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Part I

TREE PLANTINGS FOR MOSQUITO CONTROL

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INTRODUCTION. Various ecological factors may be responsible for making a situation either more favorable or less favorable for mosquito production, and each species often has different requirements.

The potential for changing floodwater mosquito habitats by tree plantings appears to have considerable merit, and is currently being studied in detail. During an intensive 5-year experimental study in a Tennessee River bottom near Florence, Alabama, a successional change in the floodwater mosquito breeding habitat was observed. As invading bottomland hardwoods grew larger, the vegetation changed gradually from the open, grassland pasture type to a canopied, woodland type. This gradual change in vegetation was accompanied by a change in the floodwater mosquito fauna. The several migratory and vicious biting species which characteristically inhabit open, grassland vegetational types were gradually replaced by less pestiferous species which remain near their woodland breeding grounds (Breeland and Pickard, 1967).

Larvae of *Anopheles quadrimaculatus* Say are usually found along shallow reservoir shorelines in warm, quiet, protected bodies of water exposed to direct sunlight where vegetation or flotage intersects the water surface. In general, the intensity of production is directly related to the amount of larval food in the water and plant life and flotage breaking the water surface.

Early workers in malaria control believed that shade was important in limiting anopheline mosquito production. Hinman and Hurlbut (1940) reared the *A. quadrimaculatus* mosquito under artificial conditions in complete absence of light and showed that shade in itself does not prevent breeding. Mosquito breeding in stands of trees growing in swamps under natural conditions was studied. In some of the more densely shaded areas, the intensity of breeding was less than that encountered in waters exposed to direct sunlight having more abundant vegetation and flotage. Shade, among other things, restricts the vegetation and thereby decreases the protection and the food of the larvae, thus indirectly influencing breeding.

In October and November 1935 and in

TABLE 1.—Summary of comparison of mosquito production associated with tree plantations and open marginal herbaceous vegetation along reservoir shorelines, 1967 and 1968.

			No. pos. dips		No. larvae		Av. no. larvae per dip		Percent						
									Anopheline			Culicine			
									Anopheles			Culex			Other
Habitat sampled	Reservoir	Total no. dips	Anoph.	Culi.	Anoph.	Culi.	Anoph.	Culi.	cr.	punct.	quad.	err.	rest.	terr.	U. sapp.
Cypress Trees	Pickwick	1945	94	38	144	47	0.07	0.02	1	83	16	2	..	98	..
Cypress Trees	Wilson	590	1	0	1	0	0.002	0	0	100	0	..	..	..	..
Tupelo Trees	Wilson	550	0	0	0	0	0	0	0	0	0	..	..	..	..
Cypress & Tupelo (Total)	Pickwick & Wilson	3085	95	38	145	47	0.05	0.015	1	83	16	2	..	98	..
Open Marginal Herbaceous Vegetation (Total)	Pickwick	1680	308	148	546	241	0.32	0.14	3	60	37	31	7	21	41

March of 1936, experimental tree plantings of baldcypress, *Taxodium distichum* (L.), and water tupelo, *Nyssa aquatica,* were made in Pickwick and Wilson Reservoirs.[1] Cursory observations have been made of these plantations over a number of years. Dips for mosquito larvae have usually been negative. A more formal study and evaluation were completed in 1968. Seven years after the Wilson Reservoir plantings were made, in water of one foot or less in depth, the lake level was raised 1.78 feet. Therefore, some of the trees in these plantations are now growing in water deeper than the normal shoreline mosquito breeding problem zone, but Hall and Penfound (1943)[2] noted that there was no herbaceous growth under these trees before the increase of water level during the winter of 1942–1943. The above plantations and the three cypress plantations in the top 2 feet of Pickwick Reservoir have shown satisfactory survival and growth.

RESULTS. In 1967 and 1968, some 32 years since planting, an evaluation of mosquito production in the tree plantations in Pickwick and Wilson Reservoirs was made.

In 1967, dipping stations were established in three selected plots of baldcypress in the Yellow Creek (Pickwick Reservoir) area and in adjacent counterplots in an open area, colonized mainly by marginal herbaceous vegetation. Dipping records from these two habitat areas were used for comparison of mosquito larval production in the open herbaceous vegetated areas with those in the tree plantations. The herbaceous vegetation has developed on sites altered either by mechanical mowing and/or herbicidal treatment for control or suppression of woody species.

During the summer of 1967, baldcypress plantation stations yielded no mosquito larvae in 150 dips, but the adjacent open herbaceous vegetation stations yielded 70 anopheline and 19 culicine larvae in 135 dips.

[1] Recommended by TVA's first biologist, Dr. James B. Lackey.

[2] Unpublished TVA report.

In 1968, dips for mosquito larvae were made from May through August. The study was terminated when the plantations in Pickwick Reservoir were dewatered through the normal seasonal water level recession. Results, for both 1967 and 1968, based on 1,945 samples, showed baldcypress habitats in Pickwick Reservoir to be less productive for mosquitoes than unshaded adjacent herbaceous vegetation. By comparison, baldcypress yielded 144 anopheline larvae in a total of 1,945 samples, while herbaceous vegetation yielded 546 anopheline larvae in 1,680 samples or about five times as many as the baldcypress. The anopheline larvae collected and identified from baldcypress dipping stations were as follows: 16 percent *A. quadrimaculatus,* 83 percent *A. punctipennis,* and 1 percent *A. crucians*; from the herbaceous vegetation plots 37 percent were *A. quadrimaculatus,* 60 percent *A. punctipennis,* and 3 percent *A. crucians.*

A total of 1,140 dips was made on Wilson Reservoir in the baldcypress and water tupelo plantations, and only one second instar larva of *A. punctipennis* was found. Due to private shoreline landfilling operations, no suitable herbaceous vegetation was available for comparative study adjacent to these plantations.

These results show that the above plantations on reservoir margins greatly reduced anopheline production as compared to marginal areas with mainly herbaceous cover (Table 1, Figs. 1, 2, and 3).

DISCUSSION. These special, evenly spaced, tree plantations of relatively water-tolerant trees are not to be equated either to natural stands that must be cleared in reservoir preparations for mosquito control or to natural stands in poorly drained areas.

It is estimated that planned tree plantings along selected reservoir shorelines can be made and maintained at a reasonable cost. For the first two or three years, the seedlings will require suppression of competing herbaceous vegetation, utilizing herbicidal and/or mechanical methods, after which they are expected to begin to change the micro-environment enough to

Figure 1.—Dipping for Mosquito Larvae—Herbaceous Vegetation—Pickwick Reservoir.

Figure 2.—Dipping for Mosquito Larvae—Cypress Tree Plantations—Pickwick Reservoir.

FIGURE 3.—Views of Cypress Tree Plantation—Wilson Reservoir (Photograph 1—1954; Photograph 2—1968)

cause the mosquito population to be reduced or altered. It should be noted that only 16 percent of the anopheline mosquito larvae collection in the baldcypress plantations were *A. quadrimaculatus,* and 98 percent of the culicine mosquitoes were the cool water breeding *Culex territans* which are not known to feed on man or other warm-blooded animals. Even though some mosquitoes may be produced in tree plantations, the population is expected to be less than in herbaceous shoreline vegetation. This simple, and potentially economical, biological mosquito control method would eliminate the need for costly, repetitive shoreline maintenance measures and application of larvicides year after year.

CONCLUSIONS. From this study, based on extensive sampling for anopheline mosquito larvae, it is concluded that mosquito production in these special tree plantations is less than in open vegetated shorelines where repetitive maintenance and control measures have been necessary. Special plantings such as these may provide satisfactory biological, long-range, economical mosquito control for certain types of reservoir shorelines.

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LOW VOLUME FOG AND MIST FOR GROUND USE

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The Jefferson County Mosquito Control District started developing ground equipment for low-volume application of insecticides in 1966. Since the District had no trucks with a capacity greater than one ton, we were limited to a maximum load of 200 gallons of fog oil, and would be forced either to purchase larger trucks, or to fog less than three hours. A series of tests with Leco 120 fog applicator indicated that the amount of insecticide per acre was more important than gallons per hour of solution.

Excellent results were obtained at 30 gallons per hour. Tests at 20 gallons per hour showed that it was possible to get a fairly good kill close to the vehicle but not at several hundred feet. Field studies showed that the fog was rising from the ground, even during cool evenings, indicating small-sized particles. Attempts to lower the heat proved unsuccessful. The burner would not stay lighted at the low pressure needed to secure a low temperature. Original equipment in the fogger was a 4.5 gallon per hour burner tip. The tip was replaced with one having a capacity of 2.0 gallons per hour. The small flame provided by the new tip allowed a reduction of the temperature in the fogging chamber. The temperature was controllable at between 550 and 650 degrees. The fog generated by the lower temperature remained close to the ground.

It is our opinion that the commonly used. dilute fog formulations are based on the fact that DDT is soluble to approximately 5 percent in diesel fuel oil. This was the earliest DDT solution used by us about 1946. Field tests with the