Vector Evaluation and Control

LESLIE D. BEADLE, M.A., GEORGE C. MENZIES, M.S., GEORGE R. HAYES, Jr., M.S., FRANK J. VON ZUBEN, Jr., C. E., and RICHARD B. EADS, Ph.D.

THE likelihood that the encephalitis reported in the 1954 Texas outbreak might be borne by mosquitoes or other arthropod vectors prompted an entomological investigation which commenced in late August. After the appraisal, a vector control program was initiated.

At least three distinct viruses have been shown to be responsible for periodic outbreaks of infectious encephalitis in the United States. Two of these, eastern equine encephalitis and western equine encephalitis, also occur in epizootic form in horses. The third, St. Louis encephalitis, does not produce clinically recognizable symptoms in horses. Both man and horses are generally believed to be dead ends in the infection chain in nature. The viremic blood levels are seldom high enough in either to infect even the most efficient vectors. Studies on these viruses have demonstrated that birds are the most common vertebrate hosts and mosquitoes the most significant vectors.

Background

The Lower Rio Grande Valley of Texas is a semitropical area with a climate and topography especially propitious for the production of mosquitoes. Several species of the local mosquito fauna are not found in other sections of the United States. The average annual rainfall is about 24 inches and natural drainage is poor. The elevation is only 40 to 200 feet above sea level, and prolific vegetation clogs the drainage ditches. The mean average temperature is 72° F., and killing frosts are seldom experienced.

Conditions favorable for mosquito production existed in Hidalgo County, located in this area, in the spring of 1954. During the period April 8–14 an average of 10 inches of rain fell over an extensive irrigated section. The nature of the terrain permitted large residual bodies of water to stand for varying periods of time. A reconnaissance survey of the flooded area revealed that emergency mosquito control measures were needed throughout the urban and rural areas of a section bounded by the cities of Edinburg on the northwest, Pharr on the southwest, Donna on the southeast, and Elsa on the northeast (see map, p. 511). Spot mosquito control was also necessary in residual floodwater areas as far west as Mission and as far east as Mercedes.

On April 16 the Governor of Texas declared a state of emergency in Hidalgo County. Following a request for assistance from the county health officer, the Texas State Department of Health and the Public Health Service combined forces to provide technical assistance, labor, equipment, and insecticides for an emergency mosquito control program. During the period April 22–May 8 a total of about 1,784 acres of water was larvicided, 13,942 acres space-sprayed (adulticided), and 304 premises residual-sprayed (*1*). Since numerous artificial containers in and adjacent to private premises were filled with water and presented a problem beyond the scope of an emergency control crew, the press and radio were utilized to

Mr. Beadle and Mr. Hayes are both senior sanitarians with the Communicable Disease Center, Public Health Service. Mr. Von Zuben and Dr. Eads are with the Texas State Department of Health, Austin, Tex. Mr. Menzies served with the same department before his death.

instruct the public in simple mosquito control measures. Heavy earth-moving equipment was brought in by the Texas Highway Department for constructing channels to drain the larger bodies of standing water. An extensive inspection survey on May 7 indicated that the adult mosquito population had been reduced to negligible levels.

Vector Evaluation

Representative samples of mosquito larvae were collected during the week of August 30 to September 4 from such habitats as roadside ditches, rain pools, seepages, dairy drains, sewage plants, reservoirs, and artificial containers on premises. Four species were represented in these collections: *Psorophora confinnis*, *Culex quinquefasciatus*, *Culex coronator*, and *Aedes vexans*. *P. confinnis* was predominant in temporary water habitats produced by rainfall during the week prior to the investigation. *C. quinquefasciatus*, the most prevalent, was found breeding in artificial containers, especially those used for watering domestic animals, and in semipermanent ground pools and drainage ditches, particularly near sewage disposal plants.

Collecting adult mosquitoes was emphasized for virus recovery tests. Specimens were gathered by the use of 3 New Jersey-type light traps, by 3 inspectors hand-collecting from shelters, and by 1 inspector assigned to biting collections. Most collecting was concentrated in areas where encephalitis cases had been reported. The majority of specimens collected for virus recovery tests were lightly anesthetized with chloroform, identified, sealed in Wassermann tubes, and sent to the laboratories in a frozen state. The remainder were sent alive to the State laboratory.

A diligent search for adult mosquitoes resulted in only about 2,000 specimens during 2 weeks of collecting. This was attributed to prevailing dry and hot weather immediately preceding the outbreak and to the intensive mosquito control operations following the April flood.

The scarcity of mosquitoes in the area is revealed by the fact that only 530 female mosquitoes were collected during 19 trap nights (table 1). *P. confinnis* ranked first (61.3 percent), followed by *C. quinquefasciatus* (13.7 percent) and *Aedes sollicitans* (13.0 percent).

Hand collections in animal shelters, garages, and outbuildings indicated that *C. quinquefasciatus* was by far the most common species of adult mosquito in both urban and rural areas (table 2). Approximately 94 percent of all specimens collected (1,083) were of this species.

Biting collections of mosquitoes alighting on exposed skin of the human observer were made at night in five residential areas. These collections indicated that *C. quinquefasciatus* was the predominant pest species in the area during the time of the study (table 3). Over 76 percent of the 407 specimens collected were of this

Table 1. Number of mosquitoes taken in light traps at six localities, Hidalgo County, Tex., September 6–12, 1954

Species	Donna (4)	Edinburg (3)	McAllen (1)	Mission (8)	Pharr (2)	Weslaco (1)	Total (19)	Percent
Psorophora confinnis	33	76	28	14	164	10	325	61.3
Culex quinquefasciatus	10	3	----	50	9	1	73	13.7
Aedes sollicitans	50	1	12	3	1	2	69	13.0
Aedes vexans	31	7	----	----	----	----	38	7.1
Anopheles quadrimaculatus	8	----	----	1	2	----	11	2.0
Culex coronator	5	4	----	----	----	----	9	1.6
Culex erraticus	1	1	----	----	----	----	2	.3
Aedes scapularis	----	1	----	----	----	----	1	.1
Culex salinarius	1	----	----	----	----	----	1	.1
Psorophora signipennis	----	----	----	----	1	----	1	.1
Total	139	93	40	68	177	13	530	99.3

NOTE: Number of trap nights in parenthesis.

species. Next in abundance were *C. coronator* (7.1 percent) and *A. vexans* (5.1 percent).

Eleven species of mosquitoes (1,613 specimens) comprising 29 pools were tested for virus (table 4). Two strains of St. Louis virus were isolated from *C. quinquefasciatus* collected at Edinburg in September 1954.

Discussion

Culex tarsalis, the mosquito reputed to be the principal vector of infectious encephalitis in western States, was not encountered during the entomologic investigation. It is considered uncommon in the Lower Rio Grande Valley. Hammon and associates (*2*) report that of approximately 23,000 mosquitoes gathered during encephalitis studies conducted in Cameron County, Tex., during the summer of 1942, only 60 were *C. tarsalis*. This is somewhat suprising since this species is abundant throughout the remainder of the State and conditions appear favorable for its development in this section.

The species is believed to be the principal vector of St. Louis encephalitis in California on the basis of the frequency of virus isolations. Reeves (*3*), Longshore and Stevens (*4*), and Lennette (*5*) report that 197 isolations of St. Louis virus have been made from *C. tarsalis* in California. There have been only three isolations of this virus from pooled *C. quinquefasciatus* mosquitoes collected in California (*3*). Investigations by Chamberlain and associates (*6*), comparing the potential of many common mosquitoes as vectors of eastern and western equine encephalitis, showed that *C. quinquefasciatus* was a very poor vector from the standpoint of threshold of infection, infection rate, and transmission rate. Even when the virus was highly concentrated in the blood of the host (10^7 to $10^{8.5}$), a negligible percentage became infected, and the few that became infected were poor transmitting agents.

Table 2. Number of mosquitoes collected in shelters, Hidalgo County, Tex., September 6–14, 1954

Species	Alamo (1)	Edcouch (2)	Edinburg (8)	Hidalgo (3)	McAllen (3)	Mercedes (4)	Mission (7)	Pharr (4)	Weslaco (3)	Total (35)	Percent
Culex quinquefasciatus	50	144	341	25	69	24	256	66	47	1,022	94.3
Anopheles quadrimaculatus		11	2	2		24			5	44	4.0
Culex erraticus						8			6	14	1.2
Anopheles crucians						1				1	.1
Culex coronator			1							1	.1
Psorophora confinnis								1		1	.1
Total	50	155	344	27	69	57	256	67	58	1,083	99.8

NOTE: Number of collections in parentheses.

Table 3. Number of mosquitoes taken in evening biting collections (human bait) at five localities, Hidalgo County, Tex., September 6–10, 1954

Species	Pharr 9/6/54	Donna 9/7/54	Mission 9/8/54	Weslaco 9/9/54	Mercedes 9/10/54	Total	Percent
Culex quinquefasciatus	3		221	86	2	312	76.6
Culex coronator		2		4	23	29	7.1
Aedes vexans	1	18			2	21	5.1
Psorophora confinnis	1	9			3	13	3.0
Aedes scapularis		8		1		9	2.2
Culex salinarius					9	9	2.2
Anopheles quadrimaculatus		5			1	6	1.4
Aedes sollicitans		4	1			5	1.2
Culex erraticus		2			1	3	.7
Total	5	48	222	91	41	407	99.5

NOTE: Collecting periods were 2 hours in length (from 7 to 9 p. m.).

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Table 4. Hidalgo County mosquitoes tested for viruses, 1954 outbreak of encephalitis

Species	Number tested	Number of pools	Number of positive pools (SLE)
Culex quinquefasciatus	1,095	15	[1] 2
Psorophora confinnis	326	3	0
Aedes sollicitans	69	1	0
Anopheles quadrimaculatus	55	3	0
Aedes vexans	38	1	0
Culex erraticus	16	1	0
Culex coronator	10	1	0
Aedes scapularis	1	1	0
Culex salinarius	1	1	0
Anopheles crucians	1	1	0
Psorophora signipennis	1	1	0
Total	1,613	29	2

[1] Edinburg.

Reeves (*3*) concludes, however, that vector mosquitoes do not require such high host titers to become infected with St. Louis virus as is the case with the other two viruses. Hammon and associates (*2*) report positive St. Louis encephalitis transmission experiments employing California strains of *C. quinquefasciatus*. During the notable epidemic of St. Louis encephalitis in the St. Louis area in 1933, circumstantial evidence implicated *Culex pipiens-quinquefasciatus* mosquitoes as vectors of the disease (*7*).

The isolation of virus from mosquitoes collected in the field does not definitely incriminate a species as a significant vector of the disease since any bloodsucking arthropod may temporarily carry the disease agent in a freshly ingested blood meal taken from an infected animal during a viremic phase. Coupled with epidemiological observations, however, the isolation of St. Louis virus from pooled *C. quinquefasciatus* during the Rio Grande Valley epidemic strongly suggests that it was the principal vector.

Vector Control

In times of emergency, personnel and equipment of a number of different organizations and levels of government may join forces and function as a single organization. Most frequently operations are under the direct administrative supervision of local authorities, who are familiar with local needs and with the problems. Such was the case with the aid provided during this encephalitis epidemic in Hidalgo County. The county health officer served as overall director. Supervisory personnel responsible for planning and directing operations were from the Hidalgo County Health Unit, from the vector control section, bureau of sanitary engineering, Texas State Health Department, and from the Communicable Disease Center, Public Health Service. Equipment and insecticides were provided by Hidalgo County, the Texas State Health Department, and the CDC Disaster Aid Unit. The communicable Disease Center also assigned 18 temporary employees to insecticiding and inspection duties.

Since *C. tarsalis*, usually incriminated as the principal vector of encephalitis in the west, had not been found in the epidemic area, the insecticidal measures were directed against the larval and adult stages of all species of mosquitoes. For general larviciding, 5 percent DDT in diesel oil was applied with hand equipment as a mist on mosquito breeding areas. Roadside ditches and other accessible places were larvicided, however, with truck-mounted power spraying equipment dispersing 5 percent DDT emulsion. To control adults in urban areas of the county, space spraying and dusting were conducted during the hours of darkness. The spray was 5 percent DDT emulsion, and the dust contained 3 percent gamma isomer BHC. Although the large-scale use of dust for the control of adult mosquitoes within urban areas was apparently unprecedented, it resulted in an observed high degree of coverage and was therefore favored in this operation.

Space spraying and dusting were begun on the night of September 9 and hand larviciding on the following morning. Both spraying and dusting were done in all urban areas of the county and also in certain rural sections. Since much of the county is urbanized, a relatively large amount of the county was treated in this way. Larviciding was conducted in all urban and some rural areas. During the period September 9–23 both larvicidal and adulti-

cidal treatments were provided twice to the areas involved. Intermittent heavy showers complicated the problem by increasing the potential mosquito breeding areas and by hampering control operations. High winds also impeded operations.

Results

In space spraying and dusting operations, 3,310 gallons of 5 percent DDT emulsion and 21,000 pounds of 3 percent gamma isomer BHC dust were applied to 20,225 acres. DDT-diesel oil larvicide in the amount of 1,312 gallons was applied on 263 acres of both actual and potential mosquito breeding area. In all, 1,256 man-hours of labor were expended. A population of approximately 72,000 within 12 incorporated areas of the county received the protection of this routine work. Also, an unestimated additional number of persons in rural areas derived benefits from nonroutine work, mostly larviciding.

Inspections of resting places of adult mosquitoes and larval habitats disclosed that the populations had been reduced to satisfactory levels.

Summary

An entomological survey and mosquito control operations were conducted during the late summer of 1954 in connection with an outbreak of encephalitis in the Lower Rio Grande Valley of Texas.

Larval and adult collections showed that the predominant mosquito species present in the affected area were *Culex quinquefasciatus* and *Psorophora confinnis.*

Eleven species of mosquitoes (1,613 specimens) comprising 29 pools were tested for virus. Two strains of St. Louis encephalitis virus were isolated from *Culex quinquefasciatus* collected at Edinburg, Tex., in September 1954.

Mosquito control operations were carried on within the area from September 9 to 23. They consisted of adulticidal treatment in urban areas with 5 percent DDT spray or 3 percent gamma isomer BHC dust, and larvicidal treatment in all urban and some rural areas with 5 percent DDT emulsion. A human population of approximately 72,000 within 12 incorporated cities and towns received protection from this work. Inspections disclosed that mosquito populations had been reduced to satisfactory levels.

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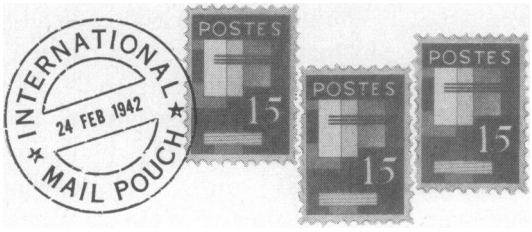

These paragraphs, based on overseas reports from public health personnel with missions and field parties of the International Cooperation Administration, give a glimpse into health work abroad. Most of the original material appears in an administrative publication distributed by the Public Health Division of the ICA.

Training Midwives

Teaching the untrained midwives who deliver most of the babies in some 40,000 Iranian villages is an important part of our program. The village midwife is a respected member of the community who usually inherits her profession.

Midwives are taught what to do and what not to do. They no longer put *surmeh* (mascara) on a new baby's eyes or *khakestar* (a mixture of oil and ashes which can cause tetanus) on the new baby's umbilical cord. They refer their "cases" to our prenatal classes and their babies to our "well baby clinics." They are our "health workers" in the villages.

Our course includes classes in management of labor and delivery, postpartum care, environmental sanitation, nutrition for mothers and babies, and personal hygiene. Attendance is by written request from the Ministry of Health. Supervision is continuous throughout the 3 or 4 months of instruction, aided at times, and in Isfahan especially, by physicians and *behyars* (public health nurse aides).

Graduates are presented with special midwifery bags and told to report every 2 weeks even if there have been no deliveries in that period.

By visiting the midwife in her home, we help her set an example of good health for her village. Each midwife has a "family folder." This means that she is registered at the health center, has had a physical examination, is subject to various health tests, and is taught the meaning and practice of good health habits.

Iranian mothers and children are fortunate in being cared for by these women.

—HELEN J. BAKHTIAR, R.N., *public health nurse consultant, United States Operations Mission, Iran.*

The Waters of Illampu

To a 100-year-old *Amauta* (Aymara sage), potable water for the village of Warisata was the dream of a long lifetime. Warisata nestles in the foothills of Bolivia's highest peak, snow-covered Illampu. The water supply for the Aymaras, an extensive gravity system with conduits made from asbestos and locally produced *mara* (mahogany) is an enviable achievement in sanitary engineering skill.

After pleasant hours of speechmaking near the elevated storage tank, a drinking ceremony was held at the village plaza fountain. Saluds were exchanged with the Ministro de Higiene y Salubridad, invited diplomats, and the village sage. With tears in his eyes, the *Amauta* related that his youthful dream of bringing the pure waters of Illampu to his people had at last come true through the kindness of his North American friends.

—GEORGE ADAMS, M.D., M.P.H., *formerly chief of the health, welfare, and housing field party, United States Operations Mission, Bolivia.*

Schistosomiasis

The harvesting of the romaine lettuce crop in Egypt will accelerate the invasion of snails into the Warraq El Arab project area. Snails are particularly fond of romaine lettuce. They quickly attach themselves to the floating leaves, so that the hundreds of stalks, washed daily during early Spring in the Sawahil and Bashtil canals, are likely to disperse aquatic snails throughout an irrigation system.

We have installed palm-leaf snail traps at 100-meter stations along the canals and drains. There are approximately 20 traps to a kilometer. The first dip-net survey of 150 kilometers yielded a small number of *Bulinus truncatus* juveniles, which were treated immediately with sodium pentachlorophenate. Findings from the first examination of the snail traps will determine our course of action.

—ANTHONY DONOVAN, M.D., *chief, Health and Sanitation Division, United States Operations Mission, Egypt.*