ARBOVIRUS SURVEILLANCE IN ILLINOIS IN 1976

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ABSTRACT. During 1975, there was widespread occurrence of St. Louis encephalitis (SLE) in Illinois where 578 cases and 47 deaths were reported. As a result, a statewide surveillance program was established to provide local health officials, mosquito abatement authorities, and the general public with early warning of high or increased levels of SLE virus transmission. Evidence of transmission was first detected in birds collected in mid-June in central and southern Illinois and reported to the public in early July. The onset of the first human case was in mid-July, but not confirmed until the third week of August. The organization, activities, results and value of this program are discussed.

INTRODUCTION. In the summer and early fall of 1975, St. Louis encephalitis (SLE) occurred at epidemic levels in midwestern and southern United States. The recognition of human disease as a result of this arbovirus was not new to Illinois. A large outbreak of SLE was retrospectively identified from Paris, in east-central Illinois, in 1932 (Rivers 1952). This outbreak preceded the 1933 epidemic in Missouri, focused in St. Louis and Jackson counties where over 1300 cases, excluding some in adjacent Illinois, were reported (Lumsden 1958). It was during this period that the etiological agent of SLE was associated with mosquitoes. Since that time, a few cases have been periodically recorded from the state with significant outbreaks reported in southeastern Illinois communities in 1964 (Kokernot et al. 1967) and 1968 (Rubin et al. 1970). The 1975 outbreak was, however, unique. There were more cases than recorded by any state since the 1933 episode in Missouri. SLE occurred in more areas of the state than ever before, with cases reported from 67 of the state's 102 counties, and it was confirmed in northern Illinois for the first time.

For the above reasons, the Illinois Department of Public Health (IDPH) deemed it desirable to develop the capability of evaluating SLE virus activity in its vertebrate and arthropod hosts before human infection appeared. The primary purpose was to identify virus transmission in nature and provide current information to local health officials, mosquito abatement agencies, and the general public. After initial results become available, efforts continued to monitor levels of virus transmission at several sites. A third purpose was to identify and study foci of arbovirus transmission. Another goal was to define the effect of California encephalitis group viruses on public health. As equipment and personnel became available, a strategy to achieve optimal coverage of 56,000 square miles and 11 million people was developed. Physically and administratively, the program was situated in the Division of Laboratories where 20,000 tests were performed in search of antibodies to SLE, WEE, EEE and California group viruses during 1975. Since all 102 counties could not be surveyed, it was decided that, initially, selected localities would be sampled on a repetitive basis.

The following criteria were established for monitoring SLE virus transmission: counties with historical involvement with SLE; counties with an attack rate during 1975 of 40 or greater per 100,000 population; and Cook County, an area with large population and extensive involvement (277 cases) in 1975. In the selected counties, studies were concentrated in a population center. Since the economy of many central and southern counties was agriculture-based, most birds were col-

lected at grain elevators, fairgrounds or stables. At these sites, an abundance of food, water, and nest material for house sparrows and other species was usually present. In addition, it was in these communities that *Culex pipiens,* the northern house mosquito, was expected to be found. Recognizing that SLE does occur sporadically, we regarded the above system as superior to random selection of county study areas. Furthermore, the program had the inherent flexibility to respond to a focus of human infection should one develop.

This program was not the first organized arbovirus study to be conducted in Illinois. In 1964 the Center for Zoonoses Research located at the University of Illinois began a study of arboviruses in the Ohio-Mississippi Basin (Kokernot and Brandley 1969). Between 1964 and 1967, they studied several arboviruses including SLE (Kokernot et al. 1969e), Flanders (Kokernot et al. 1969d), Cache Valley (Kokernot et al. 1969c), Trivittatus and Western equine encephalomyelitis (Kokernot et al. 1969a). In addition, staff of the Vector-Borne Diseases Division from the Center for Disease Control (CDC), Fort Collins, Colorado were in Illinois in 1975 (Monath, personal communication), to assess the potential for epidemic SLE activity.

MATERIALS AND METHODS. Field activities were begun in late May in southern Illinois and in mid-July in Cook County. Flying birds were trapped, banded, bled, and released after procedures of Sudia et al. (1970). The principal species sought was the house sparrow (*Passer domesticus*) because of its association with arboviruses (Chamberlain et al. 1957, Holden et al. 1973, and others). In Cook County, pigeons (*Columbia livia*) were also bled. The age of the bird was recorded to distinguish birds present during the 1975 epizootic from birds of the year. With the house sparrow, skull ossification studies by Nero (1951) were useful.

Field-collected blood was dispatched to the laboratory under refrigeration for initial studies of hemagglutination-inhibition (HI) antibody titers to SLE, WEE, and EEE (Clarke and Casals 1958, and Sever 1962). All sera were treated with protamine sulfate and acetone extracted before testing. To complement the antibody studies, attempts were made to isolate virus from the blood of young birds that had not left the nest. These specimens (0.1 ml whole blood) were placed in 0.9 ml field diluent (containing 20% inactivated fetal calf serum and 80% Medium 199), sealed, and held on dry ice until returned to the laboratory. Once there, they were inoculated intracerebrally into 2-4 day old Swiss-Webster mice.

Mosquitoes were also collected in the same communities where birds were sampled (Sudia and Chamberlain 1967). Some were obtained in CDC miniature light traps baited with dry ice as a CO_2 source but the majority was aspirated from resting sites (i.e. culverts, storm drains, and under bridges). Several mosquito abatement districts provided mosquitoes which were stored on dry ice until transported to the laboratory for identification and pooling. Pooled mosquitoes were ground in a diluent (see above) and centrifuged at 4° C. The supernatant was inoculated into duck embryo cell cultures and/or 2-4 day old suckling mice. Sampling was conducted through October with 2-3 days spent in a county during each collection period.

RESULTS. In late June, antibodies to SLE virus were detected in young birds collected earlier in the month from 3 south-central Illinois communities in Madison, Christian and Richland counties (Fig. 1). Once laboratory results from field collections were available and interpreted, they were shared with department personnel responsible for mosquito control and surveillance of human arboviral infections. Information on field and laboratory findings and the recommendations of IDPH were disseminated to appropriate individuals through the state's 7 regional offices and then to the news media (Fig. 2). The essence of the interpretation was that SLE virus had been transmitted in the state in 1976 and that precautionary

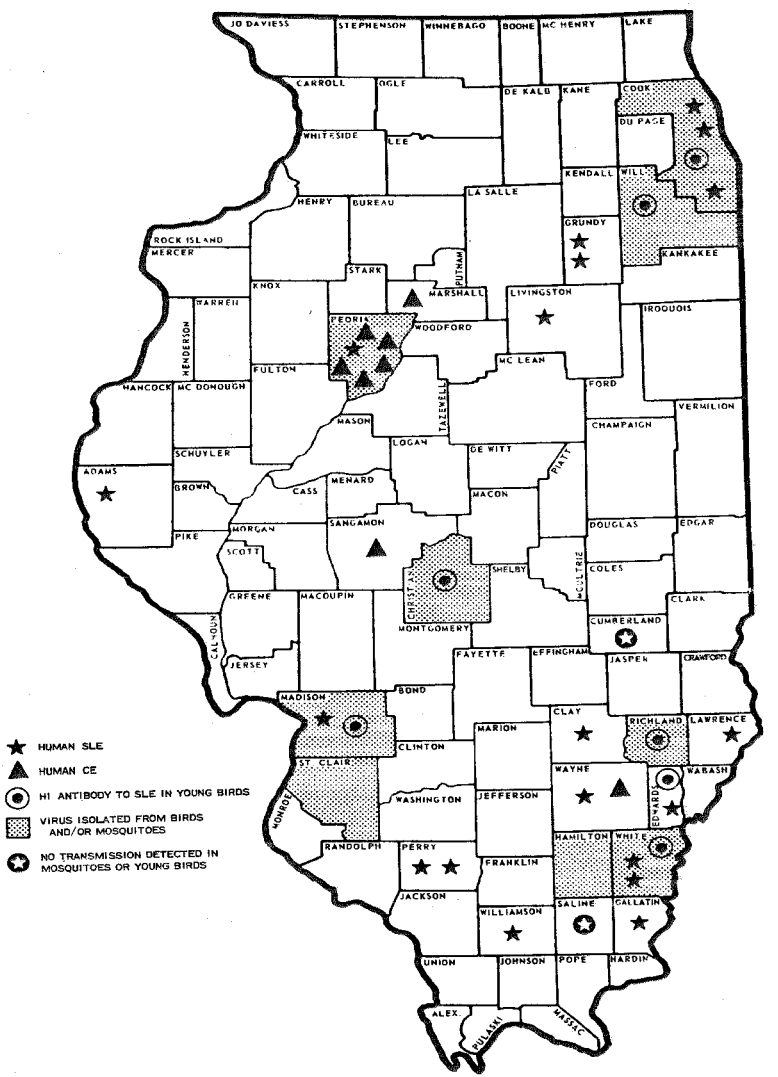

Fig. 1. Location of observed SLE and CE Group virus activity, Illinois, 1976.

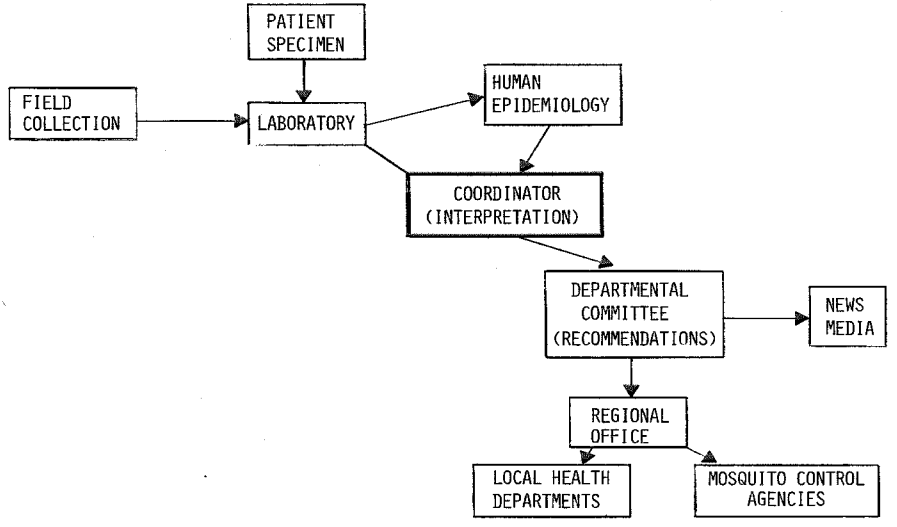

Fig. 2. Organizational scheme for coordinating arbovirus surveillance, Illinois, 1976.

measures should be taken to reduce mosquito breeding and avoid mosquitoes.

In Cook County, antibodies to SLE were detected in juvenile house sparrows collected on August 2. As monitoring continued, it was not until mid-September that a higher incidence of SLE antibodies (10 to 14%) was found in juvenile birds. These were in samples from White and St. Clair Counties and one site in Cook County.

After the first 2 human cases were confirmed on August 20 and 24, field investigations were made in those localities (Table 1). In Madison County, SLE had been recognized prior to human infection. A visit to the community of 300 in Edwards County where the second case resided yielded antibodies to SLE in 1 of 16 juvenile house sparrows.

Thirty-four species were bled for antibody studies. In 6 species HI antibodies of 1:20 or greater were detected (Table 2). These included house sparrow, pigeon (rock dove), grackle (*Quiscalus quiscula*), red-winged blackbird (*Agelaius phoeniceus*), mourning dove (*Zenaidura macroura*) and ring-necked pheasant (*Phasianus colchicus*). Two species, house sparrow and pigeon, yielded antibodies to WEE. SLE virus has been isolated from seven pools of 4 nestling and /or fledgling house sparrow bloods from three counties.

Culex mosquito populations were lower than in 1975, according to communications from CDC and local mosquito abatement districts. Seventeen strains of SLE have been isolated from 50,000 mosquitoes (9-*Culex pipiens*, 1-*Culex salinarius*, 7 *Culex* spp.) collected June through October. A California group, probably LaCrosse, virus was isolated from 300 *Aedes triseriatus* collected from Peoria County in mid-July. It is from this county along the Illinois River that 5 of the 8 diagnosed California group infections originated in 1976. This group of children, ages 5 to 14 years, was composed of 6 boys and 2 girls.

Human SLE infections were lower than in the previous year; there were 19 confirmed cases. These were widely distributed in the state. Those in southern Illinois were from areas that may be re-

Table 1. Early indication of SLE virus activity in Illinois, 1976 *

Date	County	Indicator
June 13	Madison	Antibodies**—juvenile mourning dove
June 17	Richland	Antibodies —juvenile house sparrow
June 19	Christian	Antibodies —juvenile house sparrow
July 9	Christian	Virus—*Culex pipiens*
July 11	Richland	Virus—*Culex pipiens*
July 24	Madison	*Onset—first human case*
July 26	White	Antibodies—juvenile house sparrow
July 31	Edwards	*Onset—second human case*
August 2	Cook	Antibodies—juvenile house sparrow

* Based on laboratory results as of August 31, 1976.
** HI≥20.

garded as endemic for SLE. Other cases were scattered across the state with only 3 occurring in Cook County, about 1% of the cases reported in 1975.

DISCUSSION. The emphasis during the first year of this program was on early warning. Evaluation of field samples resulted in detection of SLE virus activity in mid-June. This information was made public on July 6, about 6 weeks prior to confirmation of the first human SLE infection, a 56-year-old female from Madison County where virus activity was first detected in Illinois in 1976. With her date of onset of July 24, presumably she had been exposed to news media accounts of virus transmission prior to contact with SLE-infective mosquitoes. Had the surveillance program not been developed, evidence of current SLE transmission would not have been recognized until late August instead of late June. During other years, this interval of time could be used to implement appropriate mosquito control procedures. Continuous monitoring of virus transmission among birds and mosquitoes in 1976 did not result in issuance by IDPH of a recommendation for general use of aerial sprays for control of adult *Culex* mosquitoes, a step which was taken during the 1975 outbreak. Had transmission levels like those in 1975 been detected in June, July or August, 1976, there may have been cause for general alarm and appropriate action.

Table 2. Birds with antibodies to three arboviruses in Illinois, 1976.

Species	No. tested		HI antibodies *		
	Adult	Juvenile	EEE	SLE	WEE
Grackle	39			1	
		13			
House	854			23	
Sparrow		1,569		38	1
Mourning	0				
Dove		3		1	
Pigeon	93			1	
		163		2	3
Red-winged	6			1	
Blackbird		5			
Ring-necked	0				
Pheasant		159		1	
Other	72				
Species **		54			
Total	1,064	1,966	0	68	4

* HI≥1:20.
** 28 Species.

The isolation of virus from nest-dwelling birds and mosquitoes supplemented the antibody studies. This also aids in further understanding the ecology of the virus in Illinois.

Although the emphasis in field and laboratory studies has been on SLE, we are increasingly concerned about LaCrosse virus and its endemicity in Illinois, especially in light of recent work in Wisconsin with this virus and *Ae. triseriatus*

(Thompson et al. 1972, Watts et al. 1973). Minimal field work in a suspected La Crosse focus in north-central Illinois resulted in isolation of a California group virus from this mosquito. New cases have been recorded from Peoria County for the last several years.

Evidence of transmission of third arbovirus, WEE, in Illinois was also found in young birds. No human disease from this virus of potential veterinary significance was confirmed. The status of WEE in equines is not clear.

Sixteen of the 19 SLE cases were from regions in which virus activity had been detected in 1976. However, as we know, those results will not be applicable to 1977 and, thus, it becomes a matter of another diligent search for an impending SLE epizootic in resident birds. Unfortunately, we are unable to assess the exact impact of the program in minimizing human infections. However, early evidence of virus activity was detected and local mosquito control efforts were increased.

We are interested in follow-up studies in several areas, especially those where antibodies were detected and virus was isolated, in the absence of human disease. In another instance, antibodies were detected in juvenile birds and virus isolated from nestling house sparrows. At this rural residence in Richland County, the wife of the owner had clinical and serologic St. Louis encephalitis in 1975.

CONCLUSION. In general, the program functioned as planned and provided the information for which it was designed. We believe that this program has been and will continue to be a service to the citizens of Illinois.

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References Cited

Calisher, C.H., R.H. Kokernot, J.F. de Moore, K. R. Boyd, J. Hayes and W. A. Chappell. 1969. Arbovirus studies in the Ohio-Mississippi Basin, 1964–1967. VI. Mermet: A Simbugroup arbovirus. Am. J. Trop. Med. Hyg. 18(5):779–788.

Chamberlain, R.W., R.E. Kissling, D.D. Stamm and W.D. Sudia. 1957. Virus of St. Louis encephalitis in three species of wild birds. Amer. J. Hyg. 65 (1): 110–118.

Clarke, D. H. and J. Casals. 1958. Techniques for hemagglutination and hemagglutination-inhibition with arthropod-borne viruses. Amer. J. Trop. Med. Hyg. 7(5):561–573.

Holden, P., R.O. Hayes, C.J. Mitchell, D.B. Francy, J.S. Lazuick and T.B. Hughes. 1973. House sparrows, *Passer domesticus* (L.) as hosts of arboviruses in Hale County, Texas. I. Field studies. 1965–1969. Amer. J. Trop. Med. Hyg. 22 (2): 244–253.

Kokernot, R.H. and C. A. Brandley. 1969. Arbovirus studies in the Ohio-Mississippi Basin, 1964–1967. I. Introduction. Amer. J. Trop. Med. Hyg. 18(5):743–749.

Kokernot, R.H., C.H. Calisher, L.J. Stannard and J. Hayes. 1969a. Arbovirus studies in the Ohio-Mississippi Basin, 1965–1967. VII. Lone star virus, a hitherto unknown agent isolated from the tick *Amblyomma americanum* (Linn.) Amer. J. Trop. Med. Hyg. 18(5):789–795.

Kokernot, R.H., J. Hayes, D.H.M. Chan and K.R. Boyd. 1969b. Arbovirus studies in the Ohio-Mississippi Basin, 1964–1967. V. Trivittatus and Western equine encephalomyelitis viruses. Am. J. Trop. Med. Hyg. 18(5):774–778.

Kokernot, R.H., J. Hayes, N.J. Rose and T.H. Work. 1967. St. Louis encephalitis in McLeansboro, Illinois, 1964. J. Med. Entomol. 4(3):255–260.

Kokernot, R.H., J. Hayes, C.H. Tempelis, D.H.M. Chan, K.R. Boyd and R.J. Anderson. 1969c. Arbovirus studies in the Ohio-Mississippi Basin, 1964–1967. IV. Cache Valley Virus. Amer. J. Trop. Med. Hyg. 18(15):768–773.

Kokernot, R.H., J. Hayes, R.L. Will, B. Radivojevic, K.R. Boyd and D.H.M. Chan. 1969d. Arbovirus studies in the Ohio-Mississippi Basin, 1964–1967. III. Flanders

virus. Amer. J. Trop. Med. Hyg. 18(5):762–767.
Kokernot, R.H., J. Hayes, R.L. Will, C.H. Tempelis, D.H.M. Chan and B. Radivojevic. 1969e. Arbovirus studies in the Ohio-Mississippi Basin, 1964–1967. II. St. Louis encephalitis virus. Amer. J. Trop. Med. Hyg. 18(5):750–761.
Lumsden, L.L. 1958. St. Louis encephalitis in 1933. Publ. Hlth Repts. 73(4):340–353.
Nero, R.W. 1951. Pattern and rate of cranial ossification in the house sparrow. Wilson Bull. 63:84–88.
Rivers, T.M. 1952. *Viral and rickettsial infections of man.* J. B. Lippincott Co., Phila. 2nd Ed. 719 pp.
Rubin, R.H., T.H. Glock and N.J. Rose. 1970. St. Louis encephalitis in Saline County, Illinois. 1968. J. Infect. Dis. 122(4):347–353.
Sever, J.L. 1962. Application of a microtechnique to viral serological investigations. J. Immunol. 88:320–329.
Sudia, W.D. and R.W. Chamberlain. 1967. Collection and processing of medically important arthropods for arbovirus isolation. CDC, PHS, USDHEW, Atlanta. 65 pp.
Sudia, W.D., R.O. Lord and R.O. Hayes. 1970. Collection and processing of vertebrate specimens for arbovirus studies. CDC, PHS, USDHEW, Atlanta. 29 pp.
Thompson, W.H., R.O. Anslow, R.P. Hanson and G.R. DeFoliart. 1972. La Crosse virus isolations from mosquitoes in Wisconsin. 1964–1968. Amer. J. Trop. Med. Hyg. 21 (1): 90–96.
Watts, D.M., S. Pantuwatana, G.R. De Foliart, T.M. Yuill and W.H. Thompson. 1973. Transovarial transmission of La Crosse virus (California encephalitis group) in the mosquito. *Aedes triseriatus.* Science 182: 1140–1141.

CONTROL OF *MANSONIA* SPECIES IN GABON USING ULV PYRETHROIDS

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ABSTRACT. A field trial was carried out on Lambaréné island, Gabon, against *Mansonia* spp. with ultra low volume applications of Reslin 15S, a synthetic pyrethroid formulation containing 2.0% w/v S-bioallethrin ((+)-*trans* chrysanthemic ester of (+)-allethrolone) and 13.0% w/v bioresmethrin ((+)-*trans* chrysanthemic ester of 5-benzyl-3-furyl-methanol) applied with a Leco® HD cold aerosol ULV generator. The level of control was determined by bait catches at fixed sites. The treatments gave very high immediate kill of adult mosquitoes and, although penetration into the main breeding sites of the ULV mist was hampered by physical conditions, the level of control obtained during the trial was better than expected from a *Mansonia* spp. population model incorporating a similar spraying regime.

INTRODUCTION

Lamberéné island situated on the River Ogooué in the Moyen Ogooué region of Gabon, some 200 km southeast of the capital Libreville is an area of endemic malaria. The main transmitters are *Anopheles gambiae* Giles and *An. funestus* Giles (WHO 1974). The original purpose of the trial was to determine the level of control of *An. gambiae* by ultra low volume applications of Reslin 15S, a synthetic pyrethroid formulation, containing S-bioallethrin ((+)-*trans* chrysanthemic ester of (+)-allethrolone) and bioresmethrin ((+)-*trans* chrysanthemic ester of 5-benzyl-3-furyl-methanol) using a ground-based ULV generator. For reasons which are not clear the *An. gambiae* density at the time the trial commenced was extremely low, (end of