

SCIENTIFIC NOTE

A CHECKLIST OF THE MOSQUITOES OF NEW JERSEY WITH NOTES ON ESTABLISHED INVASIVE SPECIES

ARY FARAJOLLAHI^{1,2} AND SCOTT C. CRANS¹

¹ Center for Vector Biology, Rutgers University, New Brunswick, NJ 08901

² Mercer County Mosquito Control, West Trenton, NJ 08628

ABSTRACT. A checklist of 63 species of mosquitoes endemic in New Jersey is presented. Although *Aedes albopictus* was included in the previous checklist, the species has dramatically increased its geographic range and population numbers in recent years, and it is now prevalent in 19 of New Jersey's 21 counties. The invasive *Aedes japonicus japonicus* is also now widespread throughout the state and is an addition to the previous checklist. *Culex erraticus*, an endemic species with a previous distribution primarily in the southern portion of the state, has also expanded its range significantly in New Jersey in recent years and is now detected state-wide. Mosquito control personnel periodically discover localized populations of *Ae. aegypti*, but the species fails to overwinter successfully in New Jersey and is not included on the checklist.

KEY WORDS New Jersey, mosquitoes, checklist, distribution, invasive

The first report on the mosquitoes of New Jersey was published by J. B. Smith (1904), a Rutgers University entomologist and the founder of modern mosquito control. Smith had launched a nationwide mosquito control movement in the early part of the 20th century in New Jersey and had set the stage for other pioneers to follow suit in California, Florida, and Louisiana (Patterson 2009). When Smith started his initial investigations, no previous checklists or keys were in existence for New Jersey, and his initial task concentrated on simple detection and identification of the most widespread and troublesome pests present in the state. Smith's 1904 report included 36 species of mosquitoes; however, this checklist was revised to 35 the following year (Smith 1904).

Over the next 4 decades additional researchers both revised and added to Smith's previous work. The bulletin of Headlee (1921) lists 39 species occurring within New Jersey; Schmitt (1942) presents a checklist with 40 species; and though much had indeed changed with regard to species names by the mid 1940s, Headlee's next list included 41 different species endemic in New Jersey (Headlee 1945). Further reports continued to expand the list of mosquito species occurring within the state. A published report by Lake (1953) increased the state's mosquito fauna to 45. And 5 years later, Burbutis (1958) updated the New Jersey checklist with an accompanying identification key specific for the state that addressed synonymous species and brought the total number of mosquitoes found in New Jersey to 48. One year later, Burbutis and Lake (1959) expanded the state species list to 49. Periodic updates continued for the next four decades

(Crans 1967, Crans 1970, Lesser et al. 1975, Crans et al. 1979, McNelly and Crans 1983, Ehrenberg 1983, McNelly 1984, Crans et al. 1996) and further expanded the New Jersey species accounts. The latest published checklist of the mosquitoes of New Jersey (Crans and McCuiston 1999) includes 62 species from 10 different genera.

Since that time, 1 new species, the invasive Asian bush mosquito, *Aedes japonicus japonicus* (Theobald), has been detected in New Jersey (Peyton et al. 1999, Scott et al. 2001, Williges et al. 2008, Molaei et al. 2009). This species has since dramatically expanded its geographic range, beyond its initial discovery in Ocean County, and exhibits firmly established populations throughout the state (Musa 2008).

The Asian tiger mosquito, *Ae. albopictus* (Skuse), another introduced invasive species, has also continued to expand its population numbers and geographic range and is reported as widely established in 19 of New Jersey's 21 counties (Farajollahi and Nelder 2009). The only geographic exclusion of this species has been in the 2 northwestern counties in New Jersey (Sussex and Warren), where daily mean January temperature isotherms are lower, elevation much higher, and human population densities reduced. *Aedes albopictus* has also dramatically increased its nuisance and public health importance within the state and has been ranked as 1 of the top 3 species of concern in New Jersey (Musa 2008).

The yellow fever mosquito, *Ae. aegypti* (Linnaeus), has still not been able to overwinter successfully in New Jersey and, following Crans and McCuiston (1999), is not included on our list of endemic species. We recommend prudence to other northern states in the USA that have

included this species as part of their mosquito fauna. Addition of a species should be based on successful overwintering and established populations that are detected within many seasons.

Another species worthy of mention is *Culex erraticus* (Dyar and Knab), which was first detected in New Jersey during the 1969 vector surveillance season (Crans 1970). The species was infrequently detected in low population numbers primarily in the southernmost portion of New Jersey following its initial discovery. However, in recent years, the species has been behaving much like an invasive or reemerging species and has now expanded its population densities and geographic range within all 21 of New Jersey's counties (CVB 2011).

The present updated checklist increases the number of species known to occur in New Jersey to 63 species. We report the addition of *Ae. j. japonicus*, and the notable expansion of *Ae. albopictus* and *Cx. erraticus*. All 3 species may serve as potential vectors of disease, underscoring the public health significance of these mosquitoes. It remains to be seen whether trends of documented population changes with increases in range and relative abundance will become common across New Jersey and other regions in the northeastern USA where climatic and environmental conditions are suitable for colonization.

CHECKLIST OF NEW JERSEY MOSQUITOES¹

Genus *Aedes* Meigen

Subgenus *Aedes* Meigen

1. *Aedes cinereus* Meigen

Subgenus *Aedimorphus* Theobald

2. *Aedes vexans* (Meigen)

Subgenus *Finlaya* Theobald

3. *Aedes japonicus japonicus* (Theobald)

Subgenus *Ochlerotatus* Lynch Arribalzaga

4. *Aedes abserratus* (Felt and Young)
5. *Aedes atlanticus* (Dyar and Knab)
6. *Aedes atropalpus* (Coquillett)
7. *Aedes aurifer* (Coquillett)
8. *Aedes canadensis canadensis* (Theobald)
9. *Aedes cantator* (Coquillett)
10. *Aedes communis* (DeGeer)
11. *Aedes dorsalis* (Meigen)
12. *Aedes dupreei* (Coquillett)
13. *Aedes excrucians* (Walker)
14. *Aedes fitchii* (Felt and Young)
15. *Aedes flavescens* (Müller)
16. *Aedes grossbecki* Dyar and Knab
17. *Aedes implicatus* Vockeroth
18. *Aedes infirmatus* Dyar and Knab
19. *Aedes intrudens* Dyar

20. *Aedes mitchellae* (Dyar)
21. *Aedes punctor* (Kirby)
22. *Aedes sollicitans* (Walker)
23. *Aedes spencerii spencerii* (Theobald)
24. *Aedes sticticus* (Meigen)
25. *Aedes stimulans* (Walker)
26. *Aedes taeniorhynchus* (Wiedemann)
27. *Aedes thibaulti* Dyar and Knab
28. *Aedes trivittatus* (Coquillett)

Subgenus *Protomacleaya* Theobald

29. *Aedes hendersoni* Cockerell
30. *Aedes triseriatus* (Say)

Subgenus *Rusticoides* Shevchenko and Prudkina

31. *Aedes provocans* (Walker)

Subgenus *Stegomyia*² Theobald

32. *Aedes albopictus* (Skuse)

Genus *Anopheles* Meigen

Subgenus *Anopheles* Meigen

33. *Anopheles atropos* Dyar and Knab
34. *Anopheles barberi* Coquillett
35. *Anopheles bradleyi* King
36. *Anopheles crucians* Wiedemann
37. *Anopheles earlei* Vargas
38. *Anopheles punctipennis* (Say)
39. *Anopheles quadrimaculatus* Say
40. *Anopheles walkeri* Theobald

Genus *Culex* Linnaeus

Subgenus *Culex* Linnaeus

41. *Culex pipiens pipiens*³ Linnaeus
42. *Culex restuans* Theobald
43. *Culex salinarius* Coquillett
44. *Culex tarsalis* Coquillett

Subgenus *Melanoconion* Theobald

45. *Culex erraticus* (Dyar and Knab)

Subgenus *Neoculex* Dyar

46. *Culex territans* Walker

Genus *Culiseta* Felt

Subgenus *Climacura* Howard, Dyar and Knab

47. *Culiseta melanura* (Coquillett)

Subgenus *Culicella* Felt

48. *Culiseta morsitans* (Theobald)
49. *Culiseta minnesotae* Barr

Subgenus *Culiseta* Felt

50. *Culiseta inornata* (Williston)

Genus *Coquillettidia* Dyar

Subgenus *Coquillettidia* Dyar

51. *Coquillettidia perturbans* (Walker)

Genus *Orthopodomyia* Theobald

52. *Orthopodomyia alba* Baker
53. *Orthopodomyia signifera* (Coquillett)

Genus *Psorophora* Robineau-Desvoidy

Subgenus *Grabhamia* Theobald

¹ A complete mosquito species distribution list by county is provided at <http://www.rci.rutgers.edu/~insects/agencies.htm>.

² Accidental importations of *Aedes aegypti* may be occasionally detected in New Jersey; however, the species cannot successfully overwinter in this state and is not included on the checklist.

³ *Culex pipiens pipiens* includes 2 forms, "pipiens" and "molestus" (Farajollahi et al. 2011).

54. *Psorophora columbiae* (Dyar and Knab)
 55. *Psorophora discolor* (Coquillett)
Subgenus *Janthinosoma* Lynch Arribalzaga
 56. *Psorophora cyanescens* (Coquillett)
 57. *Psorophora ferox* (von Humboldt)
 58. *Psorophora mathesoni* Belkin and Heinemann
Subgenus *Psorophora* Robineau-Desvoidy
 59. *Psorophora ciliata* (Fabricius)
 60. *Psorophora howardii* Coquillett
Genus *Toxorhynchites* Theobald
Subgenus *Lynchiella* Lahille
 61. *Toxorhynchites rutilus septentrionalis* (Dyar and Knab)
Genus *Uranotaenia* Lynch-Arribalzaga
Subgenus *Uranotaenia* Lynch-Arribalzaga
 62. *Uranotaenia sapphirina* (Osten Sacken)
Genus *Wyeomyia* Theobald
Subgenus *Wyeomyia* Theobald
 63. *Wyeomyia smithii* (Coquillett)

The authors greatly appreciate the cooperative efforts between all 21 New Jersey County Mosquito Control Programs, Center for Vector Biology at Rutgers University, and the State Mosquito Control Commission. We are especially indebted to the various entomologists and identification specialists who have processed copious mosquito specimens and continue to advance our understandings of mosquito biology and ecology.

REFERENCES CITED

- Burbutis PP. 1958. A new key to the mosquitoes of New Jersey. *Proc NJ Mosq Exterm Assoc* 45:209–212.
 Burbutis PP, Lake RW. 1959. New mosquito records for New Jersey. *Mosq News* 19:99–100.
 Crans WJ. 1967. *Anopheles earlei* Vargas an addition to the checklist of New Jersey mosquitoes. *Mosq News* 27:430.
 Crans WJ. 1970. The occurrence of *Aedes flavescens* (Muller), *Psorophora cyanescens* (Coquillett), and *Culex erraticus* (Dyar and Knab) in New Jersey. *Mosq News* 30:655.
 Crans WJ, Chomsky MS, Guthrie D, Acqaviva A. 1996. First record of *Aedes albopictus* from New Jersey. *J Am Mosq Control Assoc* 12:307–309.
 Crans WJ, Lesser F, Candeletti T. 1979. Recent distribution records of *Culex tarsalis* in New Jersey. *Mosq News* 39:244–247.
 Crans WJ, McCuiston LJ. 1999. An updated checklist of the mosquitoes of New Jersey. *J Am Mosq Control Assoc* 15:115–116.
 CVB [Center for Vector Biology]. 2011. *The surveillance of vector-borne arboviruses and the surveillance of adult mosquito populations* [Internet]. New Brunswick, NJ: Rutgers Univ. NJ Agricultural Experiment Station [accessed December 28, 2011]. Available from: <http://vectorbio.rutgers.edu/surveillance.php>.
 Ehrenburg HA. 1983. *Aedes spencerii spencerii* in New Jersey. *Proc NJ Mosq Exterm Assoc* 70:96–97.
 Farajollahi A, Fonseca DM, Kramer LD, Kilpatrick AM. 2011. “Bird biting” mosquitoes and human disease: A review of the role of *Culex pipiens* complex mosquitoes in epidemiology. *Infection Genetics Evol* 11:1577–1585.
 Farajollahi A, Nelder MP. 2009. Changes in *Aedes albopictus* (Diptera: Culicidae) populations in New Jersey and implications for arbovirus transmission. *J Med Entomol* 46:1220–1224.
 Headlee TJ. 1921. The mosquitoes of New Jersey and their control. *NJ Agric Exp Sta Bull* 348:1–229.
 Headlee TJ. 1945. *The mosquitoes of New Jersey and their control*. New Brunswick, NJ: Rutgers Univ. Press.
 Lake EW. 1953. New mosquito distribution records for New Jersey. *Proc NJ Mosq Control Assoc* 40:152–155.
 Lesser F, Candeletti T, Crans WJ. 1975. *Culex tarsalis* in New Jersey. *Mosq News* 37:290.
 McNelly J. 1984. *Aedes thibaulti* in New Jersey. *Mosq News* 44:247–248.
 McNelly J, Crans WJ. 1983. *Psorophora Howardii* an addition to the checklist of New Jersey mosquitoes. *Mosq News* 43:237–238.
 Molaei G, Farajollahi A, Scott JJ, Gaugler R, Andreadis TG. 2009. Human bloodfeeding by the recently introduced mosquito, *Aedes japonicus japonicus*, and public health implications. *J Am Mosq Control Assoc* 25:210–214.
 Musa C. 2008. Trends of exotic mosquitoes invading New Jersey. *Proc NJ Mosq Control Assoc* 95:28–36.
 Patterson G. 2009. *The mosquito crusades: A history of the American anti-mosquito movement from the Reed Commission to the first Earth Day*. New Brunswick, NJ: Rutgers Univ. Press.
 Peyton EL, Campbell SR, Candeletti TM, Romanowski M, Crans WJ. 1999. *Aedes (Finlaya) japonicus japonicus* (Theobald), a new introduction into the United States. *J Am Mosq Control Assoc* 15:238–241.
 Schmitt JB. 1942. Five species of mosquitoes, new to New Jersey, found in last five years. *Mosq News* 2:26–29.
 Scott JJ, Carle FL, Crans WJ. 2001. *Ochlerotatus japonicus* collected from natural rockpools in New Jersey. *J Am Mosq Control Assoc* 17:91–92.
 Smith JB. 1904. *Report of the New Jersey Agricultural Experiment Station upon the mosquitoes occurring within the state, their habits, life histories, etc.* New Brunswick, NJ: New Jersey Agricultural Experiment Station.
 Williges E, Farajollahi A, Scott JJ, McCuiston LJ, Crans WJ, Gaugler R. 2008. Laboratory colonization of *Aedes japonicus japonicus*. *J Am Mosq Control Assoc* 24:591–593.