OPERATIONAL AND SCIENTIFIC NOTES

AEDES ALBOPICTUS IN FLORIDA

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Used tires are an important man-made source for mosquito proliferation and dispersal (Pratt et al. 1946, Craven et al. 1988). Recapping has made them a valuable commodity; thus, international and interstate movement is common (Reiter and Sprenger 1987). This is important when it involves mosquitoes incriminated as disease vectors. Such is the case with *Aedes albopictus* (Skuse) which has recently been discovered in 17 of the continental United States [Centers for Disease Control (CDC) 1987]. Under suitable conditions, this mosquito is an important vector of dengue viruses (Shroyer 1986). In addition, it is an aggressive human-biter causing considerable discomfort.

The purpose of this report is to document the discovery of *Ae. albopictus* in Florida and to elaborate on implications, preliminary surveillance observations, and control efforts and obstacles.

Aedes albopictus, known commonly in the U.S. as the "Asian tiger mosquito," first was discovered in Florida on July 3, 1986 in Jacksonville (Duval County), located in the northeast portion of the state (30° 20′N). Biting females were collected from a large tire lot 3.5 km west of the downtown area (Fig. 1) during an intensive surveillance effort organized in response to its discovery in other southern states. *Aedes albopictus* females were aspirated during biting collections in very low proportions (ca. 1:100) compared to *Aedes aegypti* (Linn.).

A subsequent survey of Duval County in August 1986, including 3 seaport facilities and about 60 tire dumps, revealed that the infestation was limited to this large tire lot and an adjacent property containing scrap tires. The tire lot had been in operation for only 18 months, during which time, between 1 and 2 million unsalvageable, used tires had been stockpiled for eventual shredding for fuel. Truck and automobile tires were stacked 2–3 m high over 7 ha.

Aedes albopictus was found breeding throughout the tire lot with the greatest concentration of larvae occurring in shaded tires next to a heavily wooded ravine. Relatively high landing rates of several dozen/minute were experienced during each visit to the ravine during the hottest periods of the day. *Aedes albopictus* had dispersed from this point 2 km to the south and east along an adjoining creek. Within this area, we located 5 used-tire dealers, 3 truck-tire recappers, 2 smaller tire dumps and one used-tire warehouse. Breeding was found in tires outside the warehouse, behind one of the recappers and in junkyards aligning an adjacent highway. Larvae were collected from a variety of discarded containers, such as bottles, jars, cans, hubcaps, toilets, sinks and 5-gallon buckets. Most larvae were collected from used tires. None were collected from tree holes.

Further investigation revealed that during the past 5 years, a prosperous business involving importing, recapping and reselling Japanese truck tire casings had developed. From 120 to 144 containers of tire casings, holding about 300 tires per container, were imported to Jacksonville annually. An average of 1–2% of these tires were unusable and disposed as scrap (Wayne Johnson, Retread Corporation of Florida, personal communication). At this rate we estimated between 360–830 foreign scrap tires were added to the stockpile at the infested tire lot each year. Efforts to inspect tire shipments at random for the presence of mosquitoes were negative.

Several surveillance techniques were employed to estimate the distribution, prevalence and population density of *Ae. albopictus* in the infested area. Weekly, one-minute landing rate counts, battery-powered aspirator and sweep net collections (Kumm and Novis 1938, Ho et al. 1971) were made between 0900 and 0930 hr from July 8 to September 30, 1986. During the initial inspection of the downtown tire dump in August,

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Fig. 1. The tire lot where *Aedes albopictus* was discovered in Jacksonville, Florida. A mosquito larviciding truck can be seen near the center of the picture.

a count of 50 adults per minute was made with 1–2% identified as *Ae. albopictus* and the remainder *Ae. aegypti*. One month later this count increased to an average of 100 adults per minute with 10% *Ae. albopictus*, and in September the landing rate averaged 95 per minute with 80% *Ae. albopictus*. A similar increase was reflected in sweep net and aspirator collections. Our observations indicated that the Jacksonville population of *Ae. albopictus* was increasing and was possibly displacing *Ae. aegypti* in the more shaded habitats. Furthermore, initially low adult counts compared to indigenous *Ae. aegypti*, limited distribution and the absence of tree hole breeding suggest that this infestation may be relatively new.

Larval collections from tires were made in July, August and September of 1986. Tires that were shaded contained a higher percentage of *Ae. albopictus* than those exposed to full sun. This suggested a possible preference; however, more complete studies need to be accomplished to confirm this hypothesis.

Four portable CDC traps supplied with 2.3 kg blocks of dry ice and with light bulbs removed, were operated from July 31 to September 26, 1986 to obtain relative *Ae. albopictus* population estimates (Herbert et al. 1972). These traps were placed in well shaded areas once a week, 1–2 hours before sunset, and removed 2–3 hours after sunrise the following morning. Overnight collections were very productive ranging from 1,411 to 7,522 with an average of 3,927 adults. The proportion of *Ae. albopictus* fluctuated over 2 months with only a slight increase from 10 to 20%. The majority of mosquitoes collected were *Ae. aegypti*. As with concurrent sweep net and aspirator collections, the ratio of male to female *Ae. albopictus* was high (1:0.2) in comparison to *Ae. aegypti* (1:3.3).

In September, 2 additional CDC traps (with dry ice and no light source) were operated one day each week for 30 minutes at midday. One trap was placed in a shaded area within the ravine and the other along the edge of the tire dump in partial shade. The trap in the ravine collected an average of 324 mosquitoes of which 51.2% were *Ae. albopictus* and 48.8% were *Ae. aegypti*. The other trap collected an average of 141 adults of which 39.0% were *Ae. albopictus* and 61.0% were *Ae. aegypti*. As with larval collections, *Ae. albopictus* was found more abundantly in shaded habitats.

From October 1, 1986 to the present, the Jacksonville Mosquito Control Branch has cooperated with the CDC in operating an oviposition trap surveillance program to monitor the spread of *Ae. albopictus*. As many as 15 ovipo-

sition traps (Thaggard and Eliason 1969) were placed within the infested site and areas to the north and south. Each week eggs from these traps have been collected, counted and hatched and the resulting larvae identified. To date, the only *Ae. albopictus* eggs that have been collected were from the original infested tire lot.

In 1987, the CDC organized a follow-up survey. Biting *Aedes albopictus* were collected abundantly at 25 additional sites within a 3 km radius of the originally discovered tire lot. It was also collected in 2 isolated sites ca. 9 km northeast of the tire lot near the city zoo.

During May 24, 1988, 10 female and 2 male *Ae. albopictus* were discovered in a dry ice-baited CDC light trap in Brownsville located southeast of Pensacola (Escambia County) in the extreme western portion of the Florida panhandle. The collection was incidental in that the trap was set in response to complaint calls received by the local mosquito control agency. The trap was operated from 1900 to 0700 hr on May 24 and 25 in a moderately forested, residential setting close to a swamp. *Aedes albopictus* made up 80% (12/15) of the first night collection and 2% (2/93) for the second night. No larval breeding or tires were found in a survey of a 3.2 km^2 area surrounding the trap.

Efforts to control *Ae. albopictus* in Jacksonville with insecticides have been unsatisfactory. Temporary abatement using larviciding oil (Florida Mosquito Larvicide), mixtures of *Bacillus thuringiensis israelensis* (Vectobac® 12AS) and permethrin (Pramex®), and thermal fogging with naled (Dibrom®) in diesel fuel have been employed. Insecticidal applications were required at least every 3 weeks to achieve adequate relief. Manpower limitations and costs of up to $2000/treatment (includes equipment, labor and insecticide) for the 7 ha site made such as arrangement undesirable.

Permanently eliminating mosquito production through proper tire disposal was resorted to as a better solution to the problem. This involved enforcement of existing health and fire ordinances restricting tire dumps. Such action backfired with some of the larger tire-yard operators. Faced with exorbitant landfill disposal costs of $33/ton for whole tires, they chose to move the illegal tires to neighboring counties with less stringently enforced regulations. Efforts to prevent this were employed to halt the potential spread of *Ae. albopictus* and other tire-breeding mosquitoes. In one episode involving the largest tire lot (Fig. 1), the city of Jacksonville expedited the disposal process by hiring a contractor to eliminate the tires. The city is currently seeking remuneration from the tire-yard operator through the assistance of the state attorney. To avoid future dilemmas, the city now requires tire haulers to be licensed, bonded and to provide reports on the processing of their tires. The movement of tires at night has been prohibited. These measures were intended to help preclude the build-up of illegal tire lots. In addition, the city is seeking authority to assess a vehicle wheel tax to subsidize a local tire disposal program.

The discovery of *Ae. albopictus* in Florida represents the southeastern limit of its distribution in the USA. Duval and Escambia counties are the only locations where *Ae. albopictus* have been reported in the state. This discovery is unique in comparison to the 16 other continental states from which it is known, in that Florida serves as the gateway to the Carribbean islands where endemic dengue has reached epidemic proportions. The Jacksonville infestation is located in the heart of downtown where many opportunities for rapid, widespread dispersal exist. There are two major railroad switching yards nearby, as well as several commercial truck terminals. Three interstate highways crisscross the region, and a large seaport is within 7 km. This port exports over 2,000 cargo containers to Puerto Rico each week (Foley 1986). The geographic proximity and close commercial relationship that exists among the islands and the port cities of Florida make the potential spread of dengue in the USA a threat.

Furthermore, unless efforts are made to control Florida infestations, it is quite conceivable that this mosquito could disperse to the islands where it currently does not exist. The principal vector for dengue in the Caribbean is *Aedes aegypti*. It is not known what impact this additional vector would have on the epidemiology of the disease.

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