

## **West Virginia Mosquitoes: Sequential List by Publication, Newly Found Species, Corrections, and Notes for Earlier Records**

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Source: Journal of the American Mosquito Control Association, 32(3) : 240-243

Published By: American Mosquito Control Association

URL: <https://doi.org/10.2987/16-6575.1>

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## SCIENTIFIC NOTE

### WEST VIRGINIA MOSQUITOES: SEQUENTIAL LIST BY PUBLICATION, NEWLY FOUND SPECIES, CORRECTIONS, AND NOTES FOR EARLIER RECORDS

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**ABSTRACT.** A chronological list of species based on date of publication is provided for confirmed mosquito species in West Virginia. Five additional newly found species in the state are documented with collection data. Two previously misidentified or mislabeled published records are corrected. The number of confirmed species occurring in the state is now 35, and many more species are likely present, but undetected. Significant populations of 4 widely distributed known vector species, *Aedes albopictus*, *Ae. japonicus japonicus*, *Ae. triseriatus*, and *Culex pipiens*, in West Virginia signal an urgent need for additional studies, surveillance, and increased mosquito control efforts to help prevent future native and invasive arbovirus infections and outbreaks in local residents.

**KEY WORDS** Mosquitoes, new records, updated list, West Virginia

Mosquitoes have a lengthy documented history in West Virginia. Howard et al. (1915, 1917) examined specimens in the National Museum of Natural History, Smithsonian Institution, that date back to 1898. They identified 5 species from the state and provided the following information: *Anopheles punctipennis* (Say), Huntington, November 11, 1902, A. D. Hopkins; *Culex restuans* Theobald, Kanawha Station, August 16, 1903, A. D. Hopkins; *Psorophora ciliata* (Fabricius), Kanawha Station, July 20, 1907, A. D. Hopkins; *Ps. columbiae* (Dyar and Knab), Kanawha Station, July 20, 1907, A. D. Hopkins; and *Toxorhynchites rutilus septentrionalis* (Dyar and Knab), Morgantown, June 10, 1898, A. D. Hopkins. Dyar (1922) repeated those records except that he mistakenly synonymized *Cx. restuans* under *Cx. territans* Walker. Thus, the *Cx. restuans* record of Howard et al. (1915) was reported, in error, as *Cx. territans*, by Dyar (1922). The first correct record for *Cx. territans* in West Virginia was reported later; see below. Dyar (1922) also reported *Aedes vexans* (Meigen) in West Virginia, and Dyar (1928) added a record of *Ae. trivittatus* (Coquillett) in West Virginia. Carpenter (1950) added *Ae. atropalpus* (Coquillett). Only these 8 species were listed from West Virginia in the book *Mosquitoes of North America (North of Mexico)* (Carpenter and LaCasse 1955).

The remaining species currently recognized in the state were found and documented during the 1970s to early 2000s and listed here, as well as above, in chronological order by the date of publication: *Ae. hendersoni* Cockerell, by Zavortink (1972); *Ae. canadensis canadensis* (Theobald), *Ae. sticticus*

(Meigen), *Ae. triseriatus* (Say), *An. barberi* Coquillett, *An. quadrimaculatus* s.l., *Coquillettia perturbans* Dyar, *Cx. erraticus* (Dyar and Knab), *Cx. pipiens* Linnaeus, *Cx. salinarius* Coquillett, *Cx. territans*, *Culiseta inornata* (Williston), *Orthopodomyia signifera* (Coquillett), *Ps. ferox* (von Humboldt), and *Uranotaenia sapphirina* (Osten Sacken), by Amrine and Butler (1978); *Ae. cinereus* Meigen and *Ae. sollicitans* (Walker), by Butler and Amrine (1980); *Or. alba* Baker by Heaps (1980); *Ae. abserratus* (Felt and Young) by Joy et al. (1994); *Ae. albopictus* (Skuse) by Moore (1999); *An. crucians* by Nasci et al. (2000); and *Ae. japonicus japonicus* Theobald, by Joy (2004, crediting J. W.; Amrine, personal communication). Currently the number of species known from West Virginia has increased to 30 since Joy et al. (1994) listed 26. Darsie and Ward (2005) also listed 26 species, but 2 of their species were errors (see later).

New species records for West Virginia since Joy (2004) are listed below.

*Aedes dorsalis* (Meigen): Hancock Co., Chester, Conkle Farm, 533 Conkle Farms, 40°37'27.8"N, 80°31'34.3"W, 3-4-VIII-2015, dry ice light trap, 14 females, Chelsea Everly. Hancock Co., Chester, Allison Elementary, 605 Railroad Street, 40°36'59.0"N, 80°33'40.0"W, 27-28-IX-2015, dry ice-baited Centers for Disease Control and Prevention (CDC) light trap, 105 females, Chelsea Everly. Hancock Co. Chester, Chester City Park, 375 Carolina Avenue, 40°36'45.7"N, 80°33'49.0"W, dry ice-baited CDC light trap, 9 females, Chelsea Everly.

*Aedes tormentor* Dyar and Knab: Fayette Co., Oak Hill, Minden Road, Oak Hill Sewage Treatment Facility, 37°58'45.8"N, 81°08'03.8"W, 11-12-VIII-2014, mosquito gravid trap, 1 female, Eric Dotseth, confirmed using Harrison et al. (2016).

*Anopheles walkeri* Theobald: Wood Co., Parkersburg, Parkersburg Wastewater Treatment Facility, 39°16'58.4"N, 81°33'26.6"W, 13-14-VIII-2012, dry

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ice-baited CDC light trap, 1 female, Eric Dotseth. Nicholas Co., Muddlety, Enoch Branch, 38°22'47.8"N, 80°50'16.1"W, dry ice-baited CDC light trap, 20-21-VII-2015, 1 female; 27-28-VII-2015, 1 female, Eric Dotseth.

*Psorophora horrida* (Dyar and Knab): Cabell Co. Huntington, Madison Avenue Fill, 38°24'10.1"N, 82°29'03.8"W, 18-19-VI-2014, dry ice-baited CDC light trap, 1 female, Stan Mills.

*Psorophora howardii* Coquillett: Cabell Co., Huntington, 1614 10th Avenue, 38.4154°N, 81.4288°W, 24-25-VII-2013, dry ice-baited CDC light trap, 1 female, Dustin Mills. Cabell Co., Culloden, 3002 Brierwood Drive, 38°25'05.5"N, 82°06'01.4"W, 10-IX-2013, capture off human host, 1 female, Dustin Mills. Cabell Co., 9 ½ Alley, 38°24'55.8"N, 82°25'45.1"W, 15-16-VII-2015, dry ice-baited CDC light trap, 1 female, Jessica Barton. Wood Co., Parkersburg, Parkersburg Wastewater Treatment Facility, 39°16'58.4"N, 81°33'26.6"W, 1-2-VII-2015, dry ice-baited CDC light trap, 5 females, Eric Dotseth.

With these new records there are now 35 confirmed species found in West Virginia. The current list of mosquitoes presented here for West Virginia is small, but includes more than half the 56 to 67 species found in the surrounding states of Kentucky, Maryland, Ohio, Pennsylvania, and Virginia. Yet, there appear to be no major environmental or geographical reasons that would preclude some of the species in those adjacent states from occurring in West Virginia, except for environmental effects of latitude in northern Ohio and Pennsylvania.

Amrine and Butler (1978) listed *Cx. quinquefasciatus* Say (as *Cx. p. quinquefasciatus*) occurring in West Virginia. The northernmost distribution for this species in the eastern USA barely reaches North Carolina in its most southeastern county (Harrison et al. 2016). Thus, we feel certain that their specimen(s) were actually *Cx. pipiens* or a hybrid of *Cx. pipiens* × *Cx. quinquefasciatus*. Amrine and Butler (1978) listed Fletcher (1957, currently unavailable at source, see references cited) as the collector and identifier for this identification, and said they never found *Cx. quinquefasciatus* in southern West Virginia. Based on this we are inclined to consider them *Cx. pipiens*. Unfortunately, Darsie and Ward (2005), following Amrine and Butler (1978), listed *Cx. quinquefasciatus* in West Virginia and this should be corrected to *Cx. pipiens*. Darsie and Ward (2005) also listed *An. maverlii* Reinert from West Virginia, but we consider this a typing error (= lapsus calami). The projected distribution of this species (Levine et al. 2004), indicates it probably would not occur in West Virginia, and currently it has not been found in Maryland, Pennsylvania, or Virginia (Harrison et al. 2016).

Heaps (1980) reported that *Or. alba* was collected in Monongalia Co., in the West Virginia University Forest, Coopers Rock State Park, from a red maple tree hole, 14-XII-1978, 2 larvae reared to 1 female

and 1 male. This new record for the state was not mentioned in Darsie and Ward (1981) or in the list of Joy et al. (1994). Heaps (1980) also mentioned that *Ae. hendersoni* diapausing eggs were collected in April 1979 from the same tree hole and reared to adults.

*Aedes abserratus*, reported by Joy et al. (1994), was collected in Logan Co. in southwestern West Virginia, and a long way from other collections of this species in Pennsylvania and Maryland. In Pennsylvania this species is only found in the northern half of the state, and the two collections in Maryland (Bickley et al. 1971) occurred in 1971 in Cranberry Swamp, near Finzel, in Garrett Co., which is immediately adjacent to northeastern West Virginia. Carpenter and LaCasse (1955) reported this univoltine species appears early in the spring in April and May in cold pools, and Darsie and Hutchinson (2009) reported it is associated with acidic bogs. The two known and widely separated southern locations of this species in Maryland and West Virginia, are probably due to infrequent surveillance that has failed to document a wider, but spotty, discontinuous distribution.

*Anopheles crucians* and *An. quadrimaculatus* now represent sibling species complexes. The 5 species in the *An. quadrimaculatus* complex have been described and keys are available (Reinert et al. 1997, Darsie and Ward 2005, Harrison et al. 2016), but even slightly rubbed females are difficult to identify. The *An. crucians* complex contains at least 6 rDNA identified cryptic species (Wilkerson et al. 2004), with most currently unidentifiable by morphology. Specimens of both complexes should be reported as *An. crucians* complex or *An. quadrimaculatus* complex, or *sensu lato* (s.l.), until the correct identities of the involved species are resolved by morphology or confirmed by molecular analysis.

Nasci et al. (2000) is the first published report for *An. crucians* s.l. in the state based on collections in Nicholas County. Records for specimens of *An. crucians* s.l. collected in several counties more recently are below.

*Anopheles crucians* complex: Cabell Co., Barboursville, Barboursville Park, 38°23'49.6"N, 82°17'53.0"W, 24-25-VI-2013, dry ice-baited CDC light trap, 1 female. Nicholas Co., Muddlety Enoch Branch, 38°22'47.8"N, 80°50'16.1"W, dry ice-baited CDC light trap, 6-7-IX-2012, 1 female; 1-2-VII-2013, 1 female; 24-25-VIII-2015, 1 female. Wood Co., Parkersburg, Parkersburg Wastewater Treatment Facility, 39°16'58.4"N, 81°33'26.6"W, dry ice-baited CDC light trap, 27-28-VIII-2012, 5 females; 4-5-IX-2012, 1 female; 22-23-VII-2013, 2 females; 29-30-VII-2013, 2 females; 5-6-VIII-2013, 1 female; 12-13-VIII-2013, 2 females; 3-4-IX-2013, 19 females; mosquito gravid trap, 3-4-IX-2013, 1 female.

Below we provide an updated alphabetical list of the mosquito species confirmed from West Virginia. We are including the currently recognized names for

genera and subgenera, as well as the species, and the authors of the species. To enhance the information in the list we have included after the authors' names the original publication date for the record in West Virginia. Also, we would like to point out that parentheses around an author's name means that species is no longer in the genus in which it was originally described. Thus, absence of parentheses means the species is currently in the genus in which it was originally described. Wilkerson et al. (2015) provided the abbreviations for the genera and subgenera, and Wilkerson and Linton (2015) elevated *Protomacleaya* to subgeneric level. The brackets appearing in the dates for *Ae. albopictus* indicate that although the article was in a 1894 issue of the journal, publication of that issue did not occur until 1895.

*Aedes (Ochlerotatus) abserratus* (Felt and Young, 1904)  
*Ae. (Stegomyia) albopictus* (Skuse, 1894 [1895])  
*Ae. (Georgecragius) atropalpus* (Coquillett 1902)  
*Ae. (Och.) C. canadensis* (Theobald, 1901)  
*Ae. (Aedes) cinereus* Meigen, 1818  
*Ae. (Och.) dorsalis* (Meigen, 1830)  
*Ae. (Protomacleaya) hendersoni* (Cockerell, 1918)  
*Ae. (Hulecoeteomyia) j. japonicus* (Theobald, 1901)  
*Ae. (Och.) sollicitans* (Walker, 1856)  
*Ae. (Och.) sticticus* (Meigen, 1838)  
*Ae. (Och.) tormentor* Dyar and Knab, 1906  
*Ae. (Pro.) triseriatus* (Say, 1823)  
*Ae. (Och.) trivittatus* (Coquillett, 1902)  
*Ae. (Aedimorphus) vexans* (Meigen, 1830)  
*Anopheles (Anopheles) barberi* Coquillett, 1903  
*An. (Ano.) crucians* s.l.  
*An. (Ano.) punctipennis* (Say, 1823)  
*An. (Ano.) quadrimaculatus* s.l.  
*An. (Ano.) walkerii* Theobald, 1901  
*Coquillettidia (Coquillettidia) perturbans* (Walker, 1856)  
*Culex (Melanoconion) erraticus* (Dyar and Knab, 1906)  
*Cx. (Culex) pipiens* Linnaeus, 1758  
*Cx. (Cux.) restuans* Theobald, 1901  
*Cx. (Cux.) salinarius* Coquillett, 1904  
*Cx. (Neoculex) territans* Walker, 1856  
*Culiseta (Culiseta) inornata* (Williston, 1893)  
*Orthopodomyia alba* Baker, 1936  
*Or. signifera* (Coquillett, 1896)  
*Psorophora (Psorophora) ciliata* (Fabricius, 1794)  
*Ps. (Grabhamia) columbiae* (Dyar and Knab, 1906)  
*Ps. (Janthinosoma) ferox* (von Humboldt, 1819)  
*Ps. (Jan.) horrida* (Dyar and Knab, 1908)  
*Ps. (Pso.) howardii* (Coquillett, 1901)  
*Toxorhynchites (Lynchiella) rutilus septentrionalis* (Dyar and Knab, 1906)  
*Uranotaenia (Uranotaenia) sapphirina* (Osten Sacken, 1868)

In the 1990s a dramatic increase in human cases of La Crosse virus in West Virginia (McJunkin et al. (2001), plus the arrival of West Nile virus and human cases in the 2000s, prompted increased vector surveillance in certain areas of the state. However, local mosquito surveillance and control programs were slow in developing and maintaining a local presence, and currently less than 5 counties have mosquito control components, primarily targeting the elimination of container larval habitats. This is unfortunate, as the introduction of *Ae. albopictus* in 1998 (Moore 1999) and *Ae. j. japonicus* in 2002 into West Virginia (Joy 2004), and the continued occurrence of *Cx. pipiens* and West Nile virus cases, has enhanced the likelihood of humans acquiring mosquito-borne viruses. Recent occurrences of autochthonous human dengue and chikungunya virus cases in the USA, and the most recent threat of Zika virus, are clearly making a strong case for an urgent need for more intense surveillance and interdisciplinary research (Moore 2008) on the mosquitoes of West Virginia.

We thank Stan Mills and the Cabell-Huntington Health Department for their many years in assisting with mosquito surveillance. Mosquito surveillance in part was supported by a CDC Epidemiology and Laboratory Capacity for Infectious Diseases grant.

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