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SCIENTIFIC NOTE

NEW RECORDS OF *AEDES AEGYPTI* IN SOUTHERN OKLAHOMA, 2016

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ABSTRACT. *Aedes aegypti* is an important subtropical vector species and is predicted to have a limited year-round distribution in the southern United States. Collection of the species has not been officially verified in Oklahoma since 1940. Adult mosquitoes were collected in 42 sites across 7 different cities in Oklahoma using 3 different mosquito traps between May and September 2016. Between July and September 2016, 88 *Ae. aegypti* adults were collected at 18 different sites in 4 different cities across southern Oklahoma. Centers for Disease Control and Prevention mini light traps baited with CO_2 attracted the highest numbers of *Ae. aegypti* individuals compared to Biogents (BG)-Sentinel® traps baited with Biogents (BG)-lure and octenol and Centers for Disease Control and Prevention gravid traps baited with Bermuda grass–infused water. The discovery of *Ae. aegypti* mosquitoes within urban/exurban areas in Oklahoma is important from an ecological as well as a public health perspective.

KEY WORDS *Aedes aegypti*, urban surveillance, yellow fever mosquito, Zika virus

Zika virus, a mosquito-borne flavivirus related to yellow fever, dengue, and West Nile viruses, was first detected outside of Africa and Southeast Asia in 2007 on Yap Island (Hayes 2009). Since 2013, it has been spreading throughout the Americas, where it is primarily transmitted by *Aedes aegypti* (L.) mosquitoes (Hennessey et al. 2016, Weaver et al. 2016). *Aedes aegypti* is characterized as a mostly tropical species, which is unlikely to thrive in the United States, except in southern Texas and Florida, due to seasonal low temperatures (Monaghan et al. 2016). However, the estimated range for the species includes Oklahoma and Arkansas into the central regions of Kansas and Missouri (CDC 2016).

The last published reports of *Ae. aegypti* in Oklahoma were in 1940, where it was noted to be a fairly common household pest as far north as Stillwater (Rozeboom 1938, 1942). Large-scale surveys conducted in 1964 (Morlan and Tinker 1965) or between 2003 and 2006 did not collect any *Ae. aegypti* individuals in Oklahoma (Paras et al. 2014, Noden et al. 2015). More recently, Hahn et al. (2016) reported *Ae. aegypti* in Oklahoma based on one 1988 report from VectorMap (2016) and 2 reports in 2013 and 2014 (CDC 2015), all of which lack voucher specimens and other pertinent collection information. This study had 2 objectives: to determine whether populations of *Ae. aegypti* exist in Oklahoma, and to compare the efficiency of 3 commercial mosquito traps for the collection of *Ae. aegypti* individuals in Oklahoma.

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Adult mosquitoes were collected in 6 urban/exurban locations in 7 different cities in Oklahoma between May 28, 2016, and September 20, 2016 (Fig. 1). Four cities (Lawton, Ardmore, Midwest City, and Enid) each had 16 sampling events, Ardmore and Idabel had 15 sampling events, and Frederick had 1 sampling event. Because of reports of the occurrence of *Ae. aegypti* in urban areas (Chan et al. 1971, Womack 1993, Eisen and Moore 2013), sites were selected by proximity to urban centers, reported mosquito activity, location in relation to public centers such as parks, and reduced chances of trap disturbance. Oklahoma State University County Extension agents aided in site selection by reporting mosquito problem areas in the cities. Sampling sites were adjusted when *Ae. aegypti* mosquitoes were detected in order to characterize the approximate distribution of the species in a city.

Surveillance efforts utilized 3 types of mosquito traps: the Centers for Disease Control and Prevention (CDC) mini light traps (Bioquip, Rancho Dominguez, CA), with lights removed and baited with dry-ice CO_2 released from modified insulated coolers; CDC gravid traps (John W. Hock Company, Gainesville, FL) baited with Bermuda grass–conditioned water; and Biogents (BG)-Sentinel® and BG-Sentinel 2® traps (Biogents, Regensburg, Germany), baited with BG-lure (Biogents) and octenol (Biogents).

Mosquitoes were identified using keys by Darsie and Ward (2005). All mosquitoes were viewed at 4.25× magnification under a stereomicroscope and were identified to species. After identification, all mosquitoes were stored in vials at –20°C, with *Ae. aegypti* specimens stored separately. Suspected *Ae. aegypti* specimens were verified by Lisa Coburn of Oklahoma State University and documented with photographs. Voucher specimens were deposited at the Oklahoma State University K.C. Emmerson Entomology Museum.

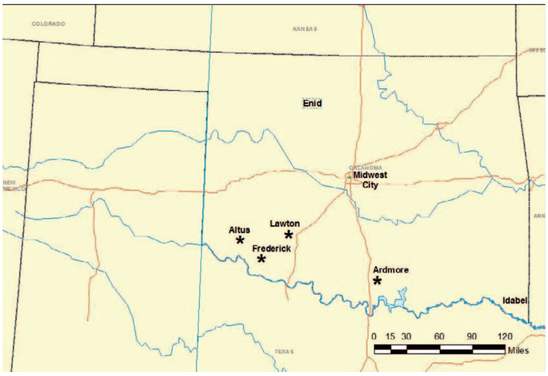

Fig. 1. Sites in Oklahoma where *Aedes aegypti* mosquitoes were collected between July and September 2016. Names include all sites where collections were carried out between May and September 2016. The sites marked with an asterisk are the sites where *A. aegypti* was collected.

Between May and September 2016, 88 *Ae. aegypti* individuals were collected during 798 trap nights at 284 sample sites. *Aedes aegypti* were collected in traps at 18 different sites in 4 different cities. *Aedes aegypti* were collected at 7 of 12 sites within the city limits of Altus and 2 of 6 sites in Frederick, Ardmore, and Lawton, OK (Fig. 1). The first collection of *Ae. aegypti* ($n = 4$) occurred on July 8, 2016, at 2 of the 6 sample sites in Altus (Table 1). By August 2016, *Ae. aegypti* ($n = 15$) mosquitoes had also been collected in Frederick ($n = 7$) and Ardmore ($n = 8$). In September, *Ae. aegypti* mosquitoes were collected at 2 of 6 sites in Lawton, OK ($n = 2$).

Of the 88 *Ae. aegypti* collected in this study, most ($n = 64$) were collected from 7 sites in Altus and 2 sites in Frederick ($n = 6$). Among positive locations in these 2 cities, most *Ae. aegypti* ($n = 52$) individuals were collected at businesses where tires were stored outside the building, followed by areas near abandoned buildings ($n = 10$), in a public park surrounded by residences ($n = 4$), in a hotel parking area ($n = 2$), in an alley ($n = 1$), in a wetland adjacent to town ($n = 1$), and at a residence within the community ($n = 1$). In Ardmore, *Ae. aegypti* individuals were collected near a drainage area adjacent to the downtown area ($n = 13$), and the remainder came from a wooded area near the downtown area between a public park and residential area ($n = 2$). In Lawton, *Ae. aegypti* individuals were collected behind a downtown urban office complex ($n = 1$) and at a dog park on the edge of the city ($n = 1$).

Among the 3 trap types used, most *Ae. aegypti* individuals were caught using dry ice–baited modified CDC mini light traps (67%), while the second most were caught with BG-Sentinel traps (21%), and the fewest were caught with gravid traps (12%). The dry ice–baited modified CDC mini light traps were significantly better at collecting *Ae. aegypti* than the other traps tested ($X^2 = 45.89$, df = 2, $P < 0.001$).

Table 1. Numbers of *Aedes aegypti* collected by date and trap type in cities in Oklahoma using 3 types of traps placed at 6 sites per location between May and September, 2016.

City	May	June	July	August	September	Total
Altus	0	0	23	34	7	64
Ardmore	0	0	0	7	8	15
Enid	0	0	0	0	0	0
Frederick[1]				7		7
Idabel	0	0	0	0	0	0
Lawton	0	0	0	0	2	2
Midwest City	0	0	0	0	0	0
Total	0	0	23	48	17	88

[1] Only 1 sampling was conducted at 6 locations in Frederick, OK, using modified CDC mini light traps.

However, the *Ae. aegypti* individuals from Lawton, OK, were only collected in 2 separate gravid traps.

The discovery of *Ae. aegypti* populations within the state of Oklahoma is important from an ecological perspective. This is the first verified and published report of *Ae. aegypti* within Oklahoma since 1940 (Rozeboom 1942). While not detected by recent surveillance efforts, *Ae. aegypti* populations may have been present in the state, according to several unpublished records between 1988 and 2014 recording the species in Oklahoma (central) and Comanche (southwest) Counties. This current surveillance effort was the first to sample mosquitoes in southwest Oklahoma, south of the Wichita Mountains or west of Lawton (Rozeboom 1942). *Aedes aegypti* may have been historically present, but it was never considered necessary to target this species in the region due to the dry, drought-prone nature of the area. Additionally, previous surveillance efforts in Ardmore may not have placed traps within the central urban area where *Ae. aegypti* normally occur and, thus, may have missed populations that may have been present.

In our study, significantly more *Ae. aegypti* individuals were collected using modified CDC mini light traps baited with CO_2 than the other traps. These results differed from a study conducted in northern Florida, in which BG-Sentinel 2 traps with yeast-generated CO_2 and lure caught 3× more *Ae. aegypti* individuals than CDC mini light traps with yeast-generated CO_2 (Harwood et al. 2015). In the current study, only trap-specific lure was used with the BG-Sentinel 2 traps, while dry ice–generated CO_2 was used with the CDC mini light traps. This may account for the differing results between studies, but sample sizes are also likely too small for effective comparison. While the use of sticky ovitraps may have improved capture rates (Russell and Ritchie 2004), it is notable that all 3 methods used in this study collected *Ae. aegypti,* as others have reported for urban sites (Reiter et al. 1986, White et al. 2009, Arimoto et al. 2015).

The discovery of *Ae. aegypti* in 4 urban areas in Oklahoma is also important from a public health standpoint. By documenting the presence and distribution of *Ae. aegypti*, public health officials can implement preparedness planning by determining the risk of local vector-borne transmission of Zika, dengue, and chikungunya viruses. Prior to 2015, Zika was unknown in the Americas (Ventura et al. 2016), but as of 2016, local transmission is occurring in southern Florida via *Ae. aegypti* mosquitoes (Likos et al. 2016). Neighboring Texas is 1 of the states in the continental USA that is thought to be able to sustain *Ae. aegypti* breeding populations year-round, providing a potential for sustained virus transmission (Hahn et al. 2016). Therefore, Texas may provide a mosquito source for yearly introduction of *Ae. aegypti* if current populations are not able to survive the winter in Oklahoma. Future studies should evaluate whether *Ae aegypti* populations are actually able to survive the winter in Oklahoma, or if they are recolonizing each year.

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