POPULATION DENSITIES OF *ANOPHELES ALBIMANUS* ADULTS AND LARVAE INSIDE AND OUTSIDE COTTON-GROWING AREAS IN EL SALVADOR[1]

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ABSTRACT. Trends in population densities of *Anopheles albimanus* Wiedemann were compared in cotton-and-noncotton-growing areas during the cotton-spraying season in an area of ca. 100 square kilometers on the Pacific Coast of El Salvador, C.A. Adult collections from stables and larval collections from breeding sites throughout the area from July 1977 to March 1979 showed no significant differences (P = 0.05) in the populations from cotton and noncotton areas. Adult densities in both cotton and noncotton areas was slightly reduced early in the spray seasons.

INTRODUCTION

The effects of chemical control of insect pests on nontarget organisms has been of much concern for many years. In cases in which the nontarget organisms are also pests, such reduction is beneficial. One such case has occurred in Central America. Cotton, the primary cash crop grown in the coastal plain of El Salvador, has been treated with prodigious amounts of a wide variety of insecticides for many years. In the past, such treatments significantly reduced natural populations of *Anopheles albimanus* Wiedemann, the primary vector of malaria in that area (Rachou et al. 1965, Georghiou 1972, Hobbs 1973). Subsequent reduction in documented transmissions of malaria also has been an indirect result of cotton spraying (Rachou et al. 1965).

The use of a wide variety of pesticides may lead to insect resistance and cross-resistance to those chemicals and associated compounds (Schoof and Taylor 1972), as happened in *An. albimanus;* the increased resistance of this insect has been well documented (Georghiou 1972, WHO 1966, Breeland et al. 1970, Georghiou 1969, Lowe et al. 1980). New evidence of extensive migration of *An. albimanus* (unpublished data) indicates that resistance originating in cotton-growing areas will eventually spread over a wider range.

With this in mind a study was made in an area on the Pacific Coast of El Salvador to determine if collections from cotton and noncotton areas represented discrete localized strains of *An. albimanus* of if they were actually from the same population. We also wanted to determine if population reductions occurred during the spray season.

METHODS AND MATERIALS

The study area (ca. 100 square kilometers) formed a triangle with the apex on the west at the port city of La Libertad and extended eastward for ca. 20 kilometers to a width of ca. 10 kilometers; it was bordered on the north by a mountain range and on the south by the Pacific Ocean. The area was devoted mainly to cotton, sugarcane, and pastureland for beef and dairy animals. The 5 major rivers in the study area drained into several large estuaries around which were large marshy areas covered by aquatic vegetation or mangrove swamps that were unsuitable for agricultural crops.

Scattered throughout the area were

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[1] This paper reflects the results of research only. Mention of a chemical in this paper does not constitute a recommendation for use by the U.S. Department of Agriculture.

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stables and adjacent corrals in which cattle were kept at night. Cattle serve as the major host for *An. albimanus;* thus, the stables provided excellent collection sites for adult female mosquitoes which were found resting during the day after having fed on cattle the previous night. Standardized adult collections were made weekly with a mouth aspirator from 14 stables from July 18, 1977 to March 25, 1979. The number of *An. albimanus* females collected per man-hr was recorded. During the same period, larval collections were made weekly at 12 sites that contained water year-round. The numbers of 3rd and 4th instar *An. albimanus* per 100 dips (made with a standard larval dipper which collect larvae from ca. 750 cm^2 of surface area) were recorded.

These adult and larval collection sites were categorized by aerial survey during the cotton-growing season as cotton (less than 1 km from cotton) and noncotton (more than 1 km from cotton). One km was chosen as an arbitrary distance that would preclude inadvertent direct application of pesticides to noncotton areas during cotton spraying. This distance did not take into account, however, the effects of contamination of breeding sites in noncotton areas by run-off water from sprayed fields. Seven stables and 7 larval sites were located in cotton areas, and 7 stables and 5 larval sites were located in noncotton areas. Collection data were summarized at 4-week intervals for both the adults and larvae within each area and subjected to correlation analysis.

RESULTS AND DISCUSSION

The adult population density was significantly (p = 0.05), but temporarily, reduced after spraying began in both spray seasons (Fig. 1). However, populations were reduced in both cotton and noncotton areas, and fully recovered by the end of the spray season. This supports observations by Georghiou (1969) that insecticidal resistance in *An. albimanus* rose during the agricultural spraying season and declined during the

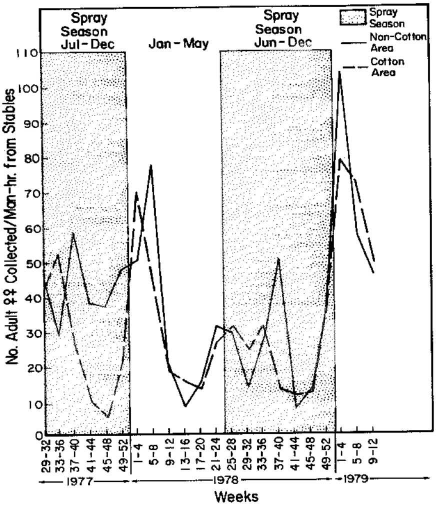

Figure 1. Adult *Anopheles albimanus* population density in cotton and noncotton-growing areas in El Salvador, C.A.

nonspraying season. However, he observed that the decline each year was less than the previous rise, indicating a continual overall rise in the resistance level. Georghiou (1972) reported that the tolerance level to most commonly used agricultural chemicals was ca. 1 to 4X in *An. albimanus* collected in June 1970, before heavy spray applications to cotton began. By the following February, after the spraying season, resistance to 6 of these chemicals had increased from ca. 4X to more than 100X. He also found that mosquitoes from his June collection, when pressured with propoxur in the laboratory for only 3 generations, increased their resistance to 6 commonly used carbamate and organophosphate insecticides by 5 to 71X. Breeland et al. (1970) reported a significant reduction in susceptibility of native adult *An. albimanus* from El Salvador to aerial applications of malathion compared to adults of a laboratory colony but only in areas of intensive cotton cultivation. Lowe et al. (1980) reported a 210X increase in resistance of

An. albimanus in El Salvador to Abate® (temephos), a chemical with very limited application in the area. The adult reduction during the nonspraying season was due to a decrease in breeding areas resulting from dry weather.

The larval population density peaked only once per year, during the dry season (Fig. 2). Bailey et al. (1980) reported that although adult density is fairly high during the rainy season (April to November), larval density is low as a result of the flushing and dispersing action of heavy rains. However, larval density in this study began to increase about midway through the spray season both inside and outside cotton areas.

When adult and larval collections were compared for the cotton and noncotton areas for each of the 2 spray seasons, they were not different statistically (P = 0.05). The adult and larval populations were also compared for the entire study period (88 weeks) and were not statistically different (P = 0.05).

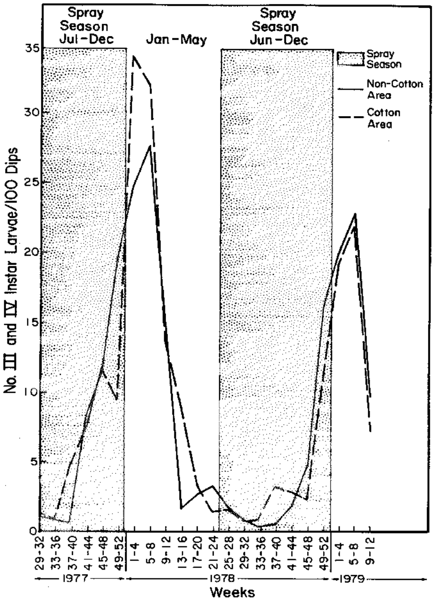

Figure 2. Larval *Anopheles albimanus* population density in cotton-and noncotton-growing areas in El Salvador, CA.

These results indicate that *An. albimanus* in the cotton- and noncotton-growing areas studied are part of the same population. Although population density was somewhat reduced early in the spray season, the population densities of both adults and larvae almost reached their yearly maximum levels by the end of the 2 spray seasons. Our explanation for the uniform response of the *An. albimanus* population reported here to agricultural spraying is that general and extensive resistance and cross-resistance to pesticides has developed in the total population. This probably has resulted from extensive applications of a broad spectrum of pesticides to cotton in the area for many years in conjunction with extensive migrations of *An. albimanus,* which has caused much genetic intermixing of individuals from all regions of the study area.

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