Antibodies to Vesicular Stomatitis New Jersey Type Virus in a Population of White-Tailed Deer

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TABLE 1. Rabies-negative fetuses from rabies-positive bats found in California, 1975–1985.*

Species of bat	Number of pregnant bats	Number of fetuses
California brown bat (*Myotis californicus*)	1	1
Big brown bat (*Eptesicus fuscus*)	2	1 each
Red bat (*Lasiurus borealis*)	2	2 and 4
Hoary bat (*Lasiurus cinereus*)	2	2 each
Mexican free-tailed bat (*Tadarida brasiliensis*)	15	1 each
Totals	22	28

* Brains of all mature bats and all fetuses were examined by the fluorescent rabies antibody technique. In addition, brains from two fetal sibling red bats and one fetal Mexican free-tailed bat were inoculated into litters of suckling mice.

nation seems probable from the results of FRA tests on the brains of fallen, naturally-infected suckling bats from the cave floor. None of 284 suckling Mexican free-tailed bats estimated to be less than 5 days of age contained rabies viral antigen in brain smears, but 76 of 395 bats (19.2%) aged 5 to 11 days were positive. Eighty-four percent of the 76 infected sucklings were 7 to 11 days old, evidently having been infected at birth.

Prenatal infection by rabies virus would seem less significant since newborn bats may acquire infection at birth or shortly thereafter from infected mothers, other animals, or possibly by aerosols in populous roosts of Mexican free-tailed bats in caves (Constantine, 1967, Rabies Transmission by Air in Bat Caves, U.S. Pub. Health Serv. Publ. 1617, 51 pp.).

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Although antibodies to vesicular stomatitis (VS) New Jersey (NJ) type previously had been reported in white-tailed deer (*Odocoileus virginianus*) (Karstad et al., 1956, J. Am. Vet. Med. Assoc. 129: 95–96; Jenney, 1967, Proc. U.S. Livestock Sanit. Assoc. 71: 371–385; Trainer and Hanson, 1969, Am. J. Epidemiol. 90: 354–358; Jenney et al., 1970, J. Wildl. Dis. 6: 488–493; Fletcher et al., 1985, J. Wildl. Dis. 21: 100–104), experimental VS infection has resulted only in a low transient viremia quickly followed by high concentrations of virus neutralizing antibodies (Karstad and Hanson, 1957, Am. J. Vet. Res. 18: 162–166). While this suggests that white-tailed deer do not act as long-term VS reservoirs, the value of this species as an indicator to detect areas of VS activity has been established (Jenney et al., 1970, op. cit.).

Antibodies to VS were first recorded on Ossabaw Island, Georgia, from two white-tailed deer collected in 1965 (Jenney et al., 1970, op. cit.). Since that time, VS antibodies also have been reported in wild swine (*Sus scrofa*), cattle (*Bos taurus*), and

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TABLE 1. Prevalence of vesicular stomatitis serum neutralizing antibodies in white-tailed deer by year and age class, Ossabaw Island, Georgia.

Age class (years)	Number seropositive*/number samples (% seropositive)			
	1981	1982	1983	1984
0.5	1/17 (6%)	3/18 (17%)	9/21 (43%)	4/15 (27%)
1.5	2/13 (15%)	5/11 (45%)	11/28 (39%)	9/27 (33%)
2.5	8/17 (47%)	5/12 (42%)	7/9 (78%)	15/28 (54%)
3.5	10/19 (53%)	10/18 (55%)	8/10 (80%)	11/17 (65%)
4.5	9/14 (64%)	8/16 (50%)	10/10 (100%)	5/8 (62%)
5.5	5/9 (55%)	9/11 (82%)	9/10 (90%)	2/5 (40%)
6.5+	6/7 (86%)	10/10 (100%)	6/7 (86%)	9/12 (75%)
Total	41/96 (43%)	50/96 (52%)	60/96 (62%)	55/112 (49%)

* Includes positive results at all dilutions.

a goat (*Capra hircus*) from Ossabaw Island (Jenney et al., 1970, op. cit.; Jenney and Brown, 1972, Proc. U.S. Anim. Health Assoc. 76: 183–193; Jenney et al., 1980, Proc. Am. Assoc. Vet. Lab. Diagnost. 23: 83–89). Serologic surveys of both wild and domestic species from 1981 to 1983 revealed the presence of VS serum neutralizing antibodies in raccoons (*Procyon lotor*), white-tailed deer, feral swine, cattle, horses (*Equus caballus*), and donkeys (*Equus asinus*) (Fletcher et al., 1985, op. cit.; Stallknecht et al., 1985, Am. J. Epidemiol. 122: 876–883). This study reports results of a 4-yr surveillance of the white-tailed deer on Ossabaw Island with emphasis on the prevalence of annual VS serum neutralizing antibodies and the potential of this species as a VS indicator. In addition, since VS is reported to be enzootic in the coastal plain of the southeastern United States (Hanson and Karstad, 1956, Proc. U.S. Livestock Sanit. Assoc. 60: 288–292), serologic results for other southeastern deer herds are presented.

Ossabaw Island is a 10,117-ha barrier island on the Georgia coast. Terrestrial habitats comprise 4,775 ha with the remaining area consisting of fresh and salt water marsh. Domestic animals and species of wildlife present on Ossabaw Island have been described previously (Fletcher et al., 1985, op. cit.; Johnson et al., 1974, Nat. Park Serv. Sci. Monogr. Ser. No. 3, pp. 197–210).

Blood from deer on Ossabaw Island was collected from hunter-killed animals killed on the southern half of the Island. Ages of deer were determined as described by Severinghaus (1949, J. Wildl. Manage. 13: 195–216). Samples collected from other southeastern areas were obtained from hunter-killed deer or from deer collected during various herd health checks (Eve and Kellogg, 1977, J. Wildl. Manage. 41: 169–177).

Serum samples were submitted to the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), National Veterinary Services Laboratories (NVSL), Ames, Iowa, for VS evaluations utilizing the microtiter serum neutralization test (NVSL, 1981, Serologic Microtitration Techniques, USDA, APHIS, NVSL, Ames, Iowa, 48 pp.). Titers of 1:32 or greater are generally considered positive, but due to the lack of available information on long-term titer persistence in this species, all titers are included.

Serum samples from Ossabaw Island were collected from 96 white-tailed deer each year during 1981, 1982, and 1983. In 1984, 112 deer were sampled. Serologic results by year and age class are shown in

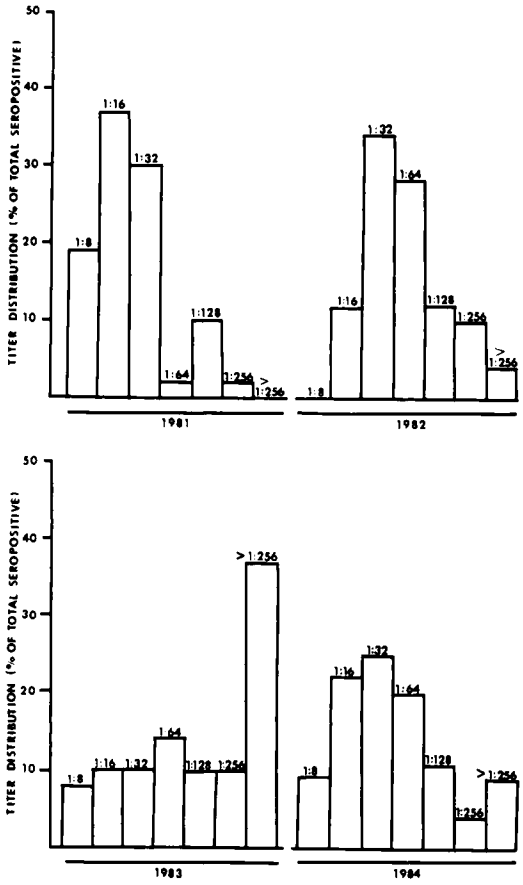

FIGURE 1. Frequency distribution of antibody titers to vesicular stomatitis NJ virus in white-tailed deer, Ossabaw Island, Georgia, 1981–1984.

Table 1 and indicate prevalences of 42%, 52%, 62%, and 49% during these 4 yr, respectively.

In order to test for correlation between age prevalence of antibodies, each observation (prevalence of antibody by age class by year) was weighted by the estimate of its own variance. A two-way analysis of variance using years as blocks detected significant differences among age means ($P > 0.001$, $R^2 = 0.950$). A linear contrast of the age means also was significant ($P < 0.0001$).

Concentrations of antibodies followed a similar pattern as prevalence, increasing from 1981 to 1983 then decreasing in 1984 (Fig. 1). High titers (≥1:128) represented 12%, 25%, 58%, 24% of all titers recorded in 1981, 1982, 1983, and 1984, respectively.

Serums were tested from 245 additional deer from 34 locations in seven southeastern states. Results are presented in Table 2.

Possible biases associated with correlations of prevalence and age, coupled with persistence of antibody in older age classes, prevent inference to relative annual incidence based on results from the total sample. For these reasons, a relative annual incidence can best be estimated in the 0.5-yr age class.

Data from this age class suggest that during these 4 yr at least 6%, 17%, 43%, and 27% of deer were exposed to VS, respectively. In sentinel swine of the same area (southern half of Ossabaw Island), seroconversion incidence increased threefold (30% to 90%) from 1982 to 1983 (Stallknecht et al., 1985, op. cit.) and decreased 0.7-fold (90% to 65%) from 1983 to 1984 (Stallknecht, unpubl. data). Although prevalences in 0.5-yr-old deer were lower, differences between years were similar, with a 2.5-fold increase and 0.6-fold decrease in antibody prevalence observed between 1982–1983 and 1983–1984, respectively. Serologic results from this age class appear to adequately reflect annual viral activity and may be useful in understanding possible cyclic behavior of this virus.

While not providing a clear picture of annual viral activity, serologic results from older age classes have application in viewing the indicator potential of this species. If possible, sampling for delineation and detection of VS foci should be biased towards older age classes. Viral activity on Ossabaw Island varied between years, but observed prevalence (positive at 1:8 or higher dilution) reached or exceeded 50% in the 3.5-yr-old age class each year. If titers normally considered positive (positive at 1:32 or higher dilution) are considered, prevalences observed in this age class

TABLE 2. Vesicular stomatitis serum neutralizing antibodies (NJ type) in white-tailed deer from the southeastern United States.

State	Year	Location	County or parish	Number tested	Serologic results
Alabama	1980	Vanity Fair Hunt Club	Monroe	9	Negative[a]
	1983	Eufala NWR	Barbour	5	Negative
	1983	Fort Rucker	Dale	7	Negative
Arkansas	1982	County-wide	Ashley	5	Negative
	1983	Lafayette WMA[b]	Lafayette	6	Negative
	1983	Wattensaw WMA	Prairie	5	Negative
	1983	White River NWR[c]	Arkansas	6	Negative
	1984	Bayou De View WMA	Poinsett	5	Negative
Florida	1981	Citrus WMA	Citrus	10	Negative
	1981	St. Marks NWR	Wakulla	10	Negative
	1981	Tosohatchee State Preserve	Orange	9	Negative
	1983	St. Marks NWR	Leon	5	Negative
	1984	Big Cypress Swamp	Collier	6	Negative
	1984	St. Vincents NWR	Franklin	6	Negative
Georgia	1979	Cumberland Island	Camden	5	Negative
	1980	Harris Neck NWR	McIntosh	5	4 Negative 1 Positive @1:16
	1983	Blackbeard Island NWR	McIntosh	5	Negative
	1983	Wassaw Island NWR	Chatham	5	Negative
	1984	Cumberland Island	Camden	15	Negative
	1984	Sapelo Island	McIntosh	24	Negative
	1984	Savannah NWR	Chatham	4	Negative
	1985	Okefenokee NWR	Charlton	5	Negative
	1985	Sapelo Island NWR	McIntosh	6	Negative
Louisiana	1979	Delta WMA	Plaquemines	5	Negative
	1981	Avery Island	Iberia	5	Negative
	1981	Saline WMA	LaSalle	5	4 Negative 1 Positive (≥1:512)
	1982	Red River/Three Rivers	Concordia	8	Negative @1:32[d]
	1983	Iron Bridge	Union	7	Negative
	1983	Tensas WMA	Madison	6	Negative
	1984	Big Lake WMA	Tensas	5	Negative
	1984	Tensas River NWR	Madison	5	Negative
South Carolina	1972	Palmento Bluff	Beaufort	5	Negative
	1983	Pickney Island NWR	Beaufort	4	Negative
	1984	Hobcaw Barony	Georgetown	12	Negative
	1985	Pickney Island NWR	Beaufort	5	4 Negative 1 Positive @1:8
Virginia	1981	Chincoteague NWR	Accomack	5	Negative
			Total	245	

[a] Negative at 1:8 dilution.
[b] WMA = Wildlife Management Area.
[c] NWR = National Wildlife Refuge.
[d] Not tested at lower dilutions.

were reduced, but still reached 21%, 44%, 60%, and 41% during these years, respectively. This suggests that, given the amounts of viral activity present on Ossabaw Island, sample sizes of 3.5+-yr-old deer could be relatively small to detect areas of enzootic activity. The inclusion of these age classes, however, may be difficult in areas where large numbers of deer are harvested.

Antibody titers recorded for Ossabaw deer (Fig. 1) also are important in understanding indicator potential. The detection of high titers paralleled observed variations in prevalence of antibody and supports previous reports that white-tailed deer produce high concentrations of virus neutralizing antibodies following VS exposure (Karstad and Hanson, 1957, op. cit.). Furthermore, age class correlations indicate that antibodies persist in exposed animals for several years as reported in cattle (Hanson and Karstad, 1957, Proc. U.S. Livestock Sanit. Assoc. 61: 300–307).

The extent of this persistence, however, is currently unclear. Based on reductions in both observed titers and prevalence of antibody from 1983 to 1984, it appears that a significant proportion of antibodies is greatly reduced or lost. Low titers normally regarded as seronegative (1:8 and 1:16) may, as in 1981, represent greater than 50% of all detected titers and may result from normal reductions in titer during years of low viral activity. Low titers, especially if detected from a small sample of white-tailed deer, therefore, should be regarded with suspicion.

With the exception of 3 of 245 additional southeastern deer, all animals tested seronegative at the 1:8 dilution. Only one high titer ($\geq$1:512) was detected from a deer collected at Saline Wildlife Management Area, LaSalle Parish, Louisiana, during 1981. Of the 245 animals, this was the only one which exhibited a titer in excess of the recognized seropositive limit ($\geq$1:32). Seropositive results in deer also were reported from this area in 1967 (Jenney et al., 1970, op. cit.). As reported with livestock, VS activity appears to be very localized (Jonkers, 1967, Am. J. Epidemiol. 86: 286–291). Further evidence of this can be found in the observation that despite persistent VS activity detected in deer on Ossabaw Island, VS antibodies have not been detected in deer sampled from other Georgia barrier islands, notably Cumberland, Blackbeard, Sapelo, and adjacent Wassaw Islands. As with the Saline WMA, Ossabaw deer have a history of VS activity dating back to the 1960's.

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