A SURVEY OF MOSQUITOES BREEDING IN USED TIRE STOCKPILES IN CONNECTICUT

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ABSTRACT. A larval survey of nine used tire disposal sites in Connecticut, was conducted from June through October 1987. No larvae of *Aedes albopictus* were uncovered indicating that this mosquito is not yet established in the state. However, eight other mosquito species in four genera were found. The most abundant and widely distributed species found breeding in permanent tire dumps were *Ae. atropalpus, Ae. triseriatus* and *Culex restuans. Culex pipiens* was the second most common *Culex* species followed by *Cx. territans* and *Cx. salinarius*. Other species included *Anopheles punctipennis* and *Culiseta melanura*. Larvae of *Ae. atropalpus* and *Cx. salinarius* were most frequently recovered from tire casings exposed to direct sunlight, while *Ae. triseriatus* and *Cs. melanura* predominated in tires shaded by bordering trees and low-lying vegetation. The other mosquito species showed no discernable preference for either habitat type.

INTRODUCTION

Since its initial discovery in Harris County, Texas in August, 1985 (Sprenger and Wuithiranyagool 1986), the Asian Tiger mosquito, *Aedes albopictus* (Skuse) has spread rapidly throughout the south and northcentral United States (Centers for Disease Control 1986a, 1986b). This northward expansion, via shipments of used tires, has clearly been fostered by man (Reiter and Sprenger 1987) and is believed to be the beginning of a permanent establishment in temperate North America, owing to the mosquito's origin (northern Asia) and ability to tolerate low temperatures and respond to short day lengths (Hawley et al. 1987). Distribution records for *Ae. albopictus* in northern Asia and climatic comparisons with North America further indicate that, in addition to the midwest, *Ae. albopictus* may be capable of infesting major portions of the northeast, including Connecticut, as part of its late summer expansion range (Nawrocki and Hawley 1987). It has most recently been found in Maryland and Delaware (Centers for Disease Control 1987), but its presence in other eastern states has yet to be determined.

The recent establishment of *Ae. albopictus* in North America has also served to focus our attention on the importance of discarded tires as a major source of breeding for certain mosquitoes. The extent of mosquito breeding in tire dumps in Connecticut is unknown.

The purpose of this study was to determine the presence or absence of *Ae. albopictus* in Connecticut and obtain current information on the variety and relative abundance of other mosquito species inhabiting tire dumps throughout the state.

MATERIALS AND METHODS

Nine used tire disposal sites, distributed throughout Connecticut, were sampled for mosquito larvae (Fig. 1). These included: the only licensed tire dump in the state (Hamden), a 40 acre site containing several million used tire casings; two privately-owned tire dumps (Monroe and Salem) and two town landfill sites (Columbia and Portland) each containing several hundred thousand tires; and three used tire/junk dealers (Southington, Stratford, and Wallingford) and one disposal area (Groton) with several hundred to a thousand tires.

Surveillance began in early June, and larval collections were made periodically until the end of October, 1987. The sampling dates for each site were as follows: Hamden, June 1, 25, July 7, 21, August 5, 18, September 11, 21, and October 26; Southington and Wallingford, June 12; Columbia, Portland and Salem, June 17, July 1, 15, 30, August 13, 26, September 2, 23, and October 28; Monroe, June 24 and July 9; Stratford, July 14; and Groton, August 5.

On each sample date, the tire dumps were thoroughly surveyed for larvae. A standard 300 ml dipper was used to collect larvae from tires

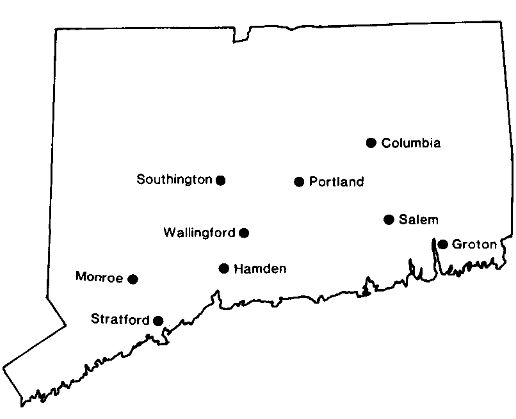

Fig. 1. Map of Connecticut showing location of used tire disposal sites surveyed for larval mosquitoes in 1987.

scattered throughout the various piles at each site. Samples were obtained from all areas of a dump, including open tires exposed to direct sunlight and tires shaded by trees and vegetation. Tire water was mixed prior to sampling in order to obtain bottom dwelling larvae. At least 50 tires per site were sampled on each date and the number of tires sampled per site varied.

Larvae were taken to the laboratory for identification. Early instars that were not readily identifiable, were reared to the fourth instar before being identified. Pupae were similarly maintained and identified as adults.

The relative abundance of each mosquito species found breeding at each site was categorized as abundant (>10 larvae/tire) or scarce (1 to 10 larvae/tire) for each sampling period. The distribution of each species in exposed and shaded tires was recorded for each site. Permanent slide mounts of voucher specimens were made for each species and are currently maintained in the collection of the author.

RESULTS

No larvae of *Ae. albopictus* were found in any of the permanent tire dumps or used tire dealerships that were sampled from June through October. However, eight other mosquito species in four genera were collected during the survey. The distribution and relative abundance of these species in the five permanent tire dumps, three used tire dealerships, and one temporary disposal area surveyed from June through September are shown in Table 1.

The most abundant and widely distributed species found breeding in the large permanent dumps were *Aedes atropalpus* (Coquillet) (88.1% of all sampled areas, n = 67), *Culex restuans* Theobald (86.6%) and *Aedes triseriatus* (Say) (67.2%). *Culex pipiens* Linn. was the second most common *Culex* species collected, occurring in 55.2% of the sampled areas, followed by *Culex territans* Walker (28.4%) and *Culex salinarius* Coquillet (16.4%), which was found in two dumps only (Portland and Salem). *Anopheles punctipennis* (Say) was regularly collected in all five tire dumps in July (44.8% of all sampled areas, n = 25), but was never plentiful (average of < 1 larva/tire), and unlike the other species, was rarely found in August or September. *Culiseta melanura* (Coquillett) was detected for the first time in August. Larvae were found breeding in several heavily shaded tires at the Salem site. These tires contained clear water with relatively little accumulated organic matter and had no contact with wood, soil or groundwater.

Aedes triseriatus, Cx. restuans and *Cx. pipiens* exhibited similar patterns of abundance (> 10 larvae/tire) in the three used tire dealerships surveyed in June and July (Table 1). However, no larvae of *Ae. atropalpus, Cx. salinarius*, or *Cs. melanura* were found breeding at any of these sites where there was a higher turnover of tires. *Anopheles punctipennis* was also comparatively scarce (1 – 10 larvae/tire and 2 of 3 sites) and *Cx. territans* was collected only once.

Samples obtained from a small temporary used tire disposal area at the US naval base in Groton during August, revealed the presence of *Cx. pipiens* and *Cx. restuans* only.

Noticeable declines in the abundance and distribution of larvae of most species were observed in the large permanent dumps by late October (not shown). *Aedes atropalpus, Cx. pipiens, Cx. territans* and *Cx. salinarius* all averaged < 10

Table 1. Relative abundance[1] of larval mosquitoes found breeding in used tire dumps, dealerships and disposal areas in Connecticut from June through July (J–J) and August through September (A–S), 1987.

	Mosquito species															
	Aedes atropalpus		*Aedes triseriatus*		*Anopheles punctipennis*		*Culex pipiens*		*Culex restuans*		*Culex salinarius*		*Culex territans*		*Culiseta melanura*	
Site	J–J	A–S	J–J	A–S	J–J	A–S	J–J	A–S	J–J	A–S	J–J	A–S	J–J	A–S	J–J	A–S
DUMPS																
Columbia	++	++	++	++	+	0	+	+	++	++	0	0	+	+	0	0
Hamden	++	++	++	++	+	0	++	++	++	++	+	+	+	+	0	0
Monroe	++	ns	++	ns	+	ns	+	ns	++	ns	0	ns	+	ns	0	ns
Portland	++	++	++	++	+	+	++	++	++	++	+	+	+	+	0	0
Salem	++	++	++	++	+	0	0	+	++	++	0	0	+	+	0	+
DEALERSHIPS																
Southington	0	ns	++	ns	+	ns	++	ns	++	ns	0	ns	+	ns	0	ns
Stratford	0	ns	++	ns	0	ns	++	ns	++	ns	0	ns	0	ns	0	ns
Wallingford	0	ns	++	ns	+	ns	0	ns	++	ns	0	ns	0	ns	0	ns
DISPOSAL AREA																
Groton	ns	0	ns	0	ns	0	ns	++	ns	++	ns	0	ns	0	ns	0

[1] ++ = >10 larvae/tire, + = 1–10 larvae/tire, 0 = not found, ns = not sampled.

Table 2. Species occurrence (as percentage of sampled areas) in exposed and shaded used tire disposal sites sampled from June through October, 1987.

Mosquito species	Exposed (n = 46)	Shaded (n = 34)	χ^2
Aedes atropalpus	93.5	58.8	14.03 **
Aedes triseriatus	45.6	91.2	17.81 **
Anopheles punctipennis	21.7	35.3	1.80 ns
Culex pipiens	63.0	58.8	0.15 ns
Culex restuans	82.6	91.2	1.21 ns
Culex territans	23.9	38.2	1.91 ns
Culex salinarius	23.9	5.9	4.67 *
Culiseta melanura	0	14.7	7.22 **

** = $P > 0.01$, * = $P > 0.05$, ns = not significant by Chi-square (χ^2) test.

larvae/tire and were found in only 3, 3, 2, and 1 of 4 sites (Columbia, Hamden, Portland, and Salem), respectively. However, *Cx. restuans* and to a lesser degree, *Ae. triseriatus*, were still locally abundant at most sites, occurring at densities of > 10 larvae/tire. *Culiseta melanura* remained relatively scarce, occurring only in Salem, but larval densities were comparable (1 to 10 larvae/tire) to those observed in the same tires sampled in September.

Throughout the study, larvae of *Ae. atropalpus* and *Cx. salinarius* were most frequently found breeding in tire casings exposed to direct sunlight (Table 2). *Aedes triseriatus*, on the other hand, predominated in tires shaded by bordering trees and low-lying vegetation, as did *Culiseta melanura*, which was exclusively found in shaded locations. Shaded tires generally contained greater amounts of organic matter. The other mosquito species showed no discernable preference for either habitat type and were equally abundant in both shady and exposed areas.

Aedes triseriatus was often associated with *Ae. atropalpus* in exposed tires, occurring in 48.8% of the same sites (n = 43). However, the most common cohabitants with *Ae. atropalpus* were *Cx. restuans* (83.7%) and *Cx. pipiens* (62.8%). In shaded tires, where *Ae. triseriatus* predominated, *Ae. atropalpus* was found breeding in 64.5% of the same sites (n = 31) but *Cx. restuans* was the most frequent cohabitant, occurring in 90.3% of the same sites. *Aedes triseriatus* and *Cx. restuans* larvae were always found in association with *Cs. melanura* but *Ae. atropalpus* never was.

DISCUSSION

This study has shown that at least eight species of mosquitoes in Connecticut currently utilize discarded tires as a larval breeding habitat. The most abundant species are *Ae. atropalpus, Ae. triseriatus, Cx. restuans* and *Cx. pipiens*. Other less common species include *An. punctipennis, Cx. territans, Cx. salinarius* and *Cs. melanura*.

Aedes albopictus does not presently appear to be established in the state, as no larvae were found breeding in any of the sites sampled from June through October. Since this survey included most of the major tire dumps in the state, it seems unlikely that *Ae. albopictus* could be established elsewhere and remain undetected. The potential for its introduction into Connecticut in the future will most probably depend on the direct importation of infested tires. However, according to most tire dealers and dump owners surveyed, there is currently very little or no importation of used tires from exotic sources for retreading and more than 90% of the used tires deposited in these dumps come from instate sources.

The diversity and abundance of mosquito species found breeding in used tire disposal areas in Connecticut are consistent with recent surveys conducted in other states (Covell and Brownell 1979, Restifo and Lanzaro 1980, White and White 1980, Kruger and Pinger 1981, Beier et al. 1983, Berry and Craig 1984). The three most abundant species observed in this study, *Ae. atropalpus, Ae. triseriatus* and *Cx. restuans*, are also the same three species most commonly associated with tire dumps in Indiana (Beier et al. 1983, Berry and Craig 1984).

Berry and Craig (1984) found *Cx. restuans* to be the most rapid and numerous colonizer of new tire habitats in Indiana. My observations on the abundance and predominance of this mosquito in used tire dealerships and temporary disposal areas with high turnover rates suggest the same may be true in Connecticut. However, while populations of *Cx. restuans* apparently peak in mid-June and are replaced by *Cx. pipiens* during July in the mid-west (Berry and Craig 1984), they show no signs of such a decline in Connecticut and remain the dominant *Culex* species in both shaded and exposed tires throughout the summer and the fall. Although *Cx. restuans* has not normally been suspected of transmitting virus encephalitides, both eastern equine encephalomyelitis (EEE) (Hayes et al. 1960) and St. Louis encephalitis (Monath and Tsai 1987) viruses have been isolated from wild-caught females. Therefore, its abundance in tire dumps should be considered a potential public health hazard.

The predominance of *Ae. triseriatus* in shaded tires at most locations, concurs with previous observations of larval breeding for this species in tire dumps (Beier et al. 1983, Berry and Craig 1984). Beier et al. (1983) have suggested that *Ae. triseriatus* probably prefers shaded tires because they mimic tree holes in being dark and full of organic matter. However, some breeding in sunlit areas was observed in this survey and thus, I must also conclude, as have others (Beier et al. 1983, Berry and Craig 1984), that *Ae. triseriatus* will oviposit and successfully breed in fully exposed tires as well. The involvement of *Ae. triseriatus* in the epidemiology of La Crosse virus (LeDuc 1979) and its potential to transmit dog heartworm, *Dirofilaria immitis* (Intermill 1973), make its prevalence in tire dumps a potentially serious problem.

The finding of a large dominant population of *Ae. atropalpus* in all permanent tire dumps indicates that this mosquito, which normally breeds in rock pools near fast-flowing streams (Means 1979), has become well adapted to breeding in used tires. This habitat represents a new record for *Ae. atropalpus* in New England although it has been previously reported in Kentucky (Covell and Brownell 1979), New York (White and White 1980), Indiana and Ohio (Restifo and Lanzaro 1980). The spread of *Ae. atropalpus* from traditional rock pool habitats to discarded tires is thought to have been a fairly recent and rapid event (Berry and Craig 1984). Its rapid attainment of dominance in tire yards following introduction has been noted by Beier et al. (1983) and Berry and Craig (1984), especially in open tires exposed to direct sunlight which it apparently has a preference for. I have also observed, as have others (Restifo and Lanzaro 1980, G. B. Craig, personal communication), that unlike the east coast, rock pool strain of *Ae. atropalpus*, which is entirely autogenous for the first gonotrophic cycle (O'Meara and Craig 1970), the tire-breeding strain will readily blood feed on man. This makes it occurrence in tire dumps of medical importance.

The discovery of *Cs. melanura*, the primary enzootic vector of EEE (Heyes 1981), represents the fourth record of larval breeding in discarded tires for this woodland-inhabiting species. The other recoveries have come from Connecticut (Wallis and Whitman 1967), Florida (Eads 1976) and New Jersey (Rupp 1977) where larvae were found in shaded tires containing water rich in organic matter. Wallis and Whitman (1967) also uncovered larvae at one location in Connecticut from exposed tires containing water with relatively little accumulated plant matter. In the present study, larvae were restricted to the heavily shaded areas of the tire dump and were found breeding in clear water with relatively little organic material that had no contact with wood, soil or groundwater. It appears that tire-breeding may be more common for *Cs. melanura* than had been previously thought. This could have important implications with regard to the epidemiology of EEE, as breeding in tire dumps could help to expand the range of *Cs. melanura* via dispersal of infested tires and thereby increase its distribution and abundance.

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