

NOTES ON THE BIOLOGY AND DISTRIBUTION OF SOME DELAWARE MOSQUITOES¹

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A review of the distribution of Delaware mosquitoes by Darsie *et al.*, (1951) reported a total of 39 species known to occur in the State. Bickley (1957) reported the occurrence of *Aedes thibaulti* Dyar & Knab, in Delaware, bringing the total to 40 species. Lake and Doll (1961) listed three more species and Lake (1963) two additional species bringing the total to 45. The present paper reports two additional State records, *Orthopodomyia alba* Baker and *Aedes fitchii* (Felt & Young) which brings the present total of known species in Delaware to 47.

Extensive larval sampling in recent years, in addition to routine light trap sampling, has enabled me to gain a better picture of the distribution of Delaware mosquitoes and to learn more about their biology.

The species reported in this paper, with the exception of *Aedes grossbecki* Dyar & Knab are rare or very limited in distribution in the State.

Orthopodomyia alba Baker. Darsie *et al.*, (1951) listed this species as a doubtful record for Delaware because the only record they knew of was based on a single adult female collected at Odessa, Delaware. Inasmuch as there is no reliable method for separating adults of *Orthopodomyia signifera* (Coquillett) and *O. alba*, this record remains doubtful. However, recent observations by the author confirm the presence of this species in Delaware. On July 14 and August 13, 1964 several larvae of *O. alba* were collected from a

large woodland tree hole located near Bombay Hook Wildlife Refuge, Delaware. A few other larvae were found in a nearby tree hole with a narrow opening of only 2¼ inches in diameter. Larvae of this species were also taken on August 6 and 24, 1965 in the large tree hole at Bombay Hook.

Anopheles barberi Coquillett, *Toxorhynchites rutilus septentrionalis* (D. & K.), *O. signifera* and *Aedes triseriatus* (Say) were found associated with this species on one or more occasions.

Aedes fitchii (Felt & Young). One second instar larva of this species was collected at Stanton, Delaware on March 18, 1966 in an open marshy area. Although an intensive search was made in the same area at a later date, no more *A. fitchii* larvae were found.

An attempt was made to rear this specimen to the adult stage but it died while moulting to the pupal stage. The collection of this species in Delaware constitutes a new State record.

Psorophora howardii Coquillett (Fig. 1). This species is more common in the southeastern United States than in the Middle Atlantic States. In Delaware, it has not been found north of the southern portion of Kent County.

Lake (1963) first reported this species in Delaware, from a collection made in Thompsonville. Since this report two additional larvae were collected near Thompsonville on August 23, 1963 in a rain pool at the edge of a woods. In addition, one female was captured at the Assawoman Wildlife Refuge, Sussex County, as it attempted to bite, on June 20, 1963.

Aedes aurifer (Coquillett) (Fig. 1). DISTRIBUTION AND ABUNDANCE. This north-

¹ Published as Misc. Paper No. 527 with the approval of the Director of the Delaware Agricultural Experiment Station. Publication No. 368 of the Department of Entomology and Applied Ecology.

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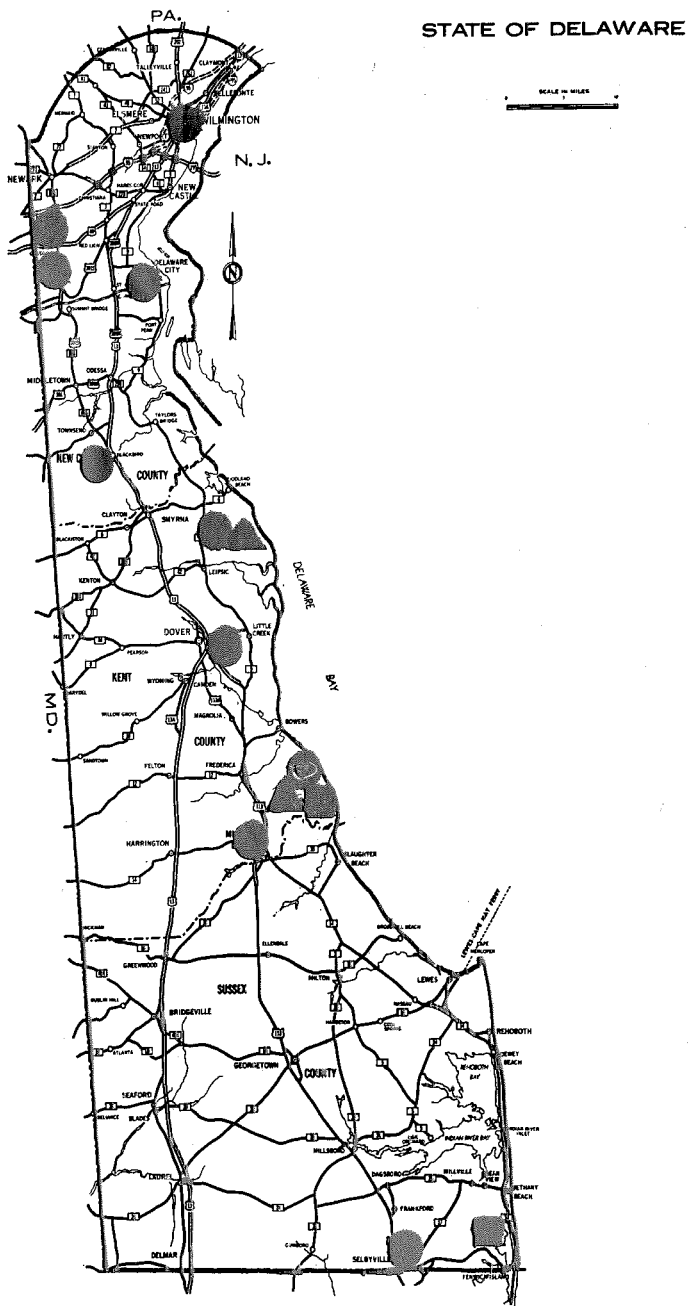


FIG. 1.—Distribution of *A. aurifer* ●, *A. infirmatus* ▲, *P. howardii* ■.

ern species apparently reaches the southernmost limit of its range on the eastern coast of the U. S., in Delaware and Maryland. Darsie *et al.*, (1951) listed five localities where adults of this species have been captured; however, one of these, viz. Ellendale State Forest, is in error. These specimens have been examined and found to be *A. thibaulti*. Additional records for this species in Delaware since 1951 are listed as follows: Thompsonville, 2 ♀ ♀, May 24, 1962; Glasgow, many ♀ ♀, May 20-31, 1963, 1 larva April 13, 1964; Bombay Hook, 1 larva, April 7, 1964; Blackbird 1 ♀, May 25, 1964; Sunset Lake, larvae, April 13, 1965, April 1, 1966.

The author has collected large numbers of larvae in marshland areas of northern New Jersey and Bristol County, Massachusetts in association with the dead blades of *Carex* sedge tussocks. Although many of these tussocks have been examined in Delaware, collections of larvae in 1965 and 1966 were the first indications that immatures occupy this type of habitat in the State.

Past records and those presented above reveal that *A. aurifer* is a rare species in Delaware, Glasgow and Sunset Lake being the only localities where any numbers were found.

ASSOCIATED LARVAE. *Aedes canadensis canadensis* (Theobald) and *A. grossbecki* were most often associated with larval *A. aurifer*.

Aedes infirmatus Dyar & Knab (Fig. 1). Lake and Doll (1961) first reported this species from Delaware with the collection of two females from Bombay Hook. Since then larvae have been collected on two occasions at Thompsonville, August 29, 1961 and July 27, 1962. Associated larvae were *Psorophora ferox* (Humboldt), *Aedes atlanticus* Dyar & Knab, *A. dubreei* (Coquillett) and *A. vexans* (Meigen).

Aedes grossbecki Dyar & Knab (Fig. 2). **DISTRIBUTION AND ABUNDANCE.** This species has been reported from the following states: Arkansas, Connecticut, Delaware, Illinois, Kentucky, Louisiana, Mary-

land, Mississippi, Missouri, New Jersey, New York, Ohio, South Carolina, Tennessee, Vermont and Virginia. It is rare over most of its range but has been found locally abundant as indicated by Venard and Mead (1953) in Ohio, by Wirth (1947) in Louisiana and by the author in Delaware.

Darsie *et al.*, (1951) reporting on the mosquitoes of Delaware state that this species is extremely rare, because only two adults had been collected. Many larval collections made since the publication of this paper have shown that this species is rather common. At the present time larvae and/or adults have been collected from 18 localities in Delaware. Although not so abundant as *A. canadensis* in woodland pools in the spring, it is seldom that such pools are dipped in Kent and New Castle Counties without securing some *A. grossbecki* larvae.

SEASONAL OCCURRENCE. Larvae have been collected from February through early May in Delaware. First instar larvae were collected as early as February 11, 1965. The temperature of the water at this time was 45° F. The latest date for larvae was May 4, 1964 when fourth instar larvae as well as pupae were present.

Adults have been collected between May 7 and July 14.

Elsewhere in its range larvae have been reported most frequently from January to May and adults April to August. One unusual exception to the normal period of larval emergence was reported by Fellton *et al.*, (1950) as follows: "The writers have identified a single female which was reared from a larva collected on August 20, 1943 by H. D. Pratt from the marginal waters of Laurel Lake, near Jacksonville, Vermont."

HABITAT. Early spring woodland pools, post oak flats, semi-permanent woodland pools in sloughs in which water will remain several weeks, low swampy woods, marshes with sedges and grass and marginal waters of a lake are reported in the literature as habitats where larvae of *A. grossbecki* have been collected.

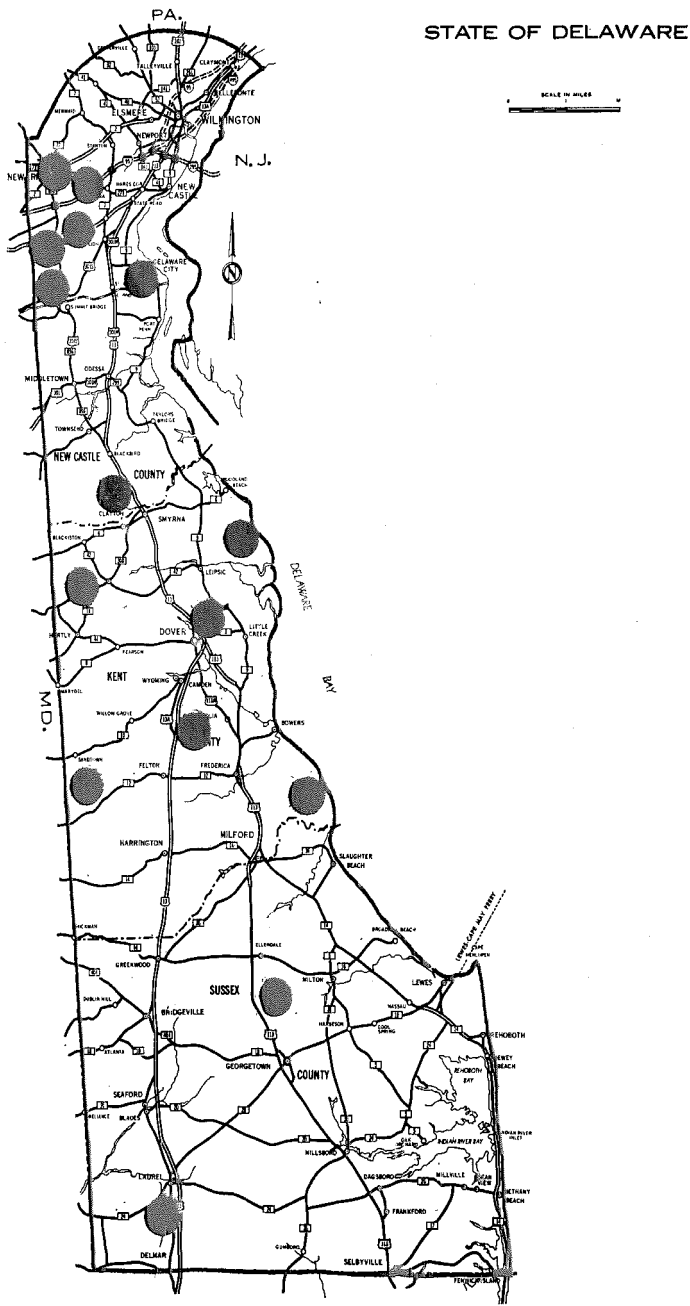


FIG 2.—Distribution of *A. grossbecki*.

In Delaware, larvae were most often found in woodland pools but occasionally some were taken in swamps, wooded edges of marshes, and extensive flooded areas in low woodlands.

ASSOCIATED SPECIES. Wirth (1947) reported *Culex restuans* Theobald, *A. canadensis*, *A. vexans*, *C. inornata* (Williston) and *Anopheles punctipennis* (Say) as occurring in collections of *A. grossbecki* larvae. Horsfall (1955) stated that *A. stimulans* is the usual associate in central Illinois. Headlee (1945) reported its occurrence with *A. canadensis* in New Jersey. In Delaware, *A. grossbecki* is most often collected with *A. canadensis* but occasionally *A. excrucians* (Walker) is found with it. The chaoborid larva *Mochlonyx cinctipes* (Coquillett) is almost always found in the same breeding sites.

EGG CONDITIONING. Eggs of this species have been successfully conditioned in the laboratory and larvae obtained by using methods similar to Horsfall and Fowler (1961) whereby egg samples were subjected to pre-cold, cold and post-cold periods.

Aedes thibaulti Dyar & Knab (Fig. 3). Shields and Lackey (1938), Horsfall (1937, 1939), Carpenter (1941, 1955) and Jenkins and Carpenter (1946) have contributed most of the presently available biological information pertaining to this species in the southern United States. Remarks on the biology of this species in the South are drawn largely from these sources.

DISTRIBUTION AND ABUNDANCE. This species is found in the southeastern United States, north to Illinois and Delaware and west to Texas. It has been reported from the following states: Alabama, Arkansas, Delaware, Florida, Georgia, Illinois, Kentucky, Louisiana, Maryland, Mississippi, Missouri, North Carolina, Ohio, South Carolina, Tennessee, Texas and Virginia. The northernmost limit of its range appears to be that reported by Venard and Mead (1953) from Cuyahoga County, Ohio. On the east coast of the

United States the northernmost limit is apparently in the vicinity of Newark, Delaware. Its present known distribution in Delaware is shown in Figure 3.

LARVAL HABITAT. In the South, larvae of this species have been collected from the hollow bases and root cavities of certain trees in low areas which are flooded in winter and spring. Most of these collections have been made from hollows of the following species of trees: tupelo or cotton gum, *Nyssa uniflora* Wang. (= *N. aquatica* Gray, B. & B. and Small); water gum, *N. biflora* Walt.; black or sour gum, *N. sylvatica* Marsh. and occasionally bald cypress, *Taxodium distichum* Rich. In one instance Carpenter (1941) reports finding larvae under a partly submerged log which was 100 feet from a hollow tree.

Lake and Doll (1961) and Joseph (1961) reported a somewhat different larval habitat in Delaware and Maryland respectively. Larval collection sites in Redden State Forest, Delaware are characterized by dense holly, *Ilex opaca* Ait., woods containing many uprooted trees such as oak, *Quercus* sp. and red maple, *Acer rubrum* L. When flooding occurred, large numbers of larvae were collected in the dark recesses under these uprooted trees.

Collections of larvae in New Castle County, Delaware were associated with temporary woodland pools and semi-permanent swamp areas in mixed hardwood forest. Hollow bases of two red maple trees provided the best collecting although larvae were also found under uprooted beech (*Fagus grandifolia* Ehrhart) and oak (*Quercus* spp.) trees.

Joseph (1961) in Maryland, also reported collecting larvae under an uprooted tree and in a large tree hole at the base of a tree which extended below the ground surface.

The use of typical tree holes or rot cavities above the ground level has not been reported. Horsfall (1939), observing this species in Arkansas, stated that larvae are not found in tree holes in

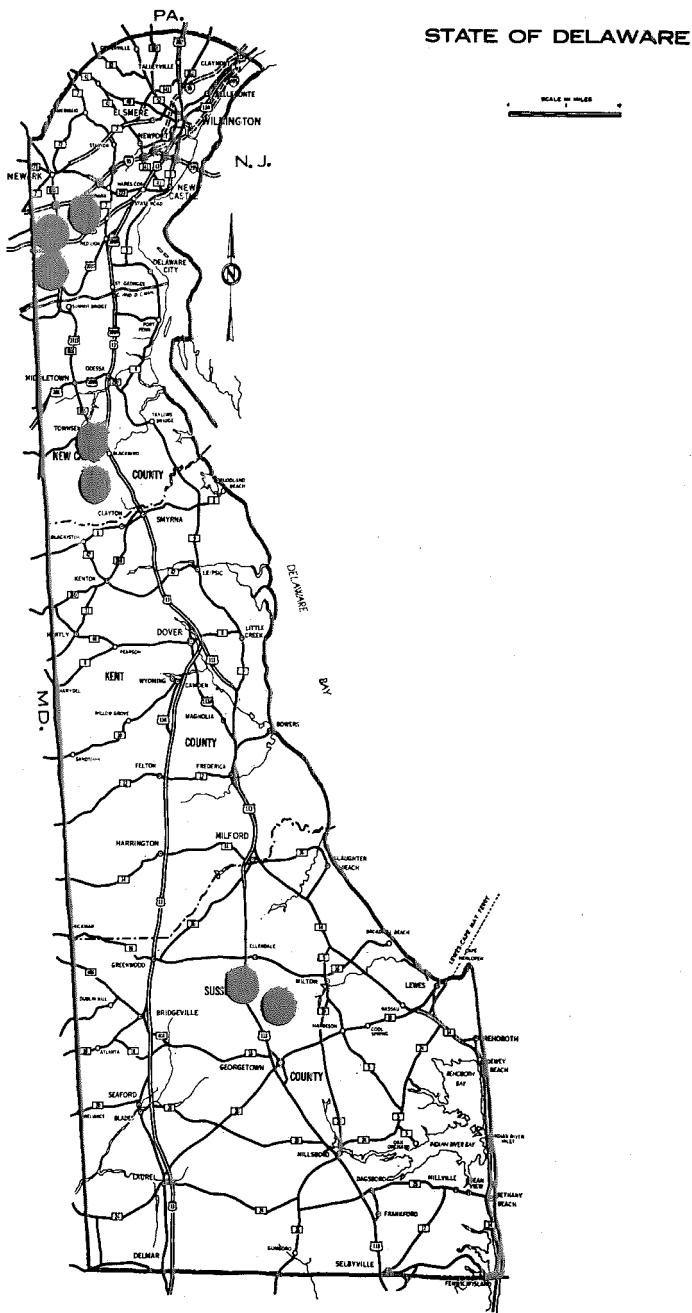


FIG. 3.—Distribution of *A. thibaulti*.

stumps of oak trees or in small holes in gum trees that are above ground level and not subject to flooding by nearby streams.

ASSOCIATED SPECIES. King *et al.*, (1960) listed larvae of *Culex territans* Walker, *Culex restuans* Theobald, *Culiseta melanura* (Coquillett) and *A. triseriatus* as occasionally being taken with *A. thibaulti* in the southeastern United States. Associated larvae in Delaware and Maryland include *Aedes c. canadensis* and *C. melanura*. In Delaware, *M. cinctipes* was often found in the same holes with *A. thibaulti* and possibly could have been responsible for some reduction in their numbers.

SEASONAL OCCURRENCE. Carpenter (1955) found larvae in Arkansas from December to May. Other investigators in the South observed the presence of larvae from February to May, occurrence in most cases being dependent on flooding of the habitat by rains. Fluctuation of water levels causes irregular hatching so that all instars may often be present at one time.

In Delaware, larvae have been collected from October until May; those larvae hatching in October and November are able to overwinter. On November 17, 1960 second and third instar larvae were collected from holes under uprooted trees at Redden State Forest, Delaware. Third and fourth instar *A. canadensis* were also present. Inspection of the same area on December 6 revealed that the *A. canadensis* and *A. thibaulti* were still present with little change in development. In addition, *M. cinctipes* larvae were found. Apparently these had been overlooked in the November collection.

Inspection of these breeding sites on March 21, 1961 disclosed that *M. cinctipes*, *A. thibaulti* and *A. canadensis* larvae apparently had successfully overwintered.

Emergence of larvae in the fall was noted on October 31, 1961 when first instar *A. thibaulti* larvae were found at Redden State Forest. By November 30, all larvae collected were either second or third instar. The author did not have an opportunity to examine these pools in the

spring of 1962 but it is assumed that larvae were able to overwinter similar to those in 1960-61 as the following winter was not as severe.

During years, such as 1962-65, when flooding did not occur in late fall, eggs remained unhatched until flooding occurred the following winter and early spring at which time larval emergence took place.

First instar larvae were collected in water as cold as 38° F.

EGG. Factors necessary for conditioning eggs of this species are not entirely known but apparently low temperatures are not required. In one experiment gravid, blood-fed females were brought into the laboratory and allowed to oviposit on gauze-covered mud balls. These eggs laid during the period of June 19 to July 2 were washed from the gauze and placed on moist filter paper, underlain by cotton. They were kept in a laboratory where temperatures ranged from 65-90° F. On December 15 these eggs were flooded with distilled water to which nutrient broth had been added. Hatching began on December 16 and continued to the 22nd and these specimens were successfully reared to adults.

Jenkins and Carpenter (1946) in referring to oviposition sites stated as follows:

The eggs are probably laid on the inner walls of the basal cavity of the tree in the summer and remain viable until winter or early spring, when they are flooded.

Collections of soil associated with known habitats of *A. thibaulti* in Delaware were processed in a Horsfall egg separator and eggs of this species were recovered. This does not eliminate the possibility of eggs being laid on the inner walls of tree cavities but further suggests that oviposition probably occurs in soil or organic debris within these tree holes.

MATING BEHAVIOR. Mating was observed on two occasions, June 3 and June 19, 1964 in the vicinity of the breeding sites at Redden State Forest, Delaware. An

account of the June 3 observations is related below.

Observations took place in the morning under partly cloudy skies with the air temperature at 65° F. in a dense holly forest. While waiting, in the vicinity of the breeding holes, for *A. thibaulti* females to land and feed, I observed males hovering near me. When female *A. thibaulti* approached, the males intercepted them and coupled in flight. Copulation lasted only a few seconds with separation usually occurring before they reached the ground. The position during copulation was ventral to ventral with female uppermost.

Many *A. canadensis* females were on the wing at the same time and male *A. thibaulti* would often grapple with females of this species very briefly then quickly release them.

Mating behavior, similar to that of *A. thibaulti* described above, has been reported by Owen (1937) and Dyar (1922) for *Aedes dianiaetus* Howard, Dyar & Knab, where females are pursued by the males and mating occurs as the females come to feed.

Summary. Two new Delaware records, *O. alba* and *A. fitchii*, are reported and new locality records for three rare species *P. howardii*, *A. aurifer* and *A. infirmatus* are listed for the State. Notes on the biology of *A. grossbecki* and *A. thibaulti*, as well as locality data, are included and a first observation of mating of *A. thibaulti* is described.

ACKNOWLEDGMENT. Acknowledgment is due Dr. Alan Stone of the U. S. National Museum for confirming the identification of the *Aedes fitchii* larva.

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