CORRELATION BETWEEN HUMAN CASES AND ANTIBODY PREVALENCE IN HOUSE SPARROWS DURING A FOCAL OUTBREAK OF ST. LOUIS ENCEPHALITIS IN MISSISSIPPI, 1979

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ABSTRACT. A small, focal outbreak of St. Louis encephalitis (SLE) in humans occurred during September 1979 in the vicinity of Greenville, Mississippi. Excellent correlation was demonstrated between the occurrence of human cases and the prevalence of SLE antibody in house sparrows collected in October 1979. At the geographic focal point of the outbreak where 11 cases were documented, the prevalence of SLE neutralizing antibody in house sparrows was 44.6%. Antibody prevalence in the birds decreased with distance from the focus of human cases and was lowest in locations without recognized human disease. Little or no serologic evidence was found for SLE virus transmission in Memphis, Tennessee, or in southern (coastal) counties of Mississippi. Results provide additional documentation for the usefulness of monitoring SLE antibody prevalence in house sparrows as an indication of the level of SLE virus transmission but emphasize the focal nature of viral activity.

INTRODUCTION

The first documented St. Louis encephalitis (SLE) outbreak in Mississippi occurred in 1974 (Powell and Blakey 1976). In 2 subsequent years, 1975 and 1976, major outbreaks occurred in the same area (Powell and Blakey 1977). During 1977 and 1978 there were 5 and 3 human cases, respectively, and in 1979 there were 18 cases (10 confirmed and 8 presumptive) recorded. No SLE cases were reported for the bordering states of Arkansas, Tennessee and Louisiana during this time interval in 1979. In 1974, 1975 and 1976, cases were reported from several geographic regions of the state and epidemics were also documented in Memphis, Tennessee. These observations suggested that, when SLE virus transmission was at an epidemic level, cases occurred over a wide geographic area. The same pattern occurred in 1978–79, when the few cases recorded were widely scattered in Mississippi. Thus, in 1979, it was of interest when cases occurred in a relatively circumscribed area of the lower Mississippi Delta region (Washington, Bolivar, Sunflower and Humphreys counties). Since 1974, active human case surveillance with laboratory testing of suspect cases had been conducted by the Mississippi State Health Department. The geographically limited occurrence of human SLE cases in 1979 could not, therefore, be reasonably attributed to incomplete case ascertainment.

The focal outbreak in 1979 in Mississippi provided an opportunity to examine the relationship between human SLE cases and antibody prevalence rates in house sparrows. It is generally accepted that extensive transmission of SLE virus must take place between mosquito vector and amplifying hosts before human cases occur. Several studies have indicated that the house sparrow *(Passer domesticus)* is an important avian host in the maintenance and amplification cycle of SLE virus because of the species' relative abundance, virus susceptibility, and viremia levels following infection (Lord et al. 1974, Bowen et al. 1980). In recent years, attention has been focused on serologic surveillance of wild birds, particularly house sparrows, as a means of detecting SLE viral transmission in advance of a human outbreak (Bowen and Francy 1980).

Previous studies have shown increased antibody prevalence rates among birds to be associated with SLE epidemics. The studies reported here provided an opportunity to further examine this relationship and to document the focal nature of epidemic transmission in Mississippi.

METHODS

Human cases were reported during an active surveillance program conducted by the Mississippi Department of Public Health and the Bureau of Epidemiology, Centers for Disease Control (CDC), Atlanta, Georgia. Acute and convalescent sera were tested by hemagglutination-inhibition at the Division of Vector-Borne Viral Diseases, CDC, Fort Collins, Colorado, and results interpreted as presumptive or confirmed infections according to recommendations given previously (Calisher and Poland 1980). Briefly, confirmed cases are those showing a fourfold or greater rise or fall in antibody titer between two appropriately spaced serum samples; presumptive cases are those with a single serum titer $\geq$1:80 and a compatible clinical illness.

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Sera from house sparrows were collected between October 6 and 17, 1979, in Sunflower and Washington counties, where cases had been reported, and in Tunica and Coahoma counties, where no cases were reported. Additional collections were made in Oktibbeha County outside the Delta region. Bird sampling sites were selected for their proximity to areas with humans at risk and for examining the question of house sparrow antibody prevalence wih regard to distance from the apparent focus of virus activity in and near Greenville. Birds were captured in Japanese mist nets. Two-tenths ml of blood was taken from the jugular vein and added to 0.9 ml of diluent (medium 199 containing 20% heat-inactivated fetal bovine serum). The mixture was centrifuged, and the diluted (1:10) serum was poured off and held at −60°C until tested for antibody. Sera were tested, as previously described (Monath 1980), by plaque-reduction neutralization (N) tests in Vero cell culture using SLE virus strain (MSI-7) isolated from nestling *P. domesticus* collected during 1975 in Sunflower County (Indianola), Mississippi. A serum was considered positive when the number of plaques was reduced >90% as compared with controls.

RESULTS

The 1979 outbreak in Mississippi was geographically limited in contrast to previous years when cases were more widely spread (Table 1). In the 5 previous years in which cases were documented, 40–100% of the total Mississippi cases were outside the lower Delta region, whereas in 1979, only 6% of the total cases occurred outside this region. The human case distribution for 1979 is shown in Fig. 1. There were 11 cases in Greenville, 2 cases in Leland, and 2 cases in Indianola. Attack rates were 23.8, 33.3 and 22.4 per 100,000 population, respectively. There were also single cases in Yazoo, Bolivar and Jackson counties, but no sparrows were sampled in those areas. The relationship between the occurrence of human SLE cases and antibody in house sparrows is summarized in Table 2, as is the distance of each bird sampling site from the Greenville focus. Comparing antibody rates for combined areas with SLE cases and those without cases yielded a highly significant statistical difference. Although the highest antibody prevalence was outlined in birds from Greenville, there was no significant difference between the Greenville rates and those in birds sampled from Indianola and Leland. With increasing distance from the focus of human cases, the antibody prevalence rate in house sparrows declined (Kendall's rank order correlation test, $n = 5$, $p < .05$).

Table 1. Geographic distribution of St. Louis encephalitis cases in Mississippi.

Year	No. (%) cases in: Lower Delta[a]	Other MS	Totals	No. (%) of Lower Delta cases from Greenville
1974	6 (26.1)	17 (73.9)	23	3 (50.0)
1975	137 (59.8)	92 (40.2)	229	79 (57.7)
1976	10 (10.3)	87 (89.7)	97	4 (40.0)
1977	—	5 (100.0)	5	—
1978	—	3 (100.0)	3	—
1979	16 (88.9)	2 (11.1)	18	11 (68.8)

[a] Lower Delta composed of Washington, Bolivar, Sunflower and Humphreys counties.

DISCUSSION

In the years when SLE outbreaks were documented prior to 1979, virus activity in this region was much more extensive geographically. This was true, not only for Mississippi, but also for the Memphis area in 1974–76. In 1979, human cases and SLE virus transmission, as measured by serologic testing of birds, were quite restricted geographically. The observations reported herein also demonstrated a consistent correlation between the intensity of virus

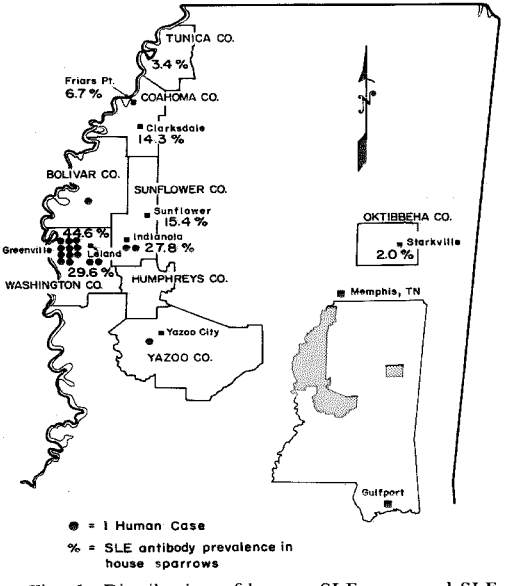

Fig. 1. Distribution of human SLE cases and SLE virus antibody prevalence in house sparrows.

Table 2. Neutralizing antibody prevalence rates in house sparrows and their relationship to human cases and distance from the epidemic focus in Greenville, MS.

Location		No. human cases	House sparrow Aby rates	Distance from Greenville (miles)
County	Community			
Washington	Greenville	11	33/74 (44.6)[a]	—
	Leland	2	8/27 (29.6)	
Sunflower	Indianola	2	15/54 (27.8)	24
	Sunflower	0	8/52 (15.4)	32
Coahoma	Clarksdale	0	5/35 (14.3)	66
	Friar's Pt.	0	1/15 (6.7)	73
Tunica	Tunica	0	3/89 (3.4)	99
Oktibbeha	Starkville	0	1/50 (2.0)	133

[a] No. positive/no. tested (% pos.)

transmission, as measured by antibody in house sparrows, and the absence or presence of human cases over a broad geographic area within a state. With increasing distance from sites where human SLE cases were detected, neutralizing antibody prevalence in house sparrows declined. These observations are also generally consistent with previous conclusions that antibody rates greater than 15% in wild birds are indicative of risk of human cases (Bowen and Francy 1980).

Sparrows sampled in this study included both juvenile and adults. The singular use of juvenile birds for surveillance is ideal in areas with a history of SLE virus transmission; however, in practice, there is minimal detectable carry-over of antibody in adult birds from one season to the next. As noted earlier, SLE epidemics occurred in Memphis in 1974 and 1975. Following these outbreaks, antibody rates to SLE virus in adult house sparrows from Memphis for April–June in 1975 were 0, 0.3, and 1.8 percent, and for 1976 the rates were 1.3, 1.5, and 0.6 percent, respectively (J. Mullenix, personal communication). In all the sampling intervals for these 2 years except June 1976, the antibody rate in juveniles was higher than for the adults, supporting the assumption that active virus transmission was taking place. Further, in the 2 years preceding the study, there was no apparent evidence of SLE virus transmission in the Greenville area. For these reasons, the data for both adult and juvenile birds were combined in this study.

House sparrows were also being bled throughout the summer during 1979 in southern Mississippi by personnel from the Gulfport Mosquito Control Commission and in Memphis, Tennessee, by personnel from the Memphis-Shelby County Health Department. One of 789 house sparrows from Memphis and none of 298 from Gulfport, Mississippi, had antibody to SLE virus. These results indicate minimal levels of SLE virus activity both south and north of the Greenville epidemic focus in 1979.

The repeated occurrence of human cases in the Greenville focus, along with the focal pattern of transmission with no evidence in house sparrows of significant virus activity either south or north of the Greenville area, is consistent with the hypothesis that SLE virus persists in endemic foci in portions of the southern U.S. The serologic results obtained in this study provide additional support for the conclusion that house sparrows serve as major amplifying hosts for SLE virus. While other passerine species may be involved to a greater degree in enzootic maintenance of SLE virus, it is unlikely that virus amplification would step up to epidemic transmission levels without evidence in house sparrows of such increased viral activity.

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AN OPERATIONAL EVALUATION OF *BACILLUS THURINGIENSIS* SEROTYPE H-14 AGAINST *ANOPHELES SUNDAICUS* IN WEST JAVA, INDONESIA

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ABSTRACT. A brackish water lagoon (ca. 4.5 ha) was treated 6 times, from the last week in June until the first week in August 1982 with a liquid formulation containing *Bacillus thuringiensis* serotype H-14 toxin. Except during conditions of strong winds, doses of 1.1 to 2.3 kg/ha gave good control of larvae of *Anopheles sundaicus*, the main vector of malaria in the coastal areas of many islands of Indonesia. Adult populations of *An. sundaicus* in nearby hamlets were steadily reduced following successful larvicide treatments but readily increased following a control failure.

INTRODUCTION

Anopheles sundaicus (Rodenwaldt) is the main vector of malaria along the coastal areas of Indonesia (Sundararaman et al. 1957). In southern Java it breeds in brackish water lagoons and in the closed mouths of rivers. Conditions favorable for breeding are 4–30 parts per thousand salinity, exposure to sunlight and the presence of floating algae. The adults have a relatively short flight range (less than 5 km), are readily attracted to man and feed mostly outdoors (S. Kirnowardoyo, unpublished data, 1980).

Bacillus thuringiensis serotype H-14 produces a protein toxin that is highly toxic to mosquito larvae (Goldberg and Margalit 1977) but does not have harmful side effects on fish, insect predators or other nontarget organisms (Miura et al. 1980). The safety of this agent has been thoroughly established and it is fully registered for use in many countries. The toxin must be ingested by mosquito larvae to induce toxicity and it only persists in field waters for a few hours; this results in a need for repeated treatments unless the predator populations build up to effective population densities.

Bacillus thuringiensis H-14 has been evaluated in small-scale field trials in lagoons having a mixed larval population containing *An. sundaicus* (75%) and *An. subpictus* Grassi (10%). A rate of 2.5 kg/ha gave good control even in the presence of large amounts of floating algae; a lower rate of 1.0 kg/ha achieved good control in open water but not when algae were abundant (Sudomo et al.1981).

The objectives of this study were: (1) to evaluate the efficacy of *Bacillus thuringiensis* H-14 against *An. sundaicus*, (2) to determine whether multiple applications of this agent might allow predators to achieve population levels that would provide longer-term control, and (3) to determine whether or not such a larviciding program could be used to reduce the incidence of female mosquitoes landing on outdoor baits in adjacent inhabited areas.

STUDY AREA

The Cibera lagoon is the main production site for *An. sundaicus* near the village of Mekarsari and Karyamukti in the Province of West Java (subdistrict Pameungpeuk, Regency of Garut). Three Kampungs (hamlets) are adjacent to the Cibera lagoon and are well within the flight range of *An. sundaicus*. Kampung Cibera is about 300 m from the edge of the lagoon,

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