

Scientific Note

A taxonomic checklist of the mosquitoes of Harris County, Texas

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Carpenter and LaCasse (1955) reviewed 143 mosquito species and Darsie and Ward (1981) listed 167 species in North America. Darsie and Ward (2005) included 174 species in North America. However, *Aedes pertinax* Grabham is a newly discovered species for North America (Shroyer et al. 2015), thus increasing the total to 175 and of those, 85 are listed in Texas. A list of mosquitoes of Texas by McGregor and Eads (1943) contained 54 species; 75 by the Division of Medical Entomology Bureau of Laboratories Texas State Health Department (TSHD) (Randolph and O'Neill 1944), and 79 by the Entomology Division, State Department of Health Laboratories in Austin, TX (Wisemann 1965). Additionally, other researchers have published their findings regarding mosquito densities and distribution in Texas (Breland 1956, Hill et al. 1958, Eads et al. 1960, Easton et al. 1968, Nielsen et al. 1968, Sublette and Sublette, 1970, Moore et al. 1990).

The number of mosquito species recorded in Texas increased, including nine new species reported by O'Neill et al. (1944) and the discoveries of other mosquito species reported over the course of time, viz. *Deinocerites spanius* Dyar and Knab (Fisk 1941), *Psorophora mexicana* (Bellardi) (Joyce 1945), *Anopheles albimanus* Wiedemann (Eads 1946), *Aedes dupreei* (Coquillett), *Culex peccator* Dyar and Knab, and *De. epitedeus* Knab (Rueger and Druce 1950), *Cx. erythrothorax* Dyar (Menzies et al. 1955), *Ae. grossbecki* Dyar and Knab (Keith 1979), *Ae. albopictus* (Skuse) (Sprenger and Wuithiranyagool 1986) and *Cx. arizonensis* Bohart (Reeves and Darsie 2003).

Currently, the Texas Department of State Health Services (DSHS) lists 79 species including the subgenus *Cx.* (*Melanoconion*) Theobald and *Ps. varipes* (Coquillett) (Fournier et al. 1989);

whereas, the Texas A&M AgriLife Extension Agricultural and Environmental Safety Department (Texas A&M 2013) lists a total of 85 including the two aforementioned species. The same number was reported by the Texas Mosquito Control Association (TMCA 2001) based on Fournier's original list of species and by Darsie and Ward (2005). However, the TMCA list contains species from Texas not reported in Fournier's list. This type of discrepancy occurs among all lists, as one would expect considering the extent and the year in which each study was conducted combined with the changes in mosquito taxonomy through time. Thus, there appear to be differences among all Texas checklists based on the number of species reported.

Although mosquito species were collected and data compiled for 51 years in Harris County, there has not been a checklist published for the mosquitoes of Harris County and the City of Houston. The goal of this report is to provide for the first time a checklist of the mosquitoes found in Harris County and the City of Houston as reported in the literature and from our collection records.

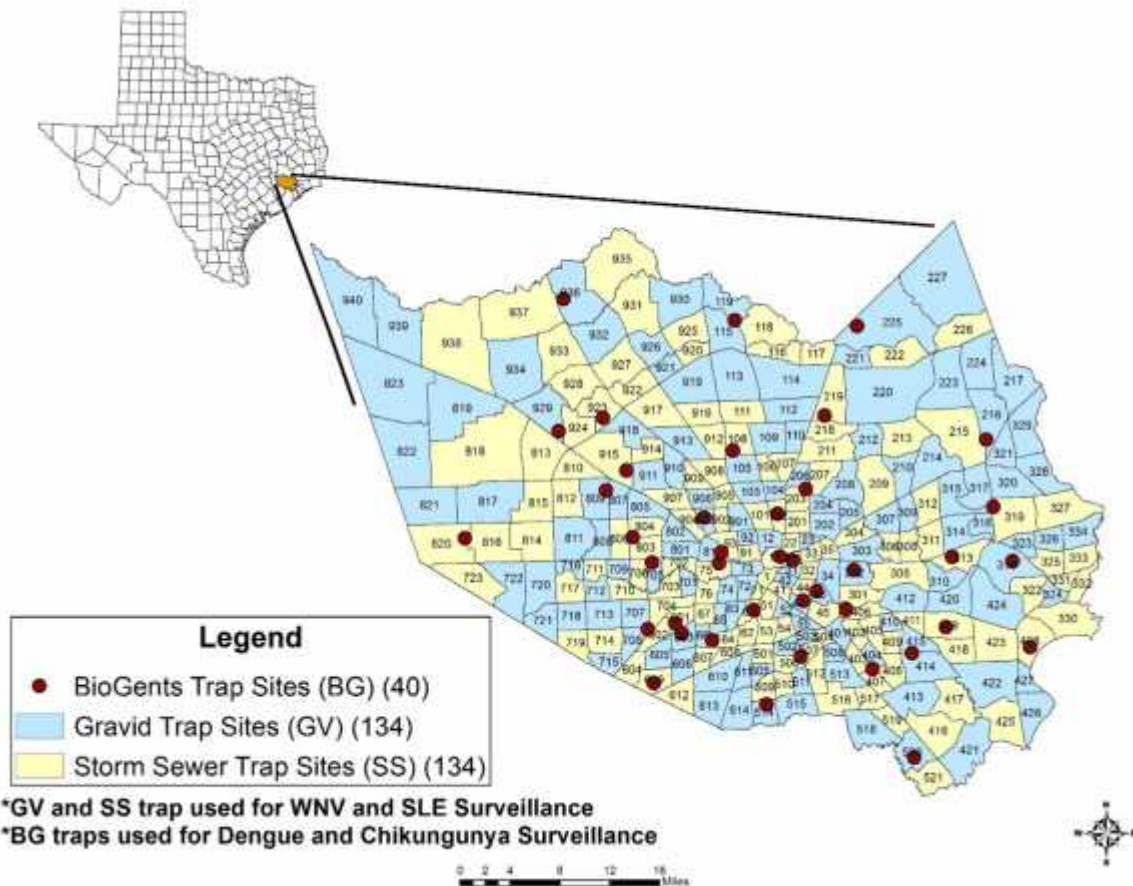
Harris County is in southeastern Texas. It is irregular in shape measuring about 90.6 km north to south, 129.5 km east to west, and covers 4,603.65 km² (Figure 1) with a population of over 4.4 million, making it the most populous county in Texas and the third most populous county in the United States (U.S. Census Bureau, 2014a). Northern and eastern portions are largely forested, southern and western portions are predominantly prairie grassland, and coastal areas are prairie and sand. The City of Houston, seat of Harris County, TX, is located on the upper Gulf coastal plain, the most populous city in Texas, and the fourth most populous city in the United States. Surface water

in the Houston region consists of lakes, rivers, and an extensive system of bayous and manmade canals that are part of the rainwater runoff management system. Abundant rainfall is a result of the proximity to the Gulf, except for rare extended dry periods, (USDA 1976). Yearly average temperature is approximately 21° C with an average high of 26.5° C, an average low of 15.5° C, and 1,264.1 mm total precipitation (NOAA 2015).

Harris County Mosquito Control District (HCMCD), a Division under Harris County Public Health and Environmental Services (HCPHES), was established in 1964 following a St. Louis encephalitis (SLE) epidemic in Houston, TX (Luby et al. 1967, Barnett et al. 1967, Chamberlain, 1980, Bell et al. 1981, Tsai et al. 1988). The HCMCD used an in-house list of 51 species representing ten genera reported to occur in Harris County, TX, in 1983. Since then, and until 2001, the list increased to 55 species under the same ten genera (HCPHES-MCD, unpublished data).

Since its establishment, mosquito surveillance included a variety of collection methods: New Jersey Light Traps (NJLT), Centers for Disease Control and Prevention (CDC) battery operated traps, bait traps, resting stations, larval collections, mechanical aspirators, and landing rate counts. Collected specimens included *Ps. columbiae* (Dyar and Knab), *Cx. salinarius* Coquillett, *Culiseta inornata* (Williston), *An. crucians* Wiedemann, *Ae. sollicitans* (Walker), and *Cx. quinquefasciatus* Say. Thirty-four species were collected out of 50 species reported in Harris County (Barnett et al. 1967).

Since the introduction of West Nile virus (WNV) in Texas in 2002, trapping methodologies changed to the use of modified gravid (GV) traps, CDC light traps (John W. Hock, Gainesville, FL) placed in residential properties, and CDC traps in the storm sewer (SS) system of Harris County and the City of Houston. This accomplished the trapping of the main vector for SLE and WNV, the Southern house mosquito, *Cx. quinquefasciatus* (Chamberlain et al. 1966, Sudia et al. 1967). Harris County is divided into 268 mosquito control operational areas (MCOA), where half are monitored by GV traps and the other half with CDC light traps was new and named *Ps. mathesoni* (Belkin and Heinemann 1975). *Aedes grossbecki* was first recorded in Crosby, TX in 1966 and in Spring, TX, in 1979 in Harris County, TX (Keith 1979). Moreover, collections made in a woodland area within the City of Houston revealed the presence of *Ae. atlanticus*, *Ae. tormentor*, *Ae. infirmatus* Dyar and Knab, *Ae. vexans* (Meigen), and *Ps. ferox* (von Humboldt) (Roberts and Scanlon 1979). In addition, Hunt and Hacker (1984) collected mosquitoes in five genera and 13 species using CDC light traps baited with dry ice in the storm drain system inside the Interstate 610 Loop in Houston, TX, where 99% of the specimens collected were *Cx. quinquefasciatus*, in contrast to the results of Sudia et al. (1967) and Kokernot et al. (1974).



Similarly, some species such as *Ae. aegypti*, *Ae. triseriatus* (Say), *Toxorhynchites rutilus septentrionalis* Dyar and Knab, *Or. signifera* (Coquillett), and *Cx. territans* Walker, among others, were collected during the discovery of *Ae. albopictus* in Harris County, TX in 1985 (Sprenger and Wuithiranyagool 1986). *Aedes epactius* Dyar and Knab, and *Ae. hendersoni* Cockerell were collected in Harris County during routine collections in 1986 (Wuithiranyagool, personal communication). *Aedes hendersoni* had been restored to full specific rank, illustrating the differences between this species and those of *Ae. triseriatus*, thus being resurrected from synonymy (Breland 1960, Darsie 1973).

Harris County Mosquito Control District did not have a reference collection, therefore one was established in 1986 after the discovery of *Ae. albopictus*. Forty-two species are currently deposited within the collection out of the current 56 mosquito species, representing ten genera (Knight and Stone 1977, Knight 1978), reported to occur in Harris County based on our collections and records (Table 1).

The following species were not collected in recent years but were reported to occur in earlier studies in Harris County, including *Ae. dupreei*, *Ae. zoosophus*, *An. barberi* Coquillett, (Kokernot et al. 1974), and *Ps. varipes* (O'Neill et al. 1944). Similarly, *Ae. hendersoni*, *An. bradleyi* King, *Cx. abominator* Dyar and Knab, *Cx. thriambus*

Dyar, *Ps. mathesoni*, and *Uranotaenia anhydor syntheta* Dyar and Shannon, described by Belkin and McDonald (1956), have not been collected recently. However, most of these species were collected nearby in the northern and southern bordering counties of Montgomery and Galveston (Fournier et al. 1989), McLennan County (Duhrkopf 1994), and in San Antonio, TX (McPhatter et al. 2012).

Possible factors for this outcome are related to: 1) discontinuing the use of some of the old trapping methodologies while adopting new developments in trapping designs, targeting species derived from different types of habitats, age structure, and physiology, thus not collecting all species as in previous years; 2) record keeping performed manually during the first ten years of operations making retrieval, sorting, and analysis of data difficult due to illegible records and archiving methods; and 3) the numb limiting the information available to confirm occurrence of these species in Harris County.

Harris County Public Health and Environmental Services Mosquito Control Division will continue to monitor the entire county with previously mentioned collecting devices, and expand its reference collection to include all recorded mosquito species in Harris County and the City of Houston. Moreover, it shall re-incorporate the use of old trapping methodologies as well as the implementation of new collecting strategies to increase the likelihood of collecting rare and new record specimens for Harris County, particularly those medically important species such as *Aedes japonicus japonicus* (Theobald), as its distribution continues to move south (Bevins 2007, Harris et al. 2015) after its introduction into the U.S. (Peyton et al. 1999). It will also continue testing all new and re-emerging vector-borne pathogens that threaten the community in the future.

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- I) Genus **AEDES** Meigen
Subgenus *Aedimorphus* Theobald
 1) *vexans* (Meigen)
 Subgenus *Georgecraigius* Reinert, Harbach & Kitching
 2) *epactius* Dyar & Knab
 Subgenus *Ochlerotatus* Lynch Arribalzaga
 3) *atlanticus* Dyar & Knab
 4) *canadensis* (Theobald)
 5) *dupreei* (Coquillett)
 6) *fulvus pallens* Ross
 7) *grossbecki* Dyar & Knab
 8) *infirmatus* Dyar & Knab
 9) *mitchellae* (Dyar)
 10) *nigromaculis* (Ludlow)
 11) *sollicitans* (Walker)
 12) *sticticus* (Meigen)
 13) *taeniorhynchus* (Wiedemann)
 14) *tormentor* Dyar & Knab
 15) *trivittatus* (Coquillett)
 Subgenus *Protomacleaya* Theobald
 16) *hendersoni* Cockerell
 17) *triseriatus* (Say)
 18) *zoosophus* Dyar & Knab
 Subgenus *Stegomyia* Theobald
 19) *aegypti* (Linnaeus)
 20) *albopictus* (Skuse)
- II) Genus **ANOPHELES** Meigen
 Subgenus *Anopheles* Meigen
 21) *atropos* Dyar & Knab
 22) *barberi* Coquillett
 23) *bradleyi* King
 24) *crucians* Wiedemann
 25) *pseudopunctipennis* Theobald
 26) *punctipennis* (Say)
 27) *quadrimaculatus* Say
- III) Genus **COQUILLETIDIA** Dyar
 Subgenus *Coquillettidia* Dyar
 28) *perturbans* (Walker)

- IV) Genus **CULEX** Linnaeus
Subgenus *Culex* Linnaeus
29) *coronator* Dyar & Knab
30) *nigripalpus* Theobald
31) *quinquefasciatus* Say
32) *restuans* Theobald
33) *salinarius* Coquillett
34) *tarsalis* Coquillett
35) *thriambus* Dyar
Subgenus *Melanoconion* Theobald
36) *abominator* Dyar & Knab
37) *erraticus* (Dyar & Knab)
Subgenus *Neoculex* Dyar
38) *territans* Walker
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- V) Genus **CULISETA** Felt
Subgenus *Culiseta* Felt
39) *inornata* (Williston)
- VI) Genus **MANSONIA** Blanchard
Subgenus *Mansonia* Blanchard
40) *titillans* (Walker)
- VII) Genus **ORTHOPODOMYIA** Theobald
41) *alba* Baker
42) *signifera* (Coquillett)
- VIII) Genus **PSOROPHORA** Robineau-Desvoidy
Subgenus *Grabhamia* Theobald
43) *columbiae* (Dyar & Knab)
44) *discolor* (Coquillett)
45) *signipennis* (Coquillett)
Subgenus *Janthinosoma* Lynch Arribalzaga
46) *cyanescens* (Coquillett)
47) *ferox* (von Humboldt)
48) *horrida* (Dyar & Knab)
49) *longipalpus* Randolph & O'Neill
50) *mathesoni* Belkin & Heinemann
Subgenus *Psorophora* Robineau-Desvoidy
51) *ciliata* (Fabricius) 52) *howardii* Coquillett
- IX) Genus **TOXORHYNCHITES** Theobald
Subgenus *Lynchiella* Lahille
53) *rutilus septentrionalis* (Dyar & Knab)
- X) Genus **URANOTAENIA** Lynch Arribalzaga
Subgenus *Pseudoficalbia* Theobald
54) *anhydor syntheta* Dyar & Shannon
Subgenus *Uranotaenia* Lynch Arribalzaga
55) *lowii* Theobald
56) *sapphirina* (Osten Sacken)
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