

AEDES ALBOPICTUS DISTRIBUTION, ABUNDANCE, AND COLONIZATION IN LEE COUNTY, FLORIDA, AND ITS EFFECT ON AEDES AEGYPTI

JONATHAN A. HORNBY, DENNIS E. MOORE AND T. W. MILLER, JR.

Lee County Mosquito Control District, P. O. Box 60005, Fort Myers, FL 33906

ABSTRACT. In 1992 the known southern limit of *Aedes albopictus* in Florida was in Lee County. Through oviposition surveillance, the distribution of *Ae. albopictus* was determined, and its frequency relative to *Aedes aegypti* and colonization pattern of areas previously occupied by *Ae. aegypti* were examined in Lee County. The data collected in the first year of surveillance demonstrate the ability of *Ae. albopictus* to rapidly and preferentially colonize large expanses of rural southwest Florida. Urban and suburban areas of the county showed slower colonization rates. In suburban areas, *Ae. albopictus* became the dominant container-breeding mosquito species, whereas it did not become dominant in urban areas. During the study period, *Ae. albopictus* did not displace *Ae. aegypti* in urban or suburban habitats. The southern limit of *Ae. albopictus* moved a distance of 8.1 km (5 mi.) in 6 wk to the southern border of the county.

INTRODUCTION

The first record of *Aedes albopictus* (Skuse) in Florida was collected in 1986 from Jacksonville (Duval County) (Peacock et al. 1988). By the end of 1991, 61 of Florida's 67 counties harbored this introduced species (Smith et al. 1990, O'Meara and Gettman 1991, O'Meara et al. 1992). An 18-month oviposition surveillance of Fort Myers, FL, begun in January 1988, indicated *Ae. albopictus* was not present (Figs. 1 and 2). George O'Meara of the Florida Medical Entomology Laboratory, Vero Beach, FL, obtained the first record for Lee County during a statewide larval survey project. This record was collected in August 1991 from a cemetery in the rural community of Alva, FL, located in the northeast corner of the county (Fig. 1). This site was considered the southern limit for *Ae. albopictus* in Florida and an unprecedented opportunity was available for monitoring the southward movement of this species. An intensive oviposition surveillance program was initiated in mid-May 1992 to determine *Ae. albopictus* distribution in Lee County and its frequency relative to *Aedes aegypti* (Linn.).

METHODS AND MATERIALS

Surveillance was performed from May 15, 1992, to May 15, 1993. Collection sites consisted of one ovitrap per site and collections were made weekly by renewing the traps with new oviposition strips and fresh reverse-osmosis water. The ovitrap was composed of a 0.5-liter, 11.5-cm-high plastic novelty cup (Louisiana Plastics Inc., St. Louis, MO) containing reverse-osmosis water and one 2 × 12.8-cm red velvetreen paper strip as an oviposition substrate. The traps were placed in shaded areas on the ground or within 1 m of

the ground and close to possible breeding sites such as tires, assorted containers, or oak trees. The area surrounding the surveillance sites was not examined for the presence of *Aedes* spp. larvae or adults. The initial 52 collection sites were expanded to 65 in the first week of July to include Pine Island and the remote southeastern Lee County.

Collected oviposition strips were processed by counting the number of prehatched and unhatched *Aedes* sp. eggs and storing them in a larval rearing room at 27°C and 80% RH for a minimum of 2 days, but usually 3-7 days. Translucent disposable 500-ml plastic containers (Fabi-Kal Corp., Kalamazoo, MI) were used for egg hatching and larval rearing. Egg hatch was stimulated by a single submergence of the oviposition strip for 3 or more days in reverse-osmosis water to a depth of 4 cm (500 ml) and adding one piece of rabbit chow (Purina Mills, Inc., St. Louis, MO). Larvae were reared in the same container and fed additionally when warranted. Upon pupation pupae were removed to emergence cages. Identification was based upon the adult stage and the number of male and female individuals for each species was recorded.

The relative frequency of *Ae. albopictus* in each collection, for each site, was calculated as a percentage of the sum of *Ae. albopictus* and *Ae. aegypti*. Trends in colonization were graphed as a running average of the relative frequency of the successful collections. A successful collection was one that produced adults from the eggs collected. The incidence of a successful collection for a particular site did not occur in a predictable manner due to factors of weather, adult prevalence, the number of alternative oviposition sites, etc. As a consequence, the time period between data points of the running average varied from a week to months. These data points were the percent

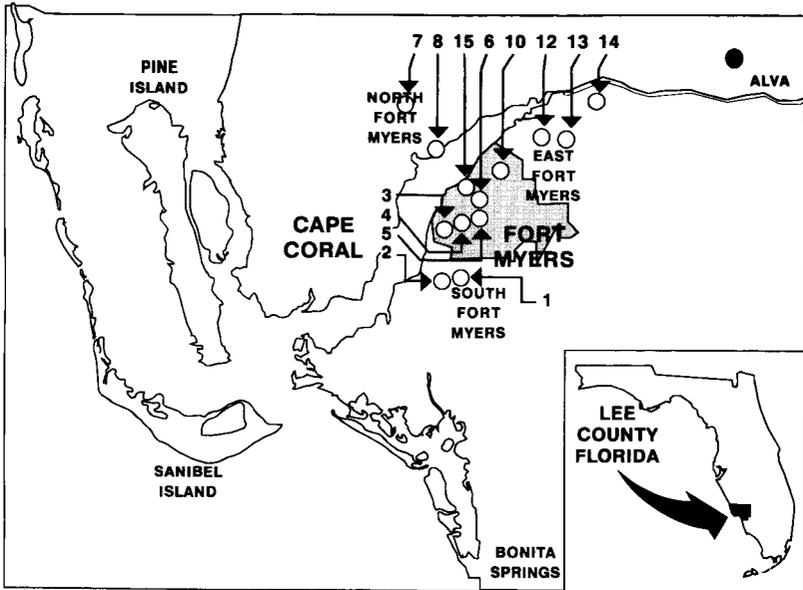


Fig. 1. Study area of Lee County, Florida, showing oviposition surveillance sites for 1988 surveillance (○) with numbers that are part of the 1992 surveillance and the first record for *Aedes albopictus* (●) in the county. The city of Fort Myers is shaded.

Ae. albopictus for that date averaged with that of the 2 preceding successful collections. In an effort to eliminate rare occurrences of container-breeding mosquito species from the data, a particular site was not included in developed data until 3 successful collections were made.

RESULTS AND DISCUSSION

The year of surveillance comprised 2,942 collections of which 1,125 successful collections produced 4,848 prehatched eggs and 31,913 unhatched eggs. A total of 20,302 *Aedes* spp. adults were produced from the unhatched eggs (62.1% hatch rate) or an average of 18.05 adults from each collection containing unhatched eggs. Of the 65 sites, 10 produced no eggs. A total of 335 *Aedes triseriatus* (Say) eggs were collected at 12 sites. A single site at the county landfill/tire shredding facility contributed half of the *Ae. triseriatus* eggs leaving an average of 15.2 eggs for the other 11 sites during the year.

The first oviposition surveillance of Lee County (1988) revealed an *Ae. aegypti* seasonal population fluctuation corresponding to the seasonal rainfall pattern (Fig. 2). As a container breeder this species is dependent on alternating intervals of drought and rainfall. The beginning of the rainy season in May corresponded to an appearance of eggs in the ovitraps and the end of the season, in October, was followed by a de-

crease in oviposition. A flurry of activity from December through January was caused by occasional rains. From February through April rainfall becomes an uncommon occurrence in southwest Florida and so did oviposition. Variation in egg population between trapping events as well as between trap sites was great.

During the first quarter of the 1992 surveillance (May 15–July 15), *Ae. albopictus* eggs were a component of 29 traps that had produced at least 3 successful collections each. Twenty-five of these positive traps encompassed all of northern Lee County. Ten of these northern traps had a relative *Ae. albopictus* frequency of 75% or more (Fig. 3). The areas where these 10 traps were placed is undeveloped or sparsely developed and consists of mixed soft and hardwood woodlands, and shrub. As the level of development increases towards suburban, urban, and commercial, the *Ae. albopictus* frequency decreased. Of the 15 traps having an *Ae. albopictus* frequency <75% and >0%, 13 were clustered within Fort Myers, North Fort Myers, and east Fort Myers, which are considered suburban to commercial areas (Fig. 3). Seven traps containing only *Ae. aegypti* eggs were scattered in south Fort Myers and south Lee County. The ovitraps first set in July did not have sufficient time to produce 3 successful collections and were not included in the first quarter data.

At the end of the second quarter (October 15)

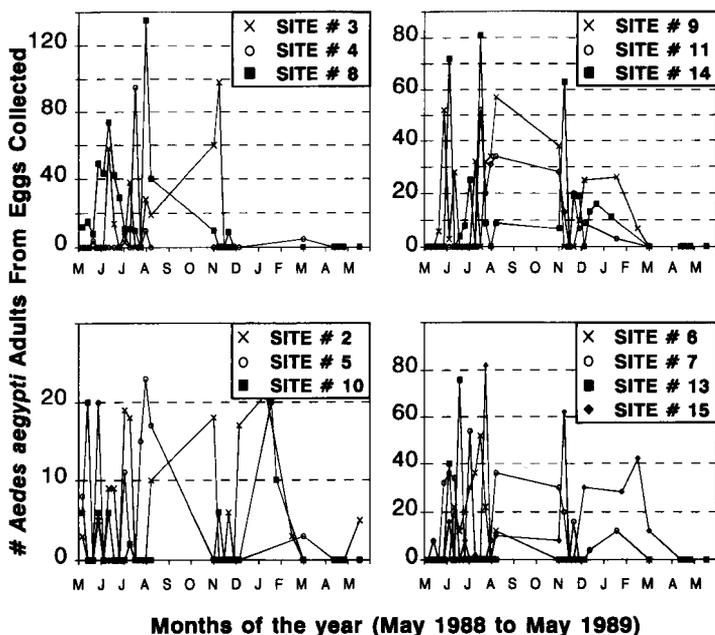


Fig. 2. Seasonal distribution of oviposition from 1988 surveillance in Lee County, Florida. *Aedes aegypti* was the only species occurring. See Fig. 1 for site location. Sites occurring on Fig. 1 and not in Fig. 2 were nonproductive.

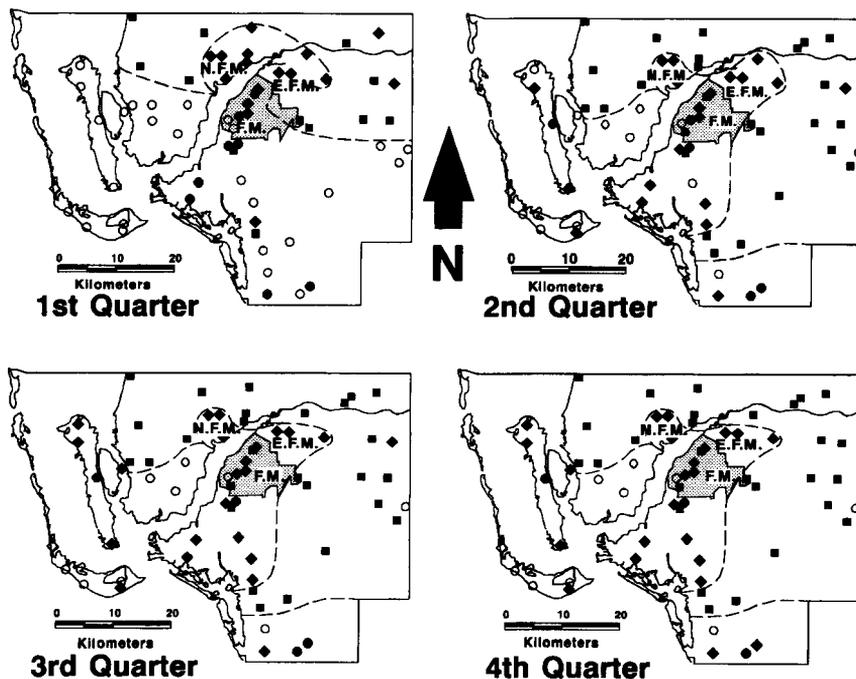


Fig. 3. Frequency of *Aedes albopictus* from ovitraps collected weekly from May 15, 1992, to May 15, 1993, in Lee County, Florida. Sites are categorized as nonproductive (O), or percent *Ae. albopictus*: 0% (●), >0% ≤75% (◆), >75% (■). Dashed line separates major >75% region from the rest.

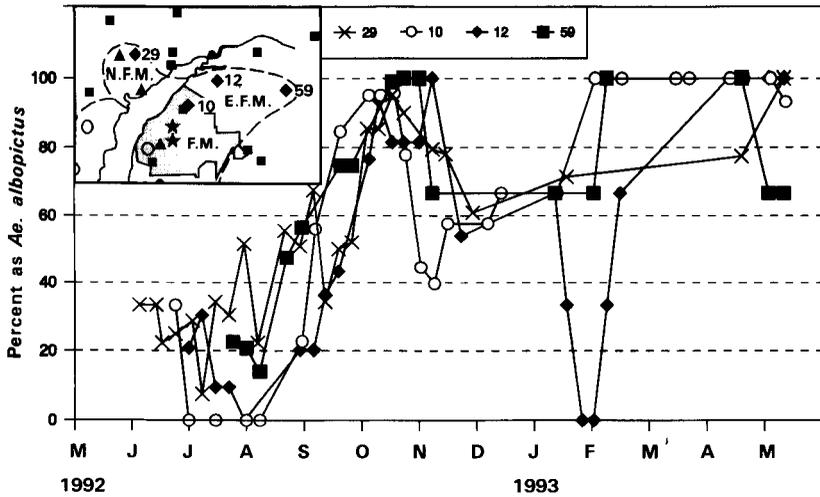


Fig. 4. Colonization of suburban Fort Myers by *Aedes albopictus*. Sites with year-total *Ae. albopictus* frequency of >50% to ≤75%. Map insert depicts location and frequency range of sites on graph and neighboring sites: Nonproductive (○), >0% to ≤25% (★), >25% to ≤50% (▲), >50% to ≤75% (◆), >75% (■).

the distribution of *Ae. albopictus* was well defined (Fig. 3). All but 11 traps had collected container-breeding mosquito eggs. *Aedes albopictus* frequencies of ≥75% were still located predominantly in the undeveloped or sparsely developed areas of the county. The rural wetlands of east Lee County were now included with northern areas as part of this high-frequency region. The suburban to commercial areas of North Fort Myers, east Fort Myers, and Fort Myers still maintained an *Ae. albopictus* frequency of <75%. It appears that *Ae. albopictus* was slow to colonize urban and suburban Fort Myers and had already heavily colonized the woodland areas surrounding the city. The propensity of *Aedes albopictus* for rural areas was also indicated by the 12-month egg population average per successful collection. The ovitraps in the ≥75% frequency regions of the county (rural) collected 2.7 times more *Ae. albopictus* eggs than the >0% and <75% frequency areas (urban/suburban) (rural = 23.25 ± 2.10 ; urban/suburban = 8.78 ± 1.47 , ±SE). *Aedes aegypti* collections were 1.04 ± 0.29 and 9.97 ± 2.06 eggs per successful ovitrap collection (rural: urban/suburban, respectively). Similar observations were made by O'Meara et al. (1992) who reported a preference of *Ae. albopictus* for rural and suburban cemeteries over tire piles in commercial and urban zones as close as 0.5 km. In an oviposition surveillance of southern Texas, Womack (1993) indicated that the greatest prevalence for this species was in San Antonio, TX. All 7 sites in this city were from garden and park settings. The other locales throughout southern Texas were composed of sites at tire-associated

businesses, suggesting a preference for rural/sylvan habitats. The second half of the Lee County surveillance showed little change in *Ae. albopictus* frequency and distribution because the dry season for southwest Florida begins in December and ends in May (Fig. 3).

Initial colonization by *Ae. albopictus* in the extreme western and southern parts of the county was observed during the first half of the surveillance. Pine Island in the west and an area just north of Bonita Springs in the south are believed to have not been colonized by *Ae. albopictus* prior to October 1992. *Aedes aegypti* or *Ae. triseriatus* were the only species collected from ovitraps in these areas during the previous months. The southern limit of *Ae. albopictus* was indicated to be between a trap 1.6 km (1 mi.) north of the southern Lee County border (Bonita Springs) and an area 9.0 km (5.6 mi.) farther north marked by the most southern trap positive for *Ae. albopictus*. On 5 occasions prior to October, traps in Bonita Springs collected *Ae. aegypti* in the absence of *Ae. albopictus*. During the following 6 wk many sites in these areas yielded at least one *Ae. albopictus* collection. As of May 15, 1993, *Ae. albopictus* had not been collected from traps 2.0 km (1.25 mi.) and 6.9 km (4.25 mi.) south of the Bonita Springs trap. *Aedes aegypti* had been collected 4 times during October–November of 1992 and twice in May 1993 at the trap 2 km (1.25 mi.) south of the Bonita Springs trap, indicating the southern limit of *Ae. albopictus* to be between this trap and Bonita Springs.

The pattern of colonization by *Ae. albopictus* for a particular site is illustrated by plotting the

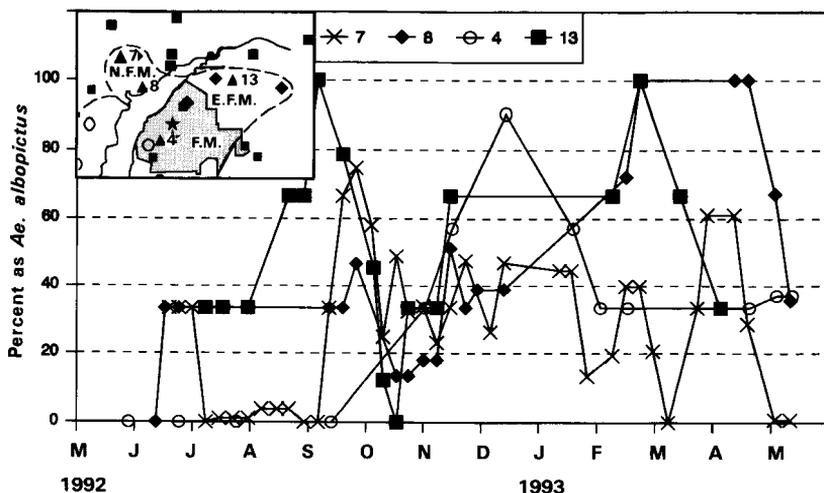


Fig. 5. Colonization of urban Fort Myers by *Aedes albopictus*. Sites with year-total *Ae. albopictus* frequency of >25% to ≤50%. Map insert depicts location and frequency range of sites on graph and neighboring sites: Nonproductive (○), >0% to ≤25% (★), >25% to ≤50% (▲), >50% to ≤75% (◆), >75% (■).

running average of the frequency for each successful collection for the entire year. In suburban areas just north of Fort Myers, where the year-total *Ae. albopictus* frequency was >50% and ≤75%, there was a steady increase in its dominance (Fig. 4). In urban areas where the year-total *Ae. albopictus* frequency was from >25% to ≤50%, the frequency was more variable from data point to data point for a particular site and between sites than in the suburban areas. No distinct trend of frequency increase was seen over the 12-month collection period, indicating *Ae. aegypti* retained a strong hold onto its dominance in these urban areas (Fig. 5). The dominance of *Ae. albopictus* in urban settings was addressed by Moore et al. (1990), who suggested the dominance of one species over the other will vary from city to city. In this study, Breteau indices were developed for several site-selection schemes in 8 cities. For the 2 sampling schemes where sites were selected randomly or sites selected offered a high probability for the presence of *Ae. albopictus*, *Ae. albopictus* was dominant over *Ae. aegypti* in 3 of 7 cities and 3 of 6 cities, random and high probability sites, respectively.

An inspection of the change in the number of eggs collected for each species over time (running average of successful collections) indicates no displacement of one species by the other where the year-total *Ae. albopictus* frequency was ≥50% and <75% (Figs. 6 and 7). Although we found no displacement of one species by the other in urban and suburban locales, ovitrap surveys by Hobbs et al. (1991) showed the replacement of *Ae. aegypti* by *Ae. albopictus* in the historic dis-

trict of Mobile, AL, from 1987 to 1990. In contrast, ovitrap surveillance of U.S. Air Force bases in the United States had an increase in the number of collections containing *Ae. albopictus* from 1990 to 1991 as well as an increase in the number of collections containing *Ae. aegypti* (McHugh 1992). However, the number of positive *Ae. aegypti* collections in 1991 was less than 1988 and 1989, revealing that a year-to-year variability by

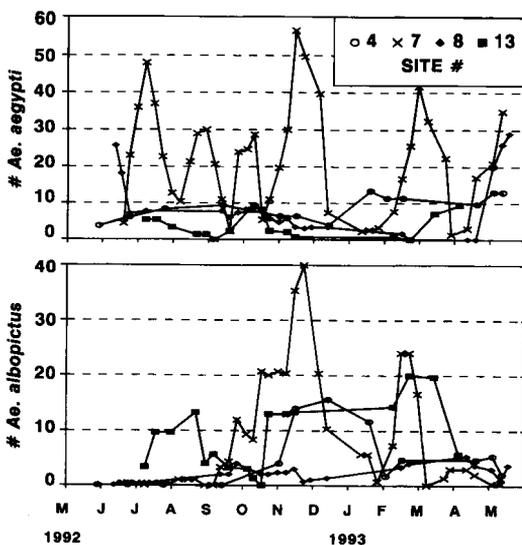


Fig. 6. Egg counts by species from ovitrap collections in urban Fort Myers. Sites with year-total *Aedes albopictus* frequency >25% to ≤50%. Site numbers refer to sites on insert of Fig. 5.

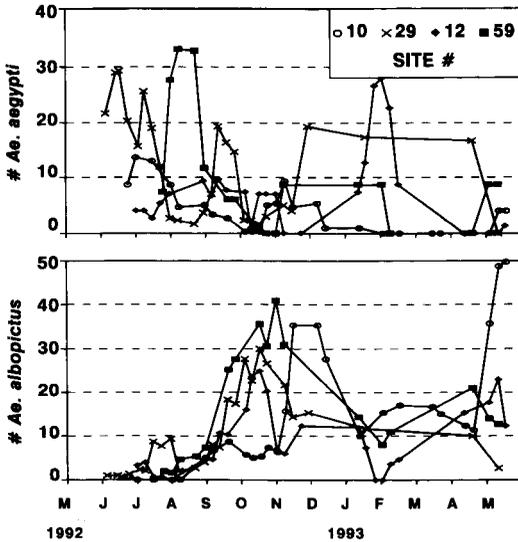


Fig. 7. Egg counts by species from ovitrap collections in suburban Fort Myers. Sites with year-total *Aedes albopictus* frequency of $>50\%$ to $\leq 75\%$. Site numbers refer to sites on insert of Fig. 4.

this species can be expected. The dominance of *Ae. aegypti* seen in urban areas in Lee County may be short-lived or it may remain because of southwest Florida's subtropical environment. As O'Meara et al. (1992) pointed out: "At lower latitudes in parts of tropical and subtropical Asia, *Ae. aegypti* populations usually dominate the urban areas, while *Ae. albopictus* is normally more abundant in rural and sylvan areas."

The data collected in the first year of the surveillance demonstrate the ability of *Ae. albopictus* to rapidly and preferentially colonize large expanses of rural southwest Florida. Urban and suburban areas of the county showed slower rates of colonization. In regions where the all-year *Ae. albopictus* frequency was from $\geq 50\%$ to $< 75\%$, *Ae. albopictus* dominance steadily increased throughout the year and became the dominant-container breeding mosquito species, whereas it did not develop dominance in areas with a fre-

quency range of $\geq 25\%$ to $< 50\%$. During the study period, *Ae. albopictus* did not displace *Ae. aegypti* in regions where the relative *Ae. albopictus* frequency was $< 75\%$. The southern limit of *Ae. albopictus* in Lee County moved a distance of 8.1 km (5 mi.) in 6 wk to Bonita Springs, its position as of May 1993.

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