In a subsequent test, 20 mixed sectioned *Dugesia* were exposed to 100, 3rd or 4th instar mosquito larvae at similar concentrations (0.1 to 0.0025 ppm). Larval predation was assessed every 48 hr for 192 hr and those that pupated were removed from treatment dishes and replaced by an appropriate number of similar instar larvae.

RESULTS AND DISCUSSION

SURVIVAL EFFECTS. Data collected indicate that *D. dorotocephala* exposed 192 hr to diflubenzuron suffered no observable deleterious effects when compared with controls. All *Dugesia* survived the different concentration levels tested with a 3% cumulative population increase in the treatments and 12% in the controls. Similarly, no noticeable adverse effects on *Dugesia* behavior or asexual reproduction were detected during the extended 360 hr post-exposure observations. The post-exposure population showed an accumulated increase of 78% and controls 72%.

PREDATORY EFFECTS. All concentrations had minimal or no visible effects on *Dugesia* during the 192 hr exposure to the insecticide. The accumulated predation levels were 93% (0.1 ppm), 88% (0.05 ppm), 97.7% (0.01 ppm), 94.7% (0.004 ppm) and 98% (0.0025 ppm). The lower predation at 0.05 ppm was probably due to abnormal temperatures during the earlier portion of this experiment rather than the effects of the treatment. Predation rates in the controls varied from 91 to 100%. With the exception of one replicate, a greater number (ca. 80%) of prey was consumed 48 hr post-inoculation. In a comparative study Nelson (1979) recorded a consumption rate of 91% with untreated sectioned *Dugesia,* 48 hr post-treatment.

Tolerance tests with *Dugesia* (Levy and Miller 1978a) using a single concentration of diflubenzuron and other larvicides produced neither mortality, immediate nor delayed effects. It seems likely that the biocontrol potential of *Dugesia* would not be impaired by a wide group of pesticides used in integrated or larviciding mosquito program.

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THE OPERATIONAL RESPONSE TO THE 1980 OUTBREAK OF EASTERN EQUINE ENCEPHALITIS IN SOUTHEASTERN GEORGIA

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The following paper is a chronological account of the actions taken by the Mosquito Control departments of Glynn and Chatham counties in response to an outbreak of EEE in 2

areas of southeast Georgia. It may be helpful to other mosquito control districts and public health officials should they be faced with a problem such as this in the future.

It is important to remember that these actions were taken as a reaction to a very volatile situation in that the citizens of Ware and Pierce counties were at a stage of near panic due to the publicity this incident attracted from the press.

The Glynn County Mosquito Control Department combined with the Chatham County Mosquito Control Commission to form a rapid response team to combat the 1980 eastern equine encephalitis (EEE) outbreak in southeastern Georgia. Three suspected human cases, 2 white males ages 21 and 60, and a white female age 57 (positively identified), of EEE were reported to the State of Georgia Epidemiology Office by the Southeastern Health Unit based in Waycross, Georgia, on July 9, 1980. All 3 of the patients were diagnosed as possible EEE victims by Dr. Jacob Greene, Neurologist, of the Baptist Hospital in Jacksonville, FL. The physician decided to notify the Waycross based Health Unit when he discovered that the 3 patients had spent time during May and June in an area of Pierce County, Georgia, where a horse had been positively diagnosed with EEE on May 18. A short time later one of the 3 people was positively identified as suffering from EEE. The other 2 died before sufficient tests could be completed.

The first report the Glynn County Mosquito Control Department received on the suspected outbreak of EEE came from Dr. Keith Sikes, State Epidemiologist, Georgia Department of Human Resources, on July 9. Immediate contact was made with Dr. Harold Spivey of the Waycross District Health Office and the Glynn County staff offered to send whatever equipment and personnel could be spared to help suppress the problem in Pierce County. Dr. Spivey stated that a definite plan of action would be completed on the following day after consultation with local, state, and private health officials.

The decision to treat Pierce County came on July 10. The Glynn County Mosquito Control Department dispatched 2 operators and spray trucks with 2 surveillance personnel and Chatham County Mosquito Control Commission dispatched 3 spray trucks, one surveillance technician and one supervisor. The spray trucks from Glynn County were calibrated to apply 93% fenthion at the 15 mph application rate of 1.5 oz/min. The spray trucks from Chatham County were calibrated to apply 91% malathion at the rate of 6.0 oz min at the 20 mph rate (Fultz and Carter 1980). All spray trucks were equipped with heavy duty variable flow control ULV pesticide generators.

All persons engaged in treating Pierce County were briefed by Mr. Oscar Fultz, Jr., Director of the Chatham County Mosquito Control Commission, on the afternoon of the 10th. The briefing consisted of the breakdown of routes the spray trucks would follow, details of the planned aerial applications, locations of light traps, and the biting mosquito count stations. It was decided to treat the northern portions of the suspected primary breeding site by air on the morning of July 11. CDC light traps were operated at 4 locations on the night of July 10/11. These collections were shipped to the Center for Disease Control, Vector-Borne Disease Division, Fort Collins, CO, for identification and viral testing. The light trap collections for the night of July 11/12 were identified by Chatham County personnel and are given in Table 1.

The biting mosquito count was conducted by Mr. Olan Chancy, Sr., of Glynn County Mosquito Control. The counts were made at 7 locations bordering on the primary epidemic area in the northern part of Pierce County. Only 3 mosquitoes were counted throughout the designated area. These mosquitoes were collected and identified later by Chatham County personnel. This small collection consisted of a *Psorophora columbiae* (Dyar and Knab) a *Coquillettidia perturbans* (Walker) and a *Ps. ciliata* (Fabr.).

On the morning of July 11, an aerial spraying support vehicle and 2 crew members arrived at a small grass airstrip outside Blackshear, GA, to load the spray plane. The pesticide formulation supplied by Glynn County was 32:1 malathion and resmethrin (Mulrennan 1980)[1] at 5% solution in #2 fuel oil. Three hundred gallons were loaded and applied in the primary epidemic area at the low volume rate of one quart/acre. The spray plane and pilot were supplied by a crop dusting company from Ware County, GA.

Confirmation of the surviving human case

[1] Mulrennan, John A., Jr., State of Florida, Department of Health and Rehabilitative Services, Memorandum No. 364. Subject: Efficacy of malathion-resmethrin formulation applied as ground ULV aerosols against adult mosquitoes. Jacksonville, FL. July 9, 1980.

Table 1. The collections of 3 CDC light traps (CO_2 baited light trap) placed in strategic positions throughout the suspected epidemic area, in Pierce County, GA. Collections were made on the night of July 11/12 and the mosquitoes were identified by Chatham County personnel.[a]

Species	Location		
	Station #5	Station #6	Station #7
Anopheles crucians	5	1	4
Aedes atlanticus	2	0	2
Ae. vexans	9	0	4
Culex nigripalpus	1	0	0
Uranotaenia sapphirina	3	0	0
Coquillettidia perturbans	0	5	17
Culex salinarius	0	2	4
Culiseta melanura	0	0	2
Psorophora ciliata	0	0	1
Ps. columbiae	0	0	3
Total	20	8	37

[a] Fultz, Thomas O., Jr., Personal communication: A report of the results of the mosquito sampling performed in Pierce County on the night of July 11/12. Chatham County Mosquito Control Commission. Savannah, GA. July 11, 1980.

was reported from the Center for Disease Control later that afternoon. The same number of spray trucks were dispatched from Glynn and Chatham counties on the night of July 11/12. This treatment ended the direct involvement by Chatham and Glynn counties in the treatment and collection of adult mosquitoes in Pierce County.

The Southeast Health District requested help in treating the city of Waycross and portions of Ware County with ULV spray trucks on the 15th of July. Glynn County responded with 2 spray trucks, the necessary crews and one supervisor on the nights of July 15/16 and 16/17. The Center for Disease Control sent a team of 3 specialists from Ft. Collins, CO; into Ware and Pierce counties on July 16 to make mosquito collections and to take serum samples from several of the local bird populations. This sampling effort lasted through the night of July 27/28. The mosquito sampling was somewhat disappointing because of the low numbers collected, but the results of the bird samplings confirmed the decisions of the Health Department authorities which led to the control applications. EEE neutralizing antibody prevalence was 42% (60/142) in wild birds and 7% (7/100) in domestic fowl. Cardinals, blue jays, brown thrashers and mockingbirds were the species with the highest antibody prevalence.[2]

During the following week, the Glynn County Mosquito Control Department returned to its normal program. On the afternoon of Tuesday, July 22, the department was contacted by Dr. Stephen Clarke, a local veterinarian, who had diagnosed a horse as very possibly suffering from advanced EEE within Glynn County north of Brunswick in a small community known as Basswood Estates. (This diagnosis was confirmed by the Animal Diagnostic Laboratory in Tifton, GA on July 28.) The department immediately responded with all the resources at its disposal to halt possible transmission of the disease to the humans of the area. The immediate goal was to reduce the adult mosquito population in the area of Basswood to as close to zero as possible in the shortest time.

Initially, the department made a survey of Basswood and the surrounding areas to determine where the highest concentration of adult mosquitoes might be. It was obvious that the bulk of the treatment would have to be accomplished by the department's helicopter. Although Basswood Estates is a large sprawling trailer park, it is surrounded by low, swampy woodlands, which have no access roads. Ground ULV units would be used where there was a road and the problem of mosquito migration into the community would be handled by an ever widening helicopter treatment pattern over the inaccessible areas. The department placed a CDC light trap at Basswood Estates. This trap and New Jersey light traps in surrounding areas were used to monitor the treatment effects in and around the main target area.

The first helicopter treatment, made more out of a public relations urgency than from sound control planning, was late in the after-

[2] Francy, Bruce D., Written communication to Dr. Keith Sikes: A report of the results of the viral sampling during July, 1980, conducted by Center for Disease Control personnel in Pierce and Ware counties, Vector-Borne Disease Division, Fort Collins, Colorado. August 14, 1980.

noon of July 22. This treatment was followed up that evening with ground ULV treatments of Basswood and surrounding areas. By the morning of Saturday, July 26, the entire northwest corner of the county, some 11 square miles had been completely treated by air, the ground ULV treatment area that included Basswood Estates had been treated 4 times, and all ground ULV treatment areas within the county had been treated at least once. All aerial treatments were made with the department's Hughes 269A helicopter calibrated to apply one quart of 5% solution of the 32:1 malathion/resmethrin formulation over a 250 ft. swath at an indicated airspeed of 50 knots. The ground ULV pesticide was 93% fenthion applied at the 15 mph rate of 1.5 oz. min from 4 spray units and one vehicle was modified to apply an ultra low volume concentration (approximately 89% pesticide) of the malathion/resmethrin formulation at a calibrated rate of 4 oz/min which is required at a vehicle speed of 15 mph.

The light trap collections, which were taken in Basswood throughout the treatment period, are summarized in Tables 2 and 3. The only potential EEE vector trapped in the area in numbers sufficient to cause concern was *Coquillettidia perturbans*. This mosquito is attributed as having a vector potential capacity of "good" for EEE (King et al. 1960). These collections show that the efforts of the department were almost immediately successful. Landing counts, supplemented with dry ice on the evening hours of July 24 and 25, supported this conclusion as only one mosquito was counted. It was collected on the 25th and later identified as *Culex salinarius* Coq.

The mosquito control efforts played a significant role in dealing with the EEE tragedy in Southeastern Georgia during July 1980. Whether or not these efforts actually suppressed the spread of the disease is another question entirely. In all probability, the weather played the major role in curbing the spread. It was very fortunate that the latter part of June and the entire month of July were very much drier than normal. In fact, only trace amounts of rainfall were reported throughout the area during the period from June 15 through the end of July. Not only did the weather prevent new mosquito breeding, but the very dry, very hot conditions probably did as much as any of the control applications to decrease the incipient numbers of potential vectors. There is no question, however, that the efforts of the Glynn and Chatham county agencies were very

Table 2. Adult mosquito collections from CDC light traps operated in Basswood Estates, Glynn County, GA in property adjacent to the property on which the diseased horse was stabled.

Species	Dates (July 1980)			
	22/23	23/24	24/25	25/26
Uranotaenia sapphirina	0	0	2	3
Aedes vexans	2	0	0	0
Coquillettidia perturbans	76	0	0	0
Culex salinarius	11	2	9	0
Cx. nigripalpus	1	0	0	0
Culiseta melanura	0	0	0	1
Anopheles crucians	5	2	0	0
Totals	95	4	11	4

Table 3. The number of adult mosquitoes captured in a New Jersey light trap baited with dry ice (CO_2) by species and date. This trap was located in Basswood Estates, Glynn County, GA.

Species	Dates (July 1980)			
	25/26	26/27	27/28	28/29
Uranotaenia sapphirina	3	0	0	2
Aedes vexans	0	2	2	0
Coquillettidia perturbans	1	0	0	0
Culex salinarius	0	3	1	2
Psorophora columbiae	0	0	1	0
Anopheles crucians	0	1	0	1
Culiseta melanura	1	0	0	0
Totals	5	6	4	5

effective in alleviating a growing panic in both Pierce and Ware counties; and in never allowing the situation to develop past the horse case of the 22nd in Glynn County. The only definitive conclusion is that after the concentrated control application had been applied in each of the crisis areas no further cases, either animal or human, were reported.

At this time, to our knowledge, no followup action is being taken in either Pierce or Ware counties. However, in Glynn County the Mosquito Control Department has contacted all local area veterinarians and asked them to report all suspected cases of EEE to the depart-

ment. Furthermore, CDC light trap collections are being made and monitored closely for possible EEE vectors. As funds are made available, other monitoring programs will be instituted.

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A MODIFIED GARDEN SPRAYER FOR SAMPLING CRAB HOLE WATER

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The major vector of sub-periodic filariasis in the South Pacific, *Aedes polynesiensis* Marks, breeds profusely in crab holes of *Cardisoma carnifex* Herbst. These crab holes are usually between 5 and 10 cm in diameter and snake their way into the ground for up to 1.5 meters. The winding nature of the tunnels makes larval sampling very difficult.

Symes (1960) working in Fiji collected larvae by "sucking as much water as possible" from crab holes with a 6 foot rubber tube. In Nigeria, Dunn (1928) modified a car pump by reversing the diaphragm and removing the lower valve. The car pump was connected to a large suction bottle which in turn had a long rubber tube attached for placing into the crab hole.

During the course of ecological studies on the mosquitoes of Western Samoa, Tonga and Fiji, a satisfactory and effective method for extracting crab hole water was devised. The equipment consisted of a modified garden pressure sprayer and 1.5 m of reinforced plastic tubing (Fig. 1).

The garden pressure sprayer is basically a hand pump screwed onto the mouth of a 4.5 liter plastic container. To modify the pump, the cup washer and check valve assembly are reversed thereby creating a vacuum in the container rather than pressure (Fig. 2). This modification, although performed for us by the pump manufacturer (The Cambrian Engineering Co. Ltd., New Plymouth, New Zealand) can be easily done at any mechanical workshop. The type of sprayer used is manufactured by various companies and is available at most gardening supply stores.

A one and a half meter length of plastic tubing, 7 mm in diameter, reinforced along the outside with a length of round plastic electrical wire (used for extension cords) and pliable binding wire is substituted for the hose and spray nozzle assembly that is supplied with the sprayer. The end of the electrical wire is inserted for 1 cm into the distal end of the tubing (Fig. 3) and then attached to the plastic tubing along the outside by wrapping a length of pliable binding wire (1.6 mm diameter) around the two. A 1 cm square hole is cut at the distal end of the tubing, just above the area where the electrical wire has been inserted.

By twisting and turning while pushing, the end of the reinforced tube can usually be inserted deep enough into the crab hole to reach the water level. The wire reinforcement adds rigidity to the tubing, thereby making it easier to perform this task. Also, the modification of the tube end prevents the opening from being plugged by mud during tube insertion. Blowing air into one end of the tube while inserting the other into the crab hole helps in preventing the opening from becoming blocked by mud and sand and also informs the operator when the water level has been reached.

Once contact with water has been established, the free end of the tube is attached to the plastic container. A maximum of 4.5 liters of water can be pumped at a time. Once all the water from the crab hole has been removed, the pump portion is unscrewed and the sample water can then be transferred to another container and examined for larvae.

This pump may also be used for sampling other container breeding habitats such as treeholes and tires.

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[2] U.S. Peace Corps, Western Samoa. Present Address: The Johns Hopkins University, School of Hygiene and Public Health, Baltimore, MD 21205.

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