (312)
Silver-haired bat	7 (14)	0 of 8	7 (28)	0 (37)	9 (11)	4 (98)

[a] Percent infected (no. tested).
[b] No. rabid of no. tested (used with samples of 10 or less).
[c] Includes three *Myotis californicus*, two *Myotis evotis*, and one *Myotis yumanensis*.

nificant. The Jaccard index of similarity was computed to compare samples (after Holmes and Podesta, 1968).

RESULTS

A total of 1,771 (1,000 suspect, 771 survey), 547, and 373 bats from Alberta, Saskatchewan, and British Columbia, respectively, was submitted for testing at ADRI. A small proportion of bats from each province was unfit for rabies testing (1.5%, 1.8%, and 3.0% from Alberta, Saskatchewan, and British Columbia, respectively). In each province, most of the specimens tested were little brown or big brown bats (Table 1) and were found between June and September (Fig. 1). Bats were submitted from a wide geographic area of Alberta and Saskatchewan, but the submissions were more restricted to southern British Columbia.

The overall prevalence of rabies in the suspect specimens was 2.9%, 4.4%, and 9.7% in Saskatchewan, Alberta, and British Columbia, respectively. The annual prevalence of rabies identified in suspect bats from western Canada generally declined between 1979 and 1983 (Fig. 2). The decline was statistically significant in Alberta and British Columbia ($\chi^2 = 5.92$ and 3.61, respectively). Each year the prevalence was similar in Alberta and Saskatchewan, but higher in British Columbia. In all three provinces, the monthly prevalence appeared unrelated to the number of bats tested (Fig. 1). In Alberta, the sex ratio of rabid bats (1.5 females: 1 male) did not differ from that of non-rabid bats (1.9 females: 1 male) ($\chi^2 = 0.55$).

In all three provinces, rabid bats were found each year between June and September; however, most were found in August and September (74%, 57%, and 69% in Alberta, British Columbia, and Saskatchewan, respectively). A few additional rabid bats were found in January and February (Saskatchewan), May (British Columbia), and May, October, and November (Alberta). Rabid silver-haired (*Lasionycteris noctivagans*), hoary (*Lasiurus cinereus*), and little brown bats usually were found in August and/or Septem-

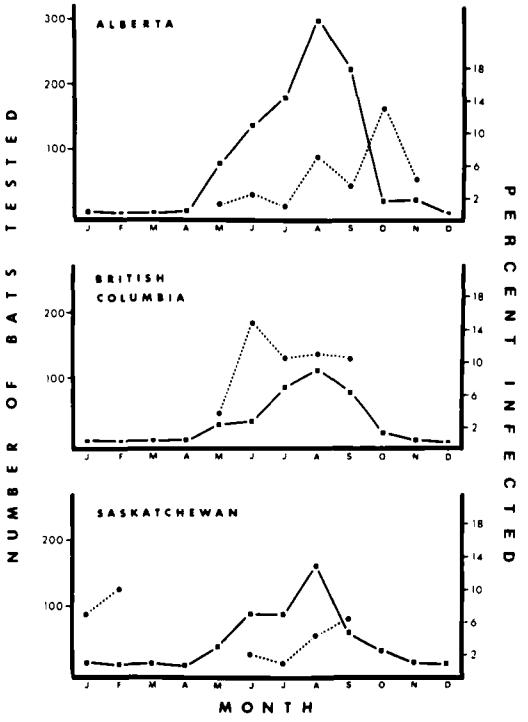

FIGURE 1. Monthly rabies infection in suspect bats from western Canada, 1979 to 1983. Only non-zero values are shown. (—— number tested, ----- percent infected.)

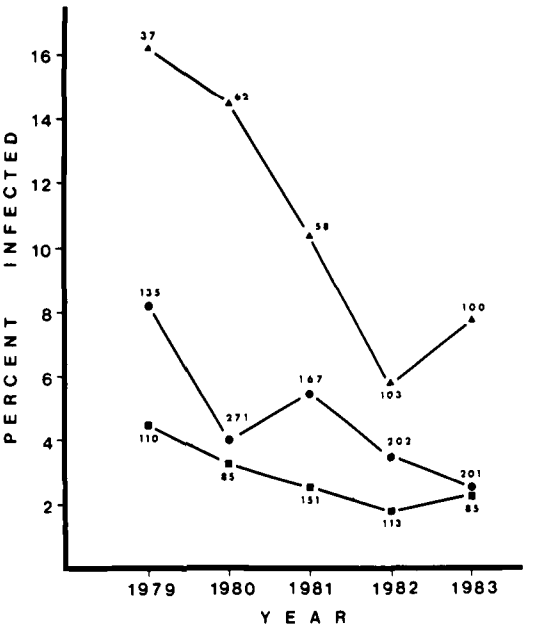

FIGURE 2. Annual rabies infection in suspect bats from western Canada, 1979 to 1983. Sample size indicated for each value. (▲ British Columbia, ● Alberta, ■ Saskatchewan.)

ber while rabid big brown bats were found throughout the year excluding March, April, and December. Rabid bats were collected throughout the populated area of all three provinces (Fig. 3).

The prevalence of rabies in suspect individuals of each species of bat differed among species but, generally, was similar among years (Table 1). In little brown bats, the proportion of bats infected was low or rabies was absent each year in all three provinces. In big brown bats, the proportion infected was relatively low in Saskatchewan, moderate in Alberta, and high in British Columbia; however, it differed indirectly with number of animals tested (Fig. 4). In silver-haired bats, the annual prevalence was variable in all provinces, ranging from zero to 17.6%, 18.2%, and 9.1% in Alberta, British Columbia, and Saskatchewan, respectively. The sample sizes of the remaining species were too small to allow detailed analyses. Among these suspect individuals, rabies was diagnosed in five of 23 (22%), two of 15 (13%), and one of three hoary bats from Alberta, Saskatchewan, and British Columbia, respectively.

Big brown bats made up the highest proportion of the rabid bats detected in each province (>55%) (Table 2). Silver-haired bats also made up significant proportions of the rabid bats from Alberta and Saskatchewan. The index of similarity in the proportion of rabies found in suspect bats of each species was high between Alberta and Saskatchewan (75) but low between Alberta and British Columbia (46) and Saskatchewan and British Columbia (54).

A total of 769 bats collected randomly in Alberta was tested between 1979 and 1983 (annual $\bar{x} = 154 \pm 93$). Most of the bats were little brown bats (68%) or big brown bats (22%) collected at nursery col-

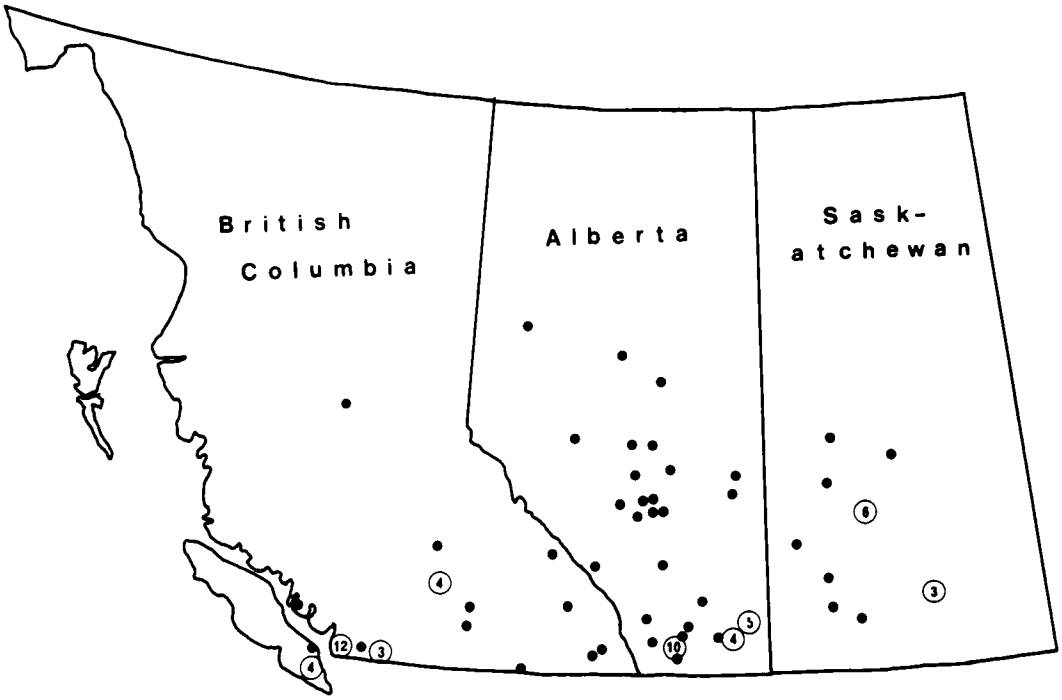

FIGURE 3. Geographic distribution of rabid bats in western Canada, 1979 to 1983. Numbers indicate multiple reports from one locality.

onies. The sex ratio was 5.4:1 in favor of females. Adults predominated in the sample. Of the 769 bats tested, only one adult female big brown bat (0.1%) collected in July 1979 was rabid. None of the little brown bats was infected.

DISCUSSION

The pattern of rabies infection was similar in insectivorous bats submitted by the public from Alberta and Saskatchewan and did not change from 1979 to 1983. Suspect big brown bats, silver-haired bats, and hoary bats provided the primary source of rabies virus detected within each province. Results suggested a similar pattern of transmission and maintenance of the virus within these two provinces and may reflect a marked similarity in habitat and in species composition, abundance, and ecology of bats in Alberta and Saskatchewan. The bat fauna of southern British Columbia is more diverse than that of Alberta and Saskatchewan (see Barbour and Davis, 1969) and, thus, additional species of bats may be involved in transmission. Also, the habitat in southern British Columbia differs markedly from that in Alberta and Saskatchewan, as reflected in the lower number of silver-haired and hoary bats submitted from British Columbia. Beauregard (1969) reported results similar to ours from bats collected in British Columbia.

Schowalter (1980) summarized information concerning rabies in bats collected in Alberta between 1971 and 1978. The index of similarity between his study and the current data was 63. During the early period, rabies-suspect big brown bats replaced suspect silver-haired bats as the species most commonly reported rabid. In the current analysis, big brown bats remained the most commonly reported species and the prevalence in suspect big brown bats has not changed markedly

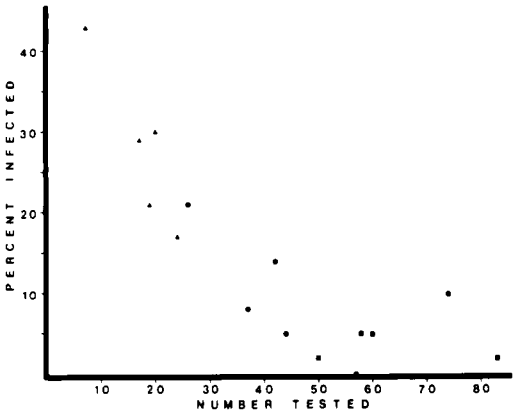

FIGURE 4. Sample bias in big brown bats. (▲ British Columbia, ● Alberta, ■ Saskatchewan.)

since 1974. The prevalence in little brown bats declined throughout the late 1970's and continued low throughout this study. The prevalence in hoary bats was lower in the current analysis.

Big brown bats found by the public consistently provided a significant source of virus. Although differences in the prevalence of rabies in suspect big brown bats from each province reflected a sample bias (see Fig. 4), a constant high proportion of the rabid bats which interact directly with people (and are thus submitted for rabies testing) are big brown bats. In western Canada this species associates closely with humans and man-made buildings. Thus, the public, particularly residents in southern British Columbia, should be warned of the potential danger of handling big brown bats.

On the contrary, the most common bat in western Canada, and the one most people are likely to encounter (the little brown bat) rarely was infected with rabies.

Data concerning the prevalence in suspect silver-haired and hoary bats must be treated cautiously. Normally, these species are solitary, forest-dwelling bats rarely seen by people (Barbour and Davis, 1969). Thus, individuals collected by the public are likely to be predisposed by disease or illness (see discussion by Constantine, 1967; Constantine et al., 1979; Schowalter, 1980). The wide variation in infection in samples of suspect individuals reflects the random nature of this "rare-event" occurrence.

TABLE 2. Rabid bats collected in western Canada, 1979 to 1983.

	Alberta	British Columbia	Saskatchewan
Number rabid	43	35	16
Little brown bat	4.7[a]	5.7	6.3
Big brown bat	55.8	62.9	56.3
Silver-haired bat	27.9	8.6	25.0
Hoary bat	11.6	2.9	12.5
Other	0	20.0[b]	0

[a] Proportion of provincial total.
[b] Three *Myotis californicus*, two *Myotis evotis*, one *Myotis yumanensis*, and one unidentified bat.

The epizootiology of rabies transmission within insectivorous bats is not understood. Martin (1959) hypothesized that the initial source of rabies in insectivorous bats resulted from interspecific interactions with infected vampire bats in Central America. He suggested that the northern colonial insectivorous species may have been infected during interactions with solitary long-ranging migratory species such as silver-haired and hoary bats. Occasional encounters between colonial and solitary species (Constantine, 1967; Schowalter, 1980) suggests the potential for such transfer still exists. However, latency in overwintering bats (Constantine, 1967; Moore and Raymond, 1970), transplacental transmission (Sims et al., 1963; Constantine et al., 1968), transmammary transmission (Sims et al., 1963), the sedentary life style, and the aggressive social behavior of the colonial species (Constantine, 1967), also appear to provide adequate mechanisms to maintain the virus within local populations.

The stability of the pattern of rabies infection in suspect big brown bats suggests that the virus may cycle independently within this species. In all three provinces, prevalences detected in big brown bats

were inversely proportional to the number of animals tested (suggesting a similar pattern of transmission). The prevalence in suspect big brown bats in Alberta has not changed over the past 10 yr. Big brown bats accounted for approximately 50% of the bats diagnosed as rabid in each province each year. On the contrary, the prevalence of rabies detected in the solitary species was not correlated with the numbers tested but differed among provinces and among years. If the virus was maintained by transmission from solitary to colonial species, marked fluctuations in the prevalence in big brown bats would be expected. Thus, our data suggest intraspecific transmission of rabies in big brown bat populations in western Canada.

Although sample bias is always a factor in analysis of rabies data (see discussion in Constantine, 1969), the patterns of infection in samples of rabies-suspect northern insectivorous bats are remarkably similar throughout Canada and the United States (Avery and Tailyour, 1960; Beauregard and Stewart, 1964; Beauregard, 1969; Bigler et al., 1975; Dorward et al., 1977; Trimarchi and Debbie, 1977; Kurta, 1979–1980; Schowalter, 1980; Steece et al., 1982; Trimarchi, 1982). The prevalences in combined samples of colonial species are consistently 2–5% ($\bar{x} = 4.2 \pm 2$) and those in non-colonial species 10–25% ($\bar{x} = 10.5 \pm 5$). Prevalences in big brown bats are generally 5–10% (range 3–20%) while those in little brown bats are consistently less than 2%. The majority of rabid bats detected in each study are big brown bats or silver-haired bats. Such consistency in the pattern of infection allows speculation that rabies virus may be maintained independently within each colonial species over a broad geographic range. Little brown bats are the most numerous species of bat in northern regions. The population estimate in Alberta is approximately 1½ million individuals (Schowalter et al., 1979). Thus, even a low prevalence in such a large population indicates a large pool of virus within the population. Little brown bats congregate in relatively large colonies throughout the summer and winter (Humphrey and Cope, 1976; Schowalter et al., 1979) and there is much admixing of the population at swarming sites in the fall. These features, in addition to the daily social aggressive behavior easily could provide sufficient intraspecific interaction to maintain the virus.

In contrast, big brown bats are less numerous (e.g., the population in Alberta is approximately 50,000) and more sedentary than little brown bats (Schowalter and Gunson, 1970; van Zyll de Jong, 1985) but have a higher prevalence of infection. Local populations remain discrete throughout the year. The amount of virus within populations of big brown bats may be similar in quantity to that in little brown bats and also may be sufficient to maintain the virus.

It is apparent that rabies virus is enzootic at relatively constant prevalences in northern colonial insectivorous bats. Local epizootics in little brown bats and big brown bats, should they occur, would be rare, short-lived events (Schowalter, 1980; Centers for Disease Control, 1983) and perhaps result from occasional interspecific transmission between colonial species and migratory solitary species. Smith et al. (1984) report two different antigenic patterns in rabies isolates from big brown bats in Maryland. Different patterns of transmission (intraspecific and interspecific) may, in part, explain their results.

ACKNOWLEDGMENTS

The author gratefully acknowledges the cooperation of personnel at ADRI in allowing access to the files. In addition B. Prins and D. Meyer conducted all diagnostic tests and made specific identification of many of the bats. D. B. Schowalter and R. Rosatte verified the identification, sex, and age of most bats from Alberta. H. Walker assisted in compiling the data. The manuscript was reviewed by J. R. Gunson, D. B. Schowalter, and members of the parasi-

tology group at the University of Alberta. The project was funded by Alberta Agriculture.

LITERATURE CITED

ABELSETH, M. K. 1966. The growth of rabies virus in tissue culture and its use as a living attenuated vaccine for domestic animals. Ph.D. Thesis. Univ. Minnesota, Minneapolis, Minnesota, 66 pp.

AVERY, R. J., AND J. M. TAILYOUR. 1960. The isolation of the rabies virus from insectivorous bats in British Columbia. Can. J. Comp. Med. Vet. Sci. 24: 143–146.

BARBOUR, R. W., AND W. H. DAVIS. 1969. Bats of America. University Press of Kentucky, Lexington, Kentucky, 286 pp.

BEAUREGARD, M. 1969. Bat rabies in Canada 1963–1967. Can. J. Comp. Med. 33: 220–226.

———, P. BOULANGER, AND W. WEBSTER. 1965. The use of fluorescent antibody staining in the diagnosis of rabies. Can. J. Comp. Med. 29: 141–147.

———, AND R. C. STEWART. 1964. Bat rabies in Ontario. Can. J. Comp. Med. Vet. Sci. 28: 43–45.

BIGLER, W. J., G. L. HOFF, AND E. E. BUFF. 1975. Chiropteran rabies in Florida: A twenty-year analysis, 1954 to 1973. Am. J. Trop. Med. Hyg. 24: 347–352.

CENTERS FOR DISEASE CONTROL. 1972. Epizootic bat rabies in Delaware and Virginia. Rabies surveillance. U.S. Dept. Health, Education, & Welfare, Atlanta, Georgia 73-8200, pp. 7–8.

———. 1983. Annual summary 1980–82. Rabies surveillance. U.S. Dept. Health & Human Services, Atlanta, Georgia 84-8255, 28 pp.

CONSTANTINE, D. G. 1967. Bat rabies in the southwestern United States. Public Health Rep. 82: 867–888.

———. 1979. An updated list of rabies-infected bats in North America. J. Wildl. Dis. 15: 347–349.

———, G. L. HUMPHREY, AND T. B. HERBENICK. 1979. Rabies in *Myotis thysanodes, Lasiurus ega, Euderma maculatum,* and *Eumops perotis* in California. J. Wildl. Dis. 15: 343–345.

———, G. C. SOLOMON, AND D. F. WOODALL. 1968. Transmission experiments with bat rabies isolates: Responses of certain carnivores and rodents to rabies viruses from four species of bats. Am. J. Vet. Res. 29: 181–190.

DORWARD, W. J., D. B. SCHOWALTER, AND J. R. GUNSON. 1977. Preliminary studies of bat rabies in Alberta. Can. Vet. J. 18: 341–348.

HOLMES, J. C., AND R. PODESTA. 1968. The helminths of wolves and coyotes from the forested regions of Alberta. Can. J. Zool. 46: 1193–1204.

HUMPHREY, S. R., AND J. B. COPE. 1976. Population ecology of the little brown bat, *Myotis lucifugus,* in Indiana and north-central Kentucky. Am. Soc. Mammal. Spec. Publ. No. 4, 81 pp.

KURTA, A. 1979–1980. Bat rabies in Michigan. Mich. Acad. 12: 221–230.

MARTIN, R. L. 1959. A history of chiropteran rabies with special reference to occurrence and importance in the United States. Wildl. Dis. No. 3, 38 pp.

MOORE, G. J., AND G. H. RAYMOND. 1970. Prolonged incubation period of rabies in a naturally infected insectivorous bat, *Eptesicus fuscus* (Beauvois). J. Wildl. Dis. 6: 167–168.

ROSATTE, R. C. 1985. Bat rabies in Alberta 1979–1982. Can. Vet. J. 26: 81–85.

SCHOWALTER, D. B. 1980. Characteristics of bat rabies in Alberta. Can. J. Comp. Med. 44: 70–76.

———, AND J. R. GUNSON. 1979. Reproductive biology of the big brown bat (*Eptesicus fuscus*) in Alberta. Can. Field Nat. 93: 48–54.

———, ———, AND L. D. HARDER. 1979. Life history characteristics of little brown bats (*Myotis lucifugus*) in Alberta. Can. Field Nat. 93: 243–251.

SIMS, R. A., R. ALLEN, AND S. E. SULKIN. 1963. Studies on the pathogenesis of rabies in insectivorous bats. III. Influence of the gravid state. J. Infect. Dis. 112: 17–27.

SMITH, J. S., J. W. SUMNER, L. F. ROUMILLAT, G. M. BAER, AND W. G. WINKLER. 1984. Antigenic characteristics of isolates associated with a new epizootic of raccoon rabies in the United States. J. Infect. Dis. 149: 769–774.

STEECE, R. S., T. J. ERICKSON, R. A. SIEM, AND E. C. BIRNEY. 1982. Chiropteran rabies in Minnesota: 1976–1980. J. Wildl. Dis. 18: 487–489.

TABEL, H., A. H. CARNER, W. A. WEBSTER, AND C. A. CASEY. 1974. History and epizootiology of rabies in Canada. Can. Vet. J. 15: 271–281.

TRIMARCHI, C. V. 1982. Rabies in North American bats. Bat Res. News 23: 80.

———, AND J. G. DEBBIE. 1977. Naturally occurring rabies virus and neutralizing antibody in two species of insectivorous bats of New York State. J. Wildl. Dis. 13: 366–369.

VAN ZYLL DE JONG, C. G. 1985. Handbook of Canadian Mammals, Vol. 2. National Museums of Canada, Ottawa, Ontario, 212 pp.