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SCIENTIFIC NOTE

FIRST RECORD OF *AEDES JAPONICUS JAPONICUS* IN OKLAHOMA, 2017

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ABSTRACT. In spring 2017, mosquito larvae were collected from 25 sites across eastern Oklahoma as part of a Zika virus vector surveillance effort. *Aedes japonicus japonicus* larvae were collected from horse troughs at 2 sites in Ottawa County, OK. Identification was made using 1 larva stored in 70% ethanol and 3 adult females reared from the larvae. Another invasive mosquito species, *Culex coronator*, was detected at 2 different sites, adding 2 additional counties to the 9 where the species had been previously reported. The presence of these invasive species in Oklahoma may have an impact on future regional arbovirus concerns.

KEY WORDS *Aedes japonicus japonicus*, Asian bush mosquito, *Culex coronator*, rural surveillance, West Nile virus

Aedes japonicus japonicus (Theobald), the Asian bush mosquito, is a species associated with rock pools, tree holes, and artificial containers throughout the world (Kampen and Werner 2014). Previously found in Taiwan, Japan, Korea, and parts of Russia and China, this species has successfully invaded and become established in many regions of the world since 1993 (Kampen and Werner 2014). Invasion of the USA was first detected in New York, New Jersey, and Connecticut in 1998. By 2012, *Ae. japonicus* had been collected in most states east of the Mississippi River (except Louisiana), and movement was detected into the Great Plains states (Iowa, Missouri) (Kaufman and Fonseca 2014). The invasion of southern US states happened later than the northern US states, with Arkansas (2010) and Mississippi (2011) being the most recent states to report occurrence. To date, no occurrence of *Ae. japonicus* has been reported in Oklahoma or Texas.

In the USA, *Ae. japonicus* is not considered a major vector of pathogens that affect humans or animals. Field-collected mosquitoes have been detected with West Nile virus (Sardelis and Turell 2001) and La Crosse encephalitis virus (US) (Sardelis et al. 2002b), while the species has demonstrated competency in the laboratory for Japanese encephalitis virus (Asia) (Takashima and Rosen, 1989), St. Louis encephalitis virus (Sardelis et al. 2003), eastern equine encephalomyelitis virus (Sardelis et al. 2002a), Rift Valley fever virus (Turell et al. 2013), and chikungunya and dengue viruses (Schaffner et al. 2011). Although the role of this invasive mosquito in vectorborne disease transmission still appears limited, its reported presence in Missouri (Gallitano et al. 2005) and Arkansas (Gaspar et al. 2012) suggested that occurrence in Oklahoma was likely and needed to be investigated.

The *Ae. japonicus* larvae collected in eastern Oklahoma during this study occurred as part of a Zika vector surveillance program funded by the Centers for Disease Control and Prevention through the Oklahoma State Department of Health. For this part of the study, a wide variety of artificial habitats (waste tires, buckets, troughs, various sizes of plastic containers, and a water-filled boat) and some natural pools were sampled in eastern Oklahoma between I-40 in the south and the Kansas border in the north. Known for its proclivity to use rural or wooded sites more than urban sites, a focus was made on artificial containers that could be easily sampled along roads in rural areas of eastern Oklahoma (Fig. 1). The location of each sampling site was recorded by geographical positioning system (Table 1). In the laboratory, collected larvae were placed in mosquito breeders (Bioquip, Rancho Dominguez, CA) that were held in an environmental chamber (25°C, 14:10 h day:night) until all the mosquitoes eclosed. Upon eclosion, female mosquitoes were identified by 3 persons using the criteria of Darsie and Ward (2005).

On June 6, 2017, mosquito larvae, including *Ae. japonicus*, were collected from a horse trough in a rural area near Quapaw in northeastern Ottawa County, OK (Fig 1). The site was 5.5 mi (8.8 km) northeast of Peoria, OK, on State Line Road between Missouri and Oklahoma. All but 1 larvae were reared to adults. For identification purposes, 1 larva was placed in 70% ethanol and identified using the larval key provided by Darsie and Ward (2005). While most resulting female mosquitoes were *Aedes epactius* (Dyar and Knab) ($n = 3$), 1 of the emerged females was identified as an *Ae. japonicus* specimen. At the time of collection, 1 adult female mosquito

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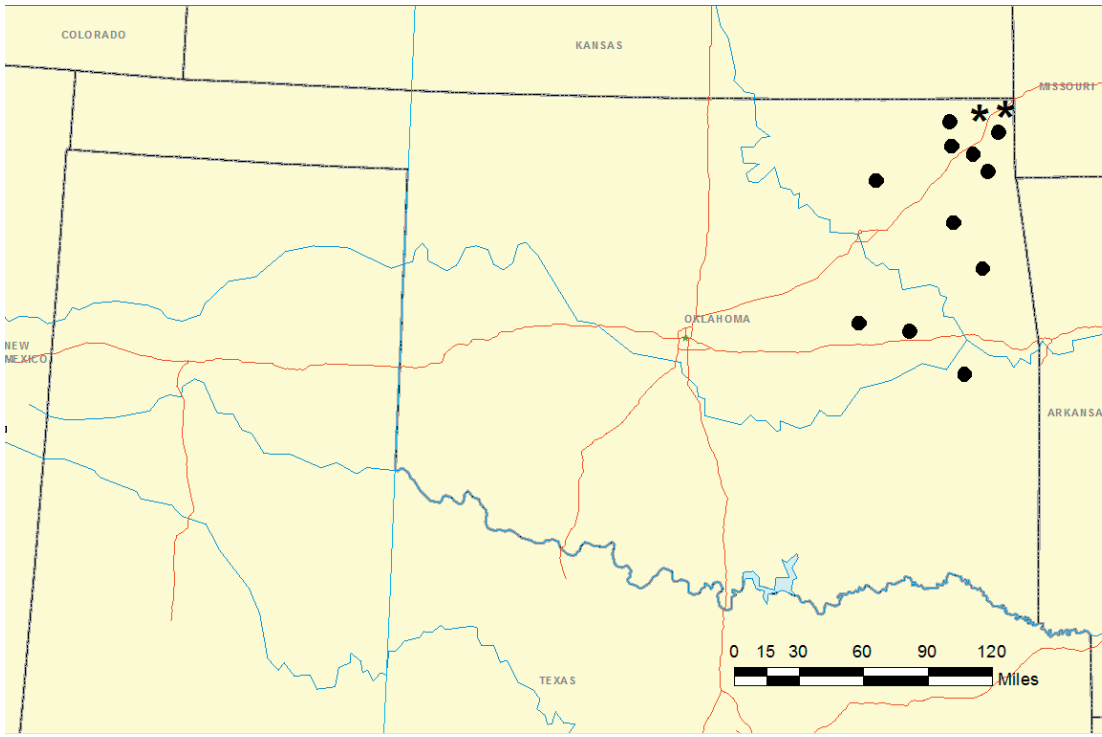

Fig. 1. Cities in Oklahoma close to where mosquitoes were collected between May and June 2017. All cities around which mosquitoes were collected are marked, and cities where *Ae. japonicus* were collected are marked by an asterisk.

was captured on the horse trough water surface and later identified as *Ae. japonicus*.

On June 7, 2017, mosquito larvae, including *Ae. japonicus*, were collected from a horse trough outside of Miami in Ottawa County, OK, 15 mi (24 km) southwest of the first site (Fig. 1). While the majority of the larvae were *Ae. epactius*, 1 adult female *Ae. japonicus* was reared and identified. All other surveillance sites in eastern Oklahoma where larvae were collected from a variety of containers yielded a variety of different mosquito species, including *Culex coronator* Dyar and Knab, but no *Ae. japonicus* specimens (Table 1). Voucher specimens of the larvae as well as 2 of the *Ae. japonicus* adults were placed into the K.C. Emerson Entomology Museum housed in the Department of Entomology and Plant Pathology in the Noble Research Center at Oklahoma State University.

This is the first record of *Ae. japonicus* in the state of Oklahoma. Previous sampling of urban areas using multiple trap types across Oklahoma in summer 2016 detected *Aedes aegypti* (L.), but no *Ae. japonicus* individuals were collected (Bradt 2017). The confirmation of *Ae. japonicus* only in the corner of the northeasternmost county of Oklahoma indicates that this species likely has recently entered the state from Missouri, where the species was first recorded in the St. Louis area (Gallitano et al. 2005). While more investigation is needed to confirm whether the species has become established in northeastern Oklahoma, it is highly likely that this species will continue to spread and become established throughout much of Oklahoma, as it has in other southern states.

In the south-central USA, it appears that *Ae. japonicus* females deposit their eggs in the same habitats that harbor *Ae. epactius* Dyar and Knab habitats. In the current Oklahoma-based study, *Ae. epactius* was identified as the only species cohabitating with *A. japonicus* during early June. *Aedes japonicus* larvae were collected together with *Ae. epactius* in the early summer months during a 2011 survey in northeastern Arkansas (Gaspar et al. 2012). As the season progressed and temperatures increased, *Ae. epactius* became the dominant species. In the current study, *Aedes japonicus* specimens were found in rural areas with adjacent heavy tree cover, which is consistent with findings in Arkansas, as well as the rest of the country (Bartlett-Healy et al. 2012, Gaspar et al. 2012, Kampen and Werner 2014, Kaufman and Fonseca 2014). Future work in this region of Oklahoma should include surveys of rock pools and tree holes in rural areas, as these are other sites where *Ae. japonicus* have been collected in the USA (Andreadis et al. 2001, Gaspar et al. 2012). While unclear how the species will interact with local mosquito fauna and adapt to the unique environmental challenges in Oklahoma, it will be necessary to

Table 1. Number of *Aedes japonicus* specimens collected during May and June 2017 in sites across eastern Oklahoma. All species of mosquitoes collected were identified after rearing larvae to adults.

Location	Latitude and longitude	Date	No. *Ae. japonicus* collected	Other mosquito species collected	Habitat
Checotah, OK	35.471035, −95.529357	May 16	0	*Culex pipiens*	Tires
	35.472388, −95.532077	May 16	0	*Cx. pipiens*	Tires
	35.462950, −95.523815	May 16	0	*Cx. pipiens*	Water-filled boat
Okmulgee, OK	35.631034, −95.984694	May 17	0	*Ae. epactius*, *Cx. pipiens*	Tires and plastic containers
	35.606333, −95.962024	May 17	0	*Ae. epactius*, *Cx. pipiens*	Tires
	35.614858, −95.961010	May 17	0	*Cx. pipiens*	Tires
Locust Grove, OK	36.203774, −95.171690	May 18	0	*Ae. epactius*, *Cx. pipiens*	Tires
	36.196221, −95.165616	May 18	0	*Cx. pipiens*	Tires
Stigler, OK	35.253827, −95.155885	May 21	0	*Cx. coronator*, *Anopheles punctipennis* *An. quadrimaculatus*	Large tires
	35.251825, −95.119244	May 21	0	*Psorophora columbiae*	Residence
	35.254478, −95.124840	May 21	0	*Cx. pipiens*	Large plastic containers
Tahlequah, OK	35.915578, −94.948610	May 25	0	0	Tires
	35.921761, −94.895878	May 25	0	*Cx. coronator*	Tires
Oologah, OK	36.452175, −95.708813	June 2	0	0	Tires
	36.437769, −95.715610	June 2	0	0	Plastic containers
Grove, OK	36.559317, −94.806937	June 4	0	*Cx. nigripalpus*, *Cx. pipiens*	Residence next to water
	36.594459, −94.820902	June 4	0	*An. quadrimaculatus*	Residence next to water
Wyandotte, OK	36.766626, −94.769784	June 4	0	*Cx. pipiens*	Ground pool
Afton, OK	36.700023, −94.943707	June 5	0	*Ps. columbiae*	Ground pool
	36.690991, −94.963704	June 5	0	0	Plastic drum
Quapaw, OK	36.981688, −94.619087	June 6	3	*Ae. epactius*	Horse water trough
Miami, OK	36.845122, −94.905584	June 7	1	*Ae. epactius*	Horse water trough
	36.845593, −94.905566	June 7	0	*Cx. pipiens*, *An. punctipennis*	Horse water trough
Vinita, OK	36.675629, −95.142814	June 22	0	*Ae. epactius*	Horse water trough
Welch, OK	36.830835, −95.136627	June 22	0	*Ae. epactius*	Large tires

continue monitoring the expansion of this species, particularly as we continue to discover the role this invasive species may play in the transmission of diseases that impact humans or animals.

The collection of *Cx. coronator* larvae at 2 sites in eastern Oklahoma indicates that the species has continued to spread in the state since the first report of its presence in 2003 in McAlester, OK (Noden et al. 2015). The collection of *Cx. coronator* in Haskell (Stigler) and Cherokee (Tahlequah) counties brings the reported distribution of the species in Oklahoma up to 11, including Pittsburg, Sequoyah, Payne, Comanche, Oklahoma, Garfield, Jackson, McCurtain, and Carter counties (Paras et al. 2014, Noden et al. 2015, Bradt 2017). Since 2003, this invasive mosquito has been recorded across southern (Altus, Lawton, Ardmore, and Idabel), central (Midwest City), and northern Oklahoma (Enid) (Bradt 2017) and in Stillwater, OK (Paras et al. 2014). An invasive species that originated in Central America (Dyar and Knab 1906), *Cx. coronator* has been recorded in all southern states, starting in New Mexico, Arizona, and Texas (Darsie and Ward 2005), and spreading to Oklahoma (Noden et al. 2015), Louisiana (Debboun et al. 2005), Mississippi (Goddard et al. 2006), Alabama (McNelly et al. 2007), Georgia (Moulis et al. 2008), and Florida (Smith et al. 2006). Like *Ae. japonicus*, the importance of *Cx. coronator* in the transmission of pathogens in the United States remains to be determined, although it has been identified as a potential vector for West Nile virus in Florida (Alto et al. 2014) as well as other arboviruses (Gray et al. 2008).

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