ARTHROPODS COLLECTED IN THE DOMINICAN REPUBLIC DURING AN OUTBREAK OF EASTERN EQUINE ENCEPHALITIS

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ABSTRACT. An outbreak of eastern equine encephalitis (EEE) occurred in the northeastern portion of the Dominican Republic during the late winter and early spring of 1978. No virus was isolated from 6,752 mosquitoes and 10,948 *Culicoides* collected in the affected area. *Culex nigripalpus* made up 72% of the mosquito catch, and no salt-marsh *Aedes* were collected. In view of the lack of EEE virus isolations from arthropods in the Dominican Republic during this and previous outbreaks, arthropod collection records may provide the strongest clues for selecting candidate vector species in the area. The collection data are summarized and discussed with this objective in mind.

INTRODUCTION

An outbreak of eastern equine encephalitis (EEE) occurred in the Dominican Republic during the late winter and early spring of 1978. Seventy-six equines died, and an additional 45 were sacrificed between February 23 and April 3, 1978. The epizootic was confined to the northeastern Provinces of Maria Trinidad Sanchez and Samana. No human case was documented. At the request of the Dominican Republic Government, the Pan American Health Organization (PAHO) and the Center for Disease Control (CDC) assisted in investigating the outbreak during March and April 1978. This report summarizes the information obtained on blood-sucking arthropods collected in the affected area.

MATERIALS AND METHODS

Arthropods were collected in battery-operated CDC light traps (Sudia and Chamberlain 1962) supplemented with approximately 1 kg of dry ice per trap (Newhouse et al. 1966). Arthropods were removed from the traps and placed in appropriately labeled glass tubes, which were sealed and transported on dry ice to the Fort Collins Laboratory for virus testing. Collection sites were selected on the basis of recent or concurrent equine encephalitis cases occurring in the area.

The Dominican Republic occupies the eastern two-thirds of the island of Hispaniola and lies between 17° and 20° north latitude. The peninsula of Samana, where the outbreak occurred, is a continuation of the Cordillera Septentrional which runs WNW-ESE parallel to the Dominican north coast for 200 km. The central part of the peninsula is hilly, with elevations of more than 500 m. The Gran Estero swamp interrupts the cordillera at the base of the peninsula, extends from the Atlantic on the north to Samana Bay on the southeast, and has a diameter of about 15 km. Tropical tubers, maize, and rice are grown throughout the area for subsistence and for the domestic market. Coconut plantations are common along the coastal plain and at the lower elevations on the peninsula.

The climate is tropical, with rainfall occurring throughout the year and reaching levels of from 150 to 200 cm per year in the northern coastal regions. Average rainfall for Samana Province was 138 cm in 1976 and 229 cm in 1977. October is usually the wettest month. Excessive rainfall during the autumn and early winter accounted for the larger amount recorded during 1977. Average monthly temperatures range from 23°C (January)

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to 28°C (September), and the hottest period is generally from June through October.

Brief descriptions of the collection sites by location follow. *Mantancitas:* Traps were placed around the perimeter of a small banana grove adjacent to an open field and a small cluster of houses. Because there is no electricity in this and the other rural areas sampled, there were no other light sources to compete with the light traps. The surrounding area contained rice fields, small garden plots, and coconut groves. *Aguas Buenas:* Collections were made on a multipurpose ranch, with cattle herds pastured in low-lying, swampy areas and with extensive plantings of coconut palms at the higher elevations. *Los Yayales:* Traps were placed in a rural area approximately 0.5 km south of the coastline and near a site where a horse with clinical encephalitis had been sacrificed during the previous week. The area is near the northwestern border of the Gran Estero swamp and contains coconut groves interspersed with rice plots in swampy areas and an occasional residence. *Rincon Molinillos:* This rural site is located within the Gran Estero swamp and is adjacent to ponds covered with water hyacinth. Small clusters of houses are located on the higher ground and are surrounded by rice fields. *Cristal:* This settlement lies southeast of several thousand hectares of rice fields. It is located on the banks of the Rio Barracote and north of Los Haitises, a series of forested limestone cone karst formations. The area immediately surrounding the settlement also contains pastureland for horses. The mosquito traps were placed at a site where a sick horse was sacrificed during the same evening, and from which EEE virus was subsequently isolated from brain material (Calisher et al. 1979).

RESULTS

Six CDC light traps supplemented with dry ice were set for 6 consecutive nights (March 29 through April 3, 1978) in the affected areas. Because 1 trap did not operate during the night of March 31 at Aguas Buenas, and 2 did not function properly at Cristal the night of April 3, the actual number of trap nights was 33. The arthropod collections are summarized in Table 1. Totals of 6,752 mosquitoes and 10,948 *Culicoides* spp. were collected and tested for virus in suckling mice (Calisher et al., 1979). *Culex nigripalpus,* the most common mosquito in the collections, comprised 72% of the mosquito catch. In addition to the mosquitoes listed in Table 1, samples of the male specimens included in the collections were identified by their terminalia as follows: *Cx. (Cx.) nigripalpus* (9 specimens), *Cx. (Cx.) chidesteri* Dyar (12), *Cx. (Cx.) secutor* Theobald (2), *Cx. (Mel.) atratus* Theobald (16), *Cx. (Mel.) opisthopus* (21), *Ae. hemisurus* (2), *Ae. pertinax* (2), *Ps. jamaicensis* (12), *Ma. dyari* (18), *Ur. socialis* (1), and *De. cancer* (1). Whereas the specimens of *Culicoides* that were pooled for virus testing were identified only to the generic level, representative specimens from some of the collections were set aside for specific identification (Table 2).

DISCUSSION AND CONCLUSIONS

Each of the mosquito species we found had been reported on the island of Hispaniola previously by Belkin and Heineman (1972) except *Cx. chidesteri,* which they indicated should be present since it has been found in Jamaica, Cuba, Puerto Rico and the Lesser Antilles. Relatively few mosquitoes were collected and tested for virus (6,752) during our study, and no virus was isolated (Calisher et al. 1979). Mosquito populations may have been at a low level in the epizootic area at the time collections were made because mosquito control operations had been carried out from February 22 to March 18, 1978, by personnel from the National Malaria Eradication Service and the anti-*Aedes aegypti* campaign. Leco ULV spray machines had been used to dispense malathion as an adulticide, and larviciding operations had been conducted using

temephos granules. Mosquito population levels were not assessed before or after the treatments. In spite of an apparent reduction in mosquito population levels at the time our study was conducted, EEE virus continued to be transmitted to horses in the affected area after mosquito control operations were completed. Another factor which may have contributed to the small number of mosquitoes collected was that rain fell during 5 of the 6 evenings and nights in which collections were made.

Our collections were made at the end of the epizootic period and, as pointed out by Eklund et al. (1950), such catches may not accurately reflect the species found or the relative numbers present during the period of peak virus transmission. Nonetheless, in view of our failure to re-

Table 1. Summary of Dominican Republic arthropods collected and tested for virus.

	March 30 Mantancitas	March 31, April 1 Aguas Buenas	April 2 Los Yayales	April 3 Rincon Molinillos	April 4 Cristal	Totals
An. albimanus Wiedemann	1	1	2	0	0	4
An. vestitipennis Dyar and Knab	0	21	4	3	3	31
An. grabhamii Theobald	0	3	0	0	0	3
An. crucians Wiedemann	0	1	2	0	0	3
An. spp.	0	30	2	0	2	34
Cx. (Cx.) nigripalpus Theobald	31	2,076	1,890	620	230	4,847
Cx. (Cx.) spp.	11	10	11	0	0	32
Cx. (Mel.) opisthopus Komp	5	218	54	2	25	304
Cx. (mel.) spp.	8	159	30	2	10	209
Ae. hemisurus Dyar and Knab	0	2	191	113	10	316
Ae. pertinax Grabham	0	2	135	1	3	141
Ae. spp.	2	4	4	0	5	15
Ps. jamaicensis Theobald	7	8	218	77	35	345
Ps. ferox (Von Humboldt)	0	0	1	0	0	1
Ma. titillans (Walker)	5	85	39	40	9	178
Ma. dyari Belkin, Heinemann, and Page	0	0	1	72	2	75
Ma. flaveola (Coquillett)	0	3	11	0	0	14
Ur. lowi Theobald	11	79	3	4	2	99
Ur. socialis Theobald	2	0	0	1	0	3
Ur. cooki Root	0	5	5	0	22	32
Ur. spp.	7	18	4	22	9	60
De. cancer Theobald	0	0	6	0	0	6
Total Mosquitoes	90	2,725	2,613	957	367	6,752
Culicoides	2,334	8,255	285	50	24	10,948
Total Arthropods	2,424	10,980	2,898	1,007	391	17,700

Table 2. *Culicoides* samples identified to species.

Species	Date and Locality		
	March 30 Mantan-citas	April 1 Aguas Buenas	April 3 Los Yayales
C. insignis Lutz	>1,000	50	>1,000
C. foxi Ortiz	0	1	5
C. pusillus Lutz	0	1	5
C. furens (Poey)	0	5	0

cover EEE virus from arthropods (Calisher et al., 1979) and the failure of Eklund et al. (1950) to recover virus from 9,923 mosquitoes tested during their investigation of the Monte Cristi outbreak, arthropod collection records may provide the strongest clues for selecting candidate species as vectors of EEE virus in the Dominican Republic.

Three striking features in the arthropod collection data are (Tables 1 and 2): 1) no *Ae. sollicitans* (Walker) or *Ae. taeniorhynchus* (Wiedemann) were collected, 2) *Cx. nigripalpus* made up 72% of the mosquito catch, and 3) *Culicoides* were more abundant than mosquitoes in the collections. Eklund et al. (1950) speculated that saltmarsh *Aedes* mosquitoes may be vectors of EEE virus in the Dominican Republic. Our data cast doubt on this supposition, at least in the Samana area. The absence of saltwater *Aedes* in our collections, and the apparent scarcity of *Culicoides furens* (Table 2) which breeds in marsh mud in alkaline and saltwater habitats, suggest that saltmarshes were not the principal production sites for the arthropods which infested the epizootic area at the time our collections were made. *Cx. nigripalpus* should be considered a potential vector of EEE virus in the Samana area in view of its relative abundance in our collections because EEE virus has been isolated from this species in the United States (Taylor et al. 1969) and Trinidad (Theiler and Downs 1973). *Cx. nigripalpus,* which is found in almost all types of ground water habitats and is a common mosquito along the coastal plains of many Caribbean islands (Belkin et al. 1970), feeds on both birds and mammals, including man. Page (1967) reported that *Cx. nigripalpus* was readily attracted to donkey-baited traps in Jamaica.

Large numbers of *Culicoides* were present in our collections, and EEE virus has been isolated from *Culicoides* sp. in the southeastern United States (Karstad et al. 1957). Among the species collected, *C. furens* is known to bite man and is a pest in many coastal areas of the West Indies, the Southeastern United States, and Central and South America. *C. insignis* was the most abundant *Culicoides* in the light trap collections. It breeds principally in fresh water. *C. pusillus* breeds in animal excreta and also in mud containing brackish water, and *C. foxi* is a freshwater species (Raccurt et al. 1977).

Although only 513 *Culex (Melanoconion)* mosquitoes were collected, members of this group should be included in the list of possible EEE virus vectors in the Dominican Republic. The virus of EEE has been isolated repeatedly from *Cx. (Mel.) taeniopus* Dyar and Knab in Trinidad and Brazil (Theiler and Downs 1973), and this or related species may be involved in the EEE virus cycle in the Dominican Republic.

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