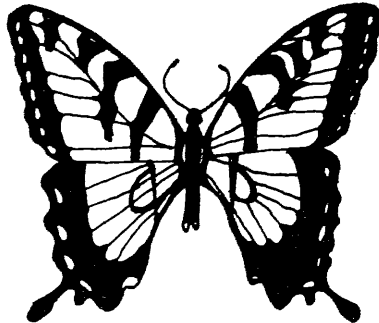


The Insects of Virginia: No. 2



Mosquitoes of Virginia (Diptera: Culicidae)

William J. Gladney and E. Craig Turner, Jr.

SOUTH EAST ASIA MOSQUITO PROJECT
DEPARTMENT OF ENTOMOLOGY
STATES HOUSE BUILDING
UNITED STATES NATIONAL MUSEUM
WASHINGTON, D. C. 20560

RESEARCH DIVISION BULLETIN 49
VIRGINIA POLYTECHNIC INSTITUTE
BLACKSBURG, VA. 24061

OCTOBER, 1969

MANUSCRIPTS FOR THIS SERIES of bulletins on the insects of Virginia are to be published as they become available. Board of Review is James McD. Grayson, Richard L. Hoffman and Michael Kosztarab. Publisher is the Research Division, Virginia Polytechnic Institute.

Only the results of unpublished, original research dealing with insects of Virginia can be printed in this series. Authors are urged to consult the latest edition of the Style Manual for Biological Journals before preparing their manuscripts, and to follow the general format shown in the published parts of the series. All manuscripts should be submitted to Dr. James McD. Grayson, Head, Department of Entomology, Virginia Polytechnic Institute, Blacksburg, Va. 24061.

One hundred reprints of bulletins in this series will be sent to authors free, at their request. Distribution policy for the bulletins is that followed by the Virginia Polytechnic Institute Research Division for its numbered bulletins in general.

The Insects of Virginia: No. 2

THE MOSQUITOES OF VIRGINIA

(Diptera: Culicidae)

by

WILLIAM J. GLADNEY

Livestock Insects Investigation Laboratory, USDA
Box 232, Kerrville, Texas 78028

and

E. CRAIG TURNER, JR.

Professor of Entomology
Virginia Polytechnic Institute
Blacksburg, Va. 24061

RESEARCH DIVISION BULLETIN 49

VIRGINIA POLYTECHNIC INSTITUTE

OCTOBER, 1969

ACKNOWLEDGMENT is made to the *Appalachian Power Company* for partial financial support for this study, to *Drs. Michael Kosztarab and Richard L. Hoffman* for assistance in reviewing the manuscript, and to *Mrs. Joyce Fisher Burroughs and Miss Nancy Fisher* for technical assistance in sorting out collected mosquito material.

Contents

Introduction	1
Genus AEADES Meigen	2
Genus ANOPHELES Meigen	8
Genus CULEX Linnaeus	14
Genus CULISETA Felt	17
Genus MANSONIA Blanchard	18
Genus TOXORHYNCHITES Theobald	18
Genus ORTHOPODOMYIA Theobald	18
Genus PSOROPHORA Robineau-Desvoidy	19
Genus URANOTAENIA Lynch-Arribalzaga	21
Literature Cited	23

The INSECTS of VIRGINIA: No. 2

The Mosquitoes of Virginia (Diptera: Culicidae)

William J. Gladney and E. Craig Turner, Jr.

INTRODUCTION

As vectors of disease and annoying pests, probably no group of insects has contributed to human suffering as much as mosquitoes. This group of Diptera, belonging to the family Culicidae has been the subject of worldwide studies for the past hundred years. Of utmost importance in the knowledge of these insects is the study of the geographic distribution and biology of the various species.

At least 45 mosquito species are now known to exist in Virginia. The vast majority of mosquito records have been obtained from extensive and numerous surveys which were conducted primarily in conjunction with control operations in the eastern coastal portion of the state. However, a mosquito study carried out by the authors during the summers of 1965 and 1966 at Smith Mountain Reservoir in southwestern Virginia produced one new record for the state and several county records.

Dorer, *et al.* (1944) list a total of 40 species present within the state. However, Bickley (1957) has noted that three additional species including *Psorophora discolor* (Coquillett), *Aedes grossbecki* Dyar and Knab, and *Aedes atropalpus* (Coquillett) were overlooked by Dorer, *et al.* (1944), since Dyar (1922) had previously recorded these three species from Virginia. Additionally, three new state records have been obtained since 1944. Bickley (1957) reported *Aedes stimulans* (Walker) from Gloucester Point, Virginia, and *Aedes thibaulti* (Dyar and Knab) from Cape Henry, Virginia. *Aedes cinereus* (Meigen) also represents a new state record obtained by the authors from the Smith Mountain Impoundment area which covers portions of Roanoke, Franklin, Bedford, Pittsylvania, and Campbell Counties.

Methods employed in sampling mosquito populations during the Smith Mountain survey included light traps, larval dip collections, resting stations, and biting collections. Malaise traps (Townes, 1962), which are tent-like devices made of fine weatherproof netting, were also utilized for trapping adult mosquitoes.

Bickley (1957) reported *A. stimulans* (Walker) from Gloucester Co. and *A. thibaulti* (Dyar and Knab) from Virginia Beach Co. as new Virginia mosquito records. *A. stimulans* was not taken in the 1965-1966 survey by the authors, but three *A. thibaulti* females were collected in Giles Co., Virginia, on August 2, 1965. Bickley (1957) further stated that *A. cinereus* (Meigen) had not been recorded from Virginia, but the 1965-66 survey produced records of this species from Franklin and Pittsylvania Counties in Virginia.

Identification keys to the mosquito fauna of Virginia have been omitted from this bulletin due to the availability of a number of other excellent references on this subject. The keys of King, *et al.* (1960) conform very closely to the mosquito species present in Virginia. Additional keys including the mosquito fauna of North America may be found in the works of Carpenter and La Casse (1955), Matheson (1966), and Carpenter, *et al.* (1946).

Many of the mosquito specimens collected in the Smith Mountain Impoundment survey are stored and available in the Virginia Polytechnic Institute Insect Collection, curated by Dr. Michael Kosztarab, Department of Entomology, Blacksburg.

It is possible that some mosquito records not included in this bulletin may be found in the U. S. National Museum. The authors made no attempt to survey the Virginia mosquito material at that institution.

The following list is a compilation of all mosquito species now known to occur in Virginia, with accompanying notes on their distribution and bionomics.

GENUS AEADES MEIGEN

Aedes aegypti (Linnaeus):—This domestic species, which is commonly referred to as the yellow fever mosquito, has been the target of an intensive eradication program by federal, state, and local health workers. Intensive efforts directed towards proper disposal and handling of potential man-made breeding sources in conjunction with urban insecticidal control programs have greatly reduced the prevalence of *A. aegypti* in many areas of the United States.

A. aegypti, although once common in the southwestern region of the state, is listed by Schliessmann (1964) as a species presumably not infesting Virginia at the present time.

Aedes atlanticus Dyar and Knab:—This species is reported as being "fairly common" by Dorer, *et al.* (1944); however, over 90% of the total records presented by these workers was obtained from the southeastern part of the state. This mosquito was found to be comparatively

scarce in southwestern Virginia. In the Smith Mountain survey, one adult specimen was taken from each of the three collecting methods of light trap, Malaise trap, and human bait. All three of these adult specimens were taken from Pittsylvania County. No larvae of *A. atlanticus* were collected in this study, but Carpenter and LaCasse (1955) classify the larval habitat of this species as temporary pools in open fields and woodlands.

Aedes atropalpus (Coquillett):—Bickley (1957) states that the larvae of this species are abundant in rock holes along the James River at Richmond (Henrico Co.) and on the Virginia (Fairfax Co.) and Maryland sides of the Potomac above Washington, D. C. No larvae or adults of *A. atropalpus* were collected in the southwestern counties included in the 1965-66 study, probably due to the absence of the rock-hole breeding habitat in this area. Carpenter (1941) believes that this species is probably of little economic importance except near heavy production areas, due to its specialized type of breeding habits and short flight range.

Aedes canadensis (Theobault):—*A. canadensis* is fairly common and well distributed throughout Virginia where suitable breeding conditions exist for its development. This mosquito is primarily a wood and pool breeder. Large numbers of larvae were collected in early May from large temporary rain pools (Fig. 1) adjacent to Smith Mountain Reservoir in Franklin County. According to Carpenter (1941), the females of *A. canadensis* are fierce biters in woodlands near their breeding areas, and feed on cold-blooded animals, including turtles.

Aedes cantator (Coquillett):—Carpenter and LaCasse (1955) state that the larvae of this species are found in coastal marshes, including both fresh and salt water, but less brackish water seems to be preferred. Records of *A. cantator* from Virginia indicate that it is quite rare within the state. Dorsey (1944) collected larvae but no adults of this species in September and October of 1943, at Camp Peary near Williamsburg (James City Co.), Virginia.

Aedes cinereus Meigen:—The collection of *A. cinereus* during the Smith Mountain survey of 1965-66 is considered a significant find since it represents a new mosquito record for Virginia. This is somewhat surprising in view of the previous extensive mosquito surveys that have been conducted in the state. On the other hand, the majority of mosquito records (Dyar, 1922; Dorsey, 1944; Dorer, *et al.*, 1944; and Bickley, 1957) have been obtained from the coastal areas, and the collection of *A. cinereus* in southwestern Virginia by the authors indicates that this species is either absent or scantily distributed along the eastern coast. This mosquito was taken in light traps, Malaise traps, and biting col-

lections during the 1965-66 seasons in Franklin and Pittsylvania Counties.

Aedes dupreei (Coquillett):—This species is listed as rare in Virginia by Dorer, *et al.* (1944). It has been reported from Lake Drummond in Princess Anne County and also from Camp Peary near Williamsburg. The larvae develop in temporary or semi-permanent woodland pools. According to King, *et al.* (1960), these “wrigglers” are difficult to collect due to their habit of hiding among the leaves and debris at the bottom of pools, where they are able to remain for long periods without coming to the surface.

Aedes fulvus pallens Ross:—This is another extremely rare *Aedes* mosquito. Dorer, *et al.* (1944) reported a single female from light-trap collections at Camp Pendleton (Virginia Beach), June 21, 1943, taken by H. P. Nicholson. Very little is known of the bionomics of *Ae. fulvus pallens*.

Aedes grossbecki Dyar and Knab:—Dyar (1922) provided the first state record for this species from Grassymead, Virginia, which was omitted from the list of Dorer, *et al.* (1944). A single specimen of *A. grossbecki* was taken by the authors in Pittsylvania Count from malaise-trap collections on July 5, 1966. According to King *et al.* (1960), this is a rare northeastern species that has been reported from a few scattered, unspecified localities in the southeastern United States.

Aedes mitchellae (Dyar):—Carpenter and LaCasse (1955) claim that although the immature stages of this species are rarely if ever found in salt marshes, its distribution seems to be limited largely to the coastal plains. *A. mitchellae* was reported by Dorer, *et al.* (1944) as a rare mosquito in traps in the Hampton Roads area but fairly common in larval collections.

Aedes sollicitans (Walker):—*A. sollicitans*, often commonly referred to as the eastern salt-marsh mosquito, breeds in the salt marshes along the Atlantic and Gulf Coasts. It is usually the most noxious and abundant mosquito encountered in salt marshes north of central Florida. *Aedes sollicitans* often makes its presence known at great distances from the marshes due to its long flight range, which may extend up to 40 miles (Headlee, 1921). According to King, *et al.* (1960) the fierce biting females often attack in full sunlight, and they are extremely annoying, often unbearably so, to persons and domestic animals. The economic importance of *Aedes sollicitans* can hardly be underestimated. Headlee (1921) reports that in many places attempts to develop tracts of land for summer resorts and for farming purposes have proven complete failures due to the extreme annoyance caused by this mosquito.



FIGURE 1. Temporary rain pool breeding habitat of *Aedes vexans*, *Aedes canadensis*, *Psorophora confinnis*, and *Anopheles punctipennis* in Franklin County.

The records of Dyar (1922), Dorer, *et al.* (1944), and Dorsey (1944) attest to the presence and high density of this pest along the Eastern Shore (Northampton, Accomack, Virginia Beach, Chesapeake, James City, and York Counties) of Virginia. However, Messersmith (unpublished data) collected large numbers of *Aedes sollicitans* larvae as far inland as Saltville (Smyth and Washington Counties), Virginia, breeding in association with salt water from mining operations.

Aedes sticticus (Meigen):—Records indicate that this species is relatively uncommon in Virginia. Dorer, *et al.* (1944) report collection of *Aedes sticticus* from Woodstock (Shenandoah Co.), February 6, 1903, by F. C. Pratt. No member of this species was taken in the 1965-66 Smith Mountain survey in southwestern Virginia. According to Carpen-

ter and LaCasse (1955), the larvae of *A. sticticus* are frequently found in floodwater pools in river valleys both in woodlands and open country. This species is often abundant after spring floods, especially in standing pools left by high river water. An indication of the adult flight range is that Michener (1947) observed females biting two and a half miles from their breeding site.

Aedes stimulans (Walker):—The only known record of this species occurring in Virginia was reported by Bickley (1957); two females were collected at Gloucester Point (Gloucester Co.), Virginia, in June, 1956. Carpenter and LaCasse (1955) state that larvae of *A. stimulans* breed in temporary pools formed by overflow of streams and in surface waters filled by melting snow and early spring rains. They further state that the larvae are among the first to appear in the spring, and the adults are encountered in April, May, or June. Apparently, Virginia is the southernmost extent of its range in the East.

Aedes taeniorhynchus (Wiedemann):—The “black salt-marsh mosquito” is very common and well distributed along the coastal and bay areas of Virginia (Dyar, 1922; Dorsey, 1944; Dorer, *et al.*, 1944). It is a predominating pest and ranks next to *A. sollicitans* in economic importance in salt-marsh situations. However, in southern Florida it usually outnumbers *A. sollicitans*. King, *et al.* (1960) found that the females were troublesome at times in the vicinity of Orlando, Florida, which is about 30 miles from the nearest salt water. Larvae of *A. taeniorhynchus* developing in effluents of salt water from oil wells have been collected from as far inland as Arkansas by Carpenter (1941).

Aedes thibaulti (Dyar and Knab):—This mosquito was first collected in Virginia by Bickley (1957) in the Seashore State Park, at Cape Henry (Virginia Beach), Virginia, during May and June, 1945. The senior author collected three females of *A. thibaulti* in a rabbit-baited Fallis trap in Giles County, Virginia, on August 2, 1965. This mosquito oviposits in tree and stump holes in marshy areas which are subject to flooding. Carpenter (1941) states that larvae are usually found in the hollow bases and root cavities of sweet gum and tupelo gum trees. Carpenter (1941) further reports that the adults of this species are usually encountered in thickets and woods during March, April, and May in Arkansas and that they are fierce biters, attacking at mid-day. This mosquito is of little economic importance in Virginia, probably due to a limited number of suitable breeding habitats.

Aedes triseriatus (Say):—The larvae of *A. triseriatus* usually develop in tree-hole cavities and are, hence, commonly called the tree-hole *Aedes*. However, Dorsey (1944) has taken larvae of this species from artificial

freshwater containers (e.g., cans, jars) and Darsie, *et al.* (1951) reported their collection from a freshwater, semi-permanent, roadside pool. Numerous larvae of this species were collected from a tree hole (Fig. 2) on the V. P. I. campus in Blacksburg in early May, 1966. Larvae were also collected in Giles County from a similar habitat. The senior author found *A. triseriatus* females particularly annoying during the month of August in a wooded area in Pittsylvania County. The adults bit fiercely and persistently during the late afternoon in shaded areas. This mosquito is of considerable importance since Chamberlain, *et al.* (1954) rated its vector potential for Western and Eastern encephalitis as "excellent."

Aedes trivittatus (Coquillett):—Very little is known of the bionomics of this mosquito species. Although widely distributed, *A. trivittatus* is generally rare in most localities and is seldom encountered. Adults were



FIGURE 2. Tree-hole breeding site of *Aedes triseriatus*.

taken in light traps on infrequent occasions from June through September, 1966, in Franklin, Roanoke, and Pittsylvania Counties. Only two larvae of this species were collected [from temporary rain pools (Fig. 1)] in two years of sampling at Smith Mountain. Owen (1937) found that the bite of this mosquito was the most painful of any species in Minnesota and that to encounter this mosquito in large numbers is an experience not to be forgotten.

Aedes vexans (Meigen):—Outside the salt-marsh region of the east coast, *A. vexans* is probably the most abundant and widely distributed *Aedes* in Virginia. In some areas of the Northern States it is the principal pest species (King, *et al.*, 1960). This mosquito ranked third in abundance in two years of light-trap and one year of Malaise-trap collections at the Smith Mountain area. Females bit persistently in mid-afternoon when their resting places (tall grasses) were disturbed in Franklin County. Larvae were found associated with *A. canadensis*, *Psorophora confinnis*, *Anopheles punctipennis*, *A. trivittatus*, *A. cinereus*, and *Culex restuans*. The range of favorable larval habitats is apparently quite wide. Immature stages of *A. vexans* were taken from such diverse breeding sites as hoofprints filled with water polluted by animal wastes (Fig. 3) and from temporary freshwater pools (Fig. 1). The eggs are deposited in typical *Aedes* fashion on the muddy edges of receding pools. Unlike the eggs of many *Aedes* mosquitoes, those of *A. vexans* hatch during the same season that they are laid and this facilitates, in some locations, the production of many broods during the season (Freeborn, 1926). Production of this species begins in early May in southwestern Virginia and continues at a rather constant rate throughout the summer, depending on the frequency of rainfall.

GENUS ANOPHELES MEIGEN

Anopheles atrops Dyar and Knab:—Relatively little is known about the life history of this salt-marsh breeding anopheline. Dorer, *et al.* (1944) report that larvae of this species were collected at Onley, Accomack Co., (Eastern Shore) on September 9, 1932. According to Matheson (1966) the adults readily bite man in the bright sunlight or at night and flights of at least a mile have been reported for this species.

Anopheles barberi Coquillett:—As opposed to other members of the genus *Anopheles*, the larvae of *A. barberi* usually develop in tree holes. However, Darsie, *et al.* (1951) and Dorer, *et al.* (1944) report collections of larvae from water-filled tin cans. This species is quite rare in



FIGURE 3. Hoofprints filled with water polluted by animal wastes which supported larvae of *Aedes vexans*.

Virginia, but its presence in the Williamsburg area and Princess Anne County (now Virginia Beach) has been established by Dorer, *et al.* (1944). One larva of *A. barberi* was reared from tree-hole water taken in Giles County during the summer of 1965 by J. A. Hair. According to Matheson (1966), this species hibernates in the Northern States as second-stage larvae frozen solidly in ice in the tree holes.

Anopheles bradleyi King:—This species is another anopheline that is common to the Eastern Shore. It is reported as being a prevalent mosquito in the Hampton Roads area by Dorer, *et al.* (1944) and a survey conducted by Dorsey (1944) established that it was the most abundant *Anopheles* at Camp Peary near Williamsburg. Due to its close taxonomic similarity to *A. crucians*, few details are known of the bionomics and life history of this species.

Anopheles crucians Wiedemann:—This mosquito was found to be comparatively rare in the two-year Smith Mountain Reservoir survey. Dorer, *et al.* (1944) state that *A. crucians* is common in the Hampton Roads area but rare in northern Virginia. However, these workers point out that many adults taken in the coastal and bay areas are probably *A. bradleyi* and not *A. crucians*, which they closely resemble. A total of 29 *A. crucians* adults were taken from two summers' light-trap activity in Pittsylvania County. The principal breeding site of this species in the Smith Mountain region was a marsh area (Fig. 4) created by the construction of a spillway on Frying Pan Creek in Pittsylvania County.

King, *et al.* (1960) found that in the vicinity of Lake Apopka in Central Florida, where *A. crucians* becomes extremely abundant, the num-



FIGURE 4. Aerial photograph of a marsh area in Pittsylvania County that supported larval populations of *Anopheles crucians*, *A. quadrimaculatus*, *A. punctipennis*, *Culex restuans*, *C. territans*, and *Uranotaenia sapphirina*.

ber taken out-of-doors at night while attempting to bite man was repeatedly very small in comparison with the total numbers present, as indicated by light-trap collections. In accordance with these studies, only one *A. crucians* female was taken in eight 1-hour biting collections at the marsh site in Pittsylvania County.

Anopheles punctipennis (Say):—According to Matheson (1966), this species is the most widely distributed nearctic anopheline, and it is probably the most prevalent member of its genus outside the coastal areas in Virginia.

Bradley and King (1941) point out that *A. punctipennis* may utilize both permanent and temporary waters for breeding; however, the most general characteristic of their breeding waters is that these are clean. Foul or contaminated waters are seldom inhabited. Unlike other *Anopheles*, *A. punctipennis* is frequently found in moving as well as still water. The margins of streams often provide adequate protection for this species. Bradley and King (1941) state that *A. punctipennis* breeds in a great variety of places. Margins of flowing streams, pools in intermittent stream beds, springs, ponds and pools, artesian wells, artificial water receptacles, and new borrow pits and other excavations are noted as breeding places of this species. The almost unlimited number of favorable breeding sites probably accounts for its wide distribution. It is usually the first anopheline to occur in certain rain or floor pools when microorganisms are scarce.

Horsfall (1955) reported that in domestic situations this species has been found to feed naturally on man, horse, cow, pig, sheep, dog, cat, and fowl. However, in the authors' survey, biting collections conducted in Franklin County revealed that extremely low numbers are attracted to human bait in comparison to numbers present as indicated by light-trap and larval collections.

A. punctipennis was one of the two abundant mosquitoes found breeding in association with the newly-impounded Smith Mountain Reservoir. The situation that best typified the majority of mosquito breeding grounds on Smith Mountain Lake was that of small coves containing calm water and abundant aquatic and terrestrial growth as shown in Fig. 5.

A few larvae of this species were also collected from tobacco irrigation pounds (Fig. 6) and temporary rain pools (Fig. 1) in Franklin County.

No information could be found on the flight range of *A. punctipennis*; however, Bradley and King (1941) consider all nearctic anophelines to be comparatively weak fliers.



FIGURE 5. A portion of a small cove which represented a typical breeding site of *Anopheles punctipennis* and *Culex salinarius* on Smith Mountain Lake.

Anopheles quadrimaculatus Say:—Before malaria was so effectively suppressed in the United States, *A. quadrimaculatus* constituted a most severe disease threat in this country. It was without question the prime transmitting agent of the causal organism of malaria in the East.

The records of Dorsey (1944) reveal that it is a common and predominating pest in eastern Virginia. It was also found breeding in a few localities in southwestern Virginia. While Smith Mountain Reservoir was in the process of filling, a large cove of the lake in Franklin County offered favorable breeding grounds for this species. Routine inspections of barrel resting stations produced an average of over one "quad" per visit and moderate numbers were also taken in light traps.



FIGURE 6. Tobacco irrigation pond which supported small numbers of *Anopheles punctipennis* larvae.

A marsh (Fig. 4) in Pittsylvania County also provided an extensive breeding area for *A. quadrimaculatus*. In the case of *A. quadrimaculatus*, it is a common practice to limit control measures to a radius of from one-half to one mile from habitations, depending on intensity of breeding, since many authors believe that few migrate farther than a mile from their breeding grounds.

Anopheles walkeri Theobault:—This species is relatively uncommon in Virginia, as it is in most other localities. *A. walkeri* was never encountered in the southwestern counties involved in the Smith Mountain survey. Dorer *et al.* (1944) report it as rare and states that it has been taken occasionally in light traps in northern Virginia and Cape Henry. Relative to its known habits, water dense with vegetation is preferred as a breeding place (Stearns, *et al.*, 1933).

GENUS CULEX LINNAEUS

Culex erraticus Dyar and Knab:—*C. erraticus* is most often encountered breeding in association with large permanent bodies of water. Adults were taken most often in the vicinity of an impounded creek in Pittsylvania County during the Smith Mountain survey. In biting collections carried out at this area, *C. erraticus* comprised 22.7% of the total catch. Although attracted to human bait in large numbers after sunset, the females were not persistent biters and often flew from the host at the slightest provocation. King, *et al.* (1960) indicate that the species has a preference for the blood of fowls and often attacks them on roosts at night.

Culex peccator Dyar and Knab:—The appearance of this *Melanoconion* is quite similar to that of *C. erraticus*, and the separation of the two species is made from very indistinct morphological characters. It is quite rare in Virginia; Dorsey (1944) captured only one female in a survey near Williamsburg, and the writer's only encounter with this species was two females from light-trap collections in Franklin County during the 1965 season.

Culex pipiens pipiens Linnaeus:—The so-called northern house mosquito breeds primarily in domestic situations that offer a source of polluted water. Dyar (1922) collected it in Virginia Beach Co., on September 20, 1911. Larvae are quite common in catch basins and accumulations of water in city dumps. Turner collected sizeable numbers of *C. pipiens pipiens* larvae developing in a waste lagoon (Fig. 7) formed by the effluent from a dairy barn in Blacksburg. This mosquito is not entirely limited to domestic situations, since the authors collected five larvae of this species from standing water in depressions left by tractor tires in Franklin County. *C. pipiens pipiens* is generally regarded as the most pestiferous mosquito outside the coastal and bay areas of Virginia.

Culex pipiens quinquefasciatus (Say):—This subspecies of the *Culex pipiens* group is most prevalent in states south of Virginia. There is some indication that *C. pipiens pipiens* and *C. pipiens quinquefasciatus* overlap in this state, since Dorer, *et al.* (1944) identified a single male specimen from the Norfolk area. The appearance and habits of this subspecies are quite similar to those of *C. pipiens pipiens*. The larvae frequently breed in artificial receptacles or in ground water if it is polluted. Females frequently enter homes after dark to feed upon man and make their presence known by a distinct "singing" produced by their particular wing beat frequency.

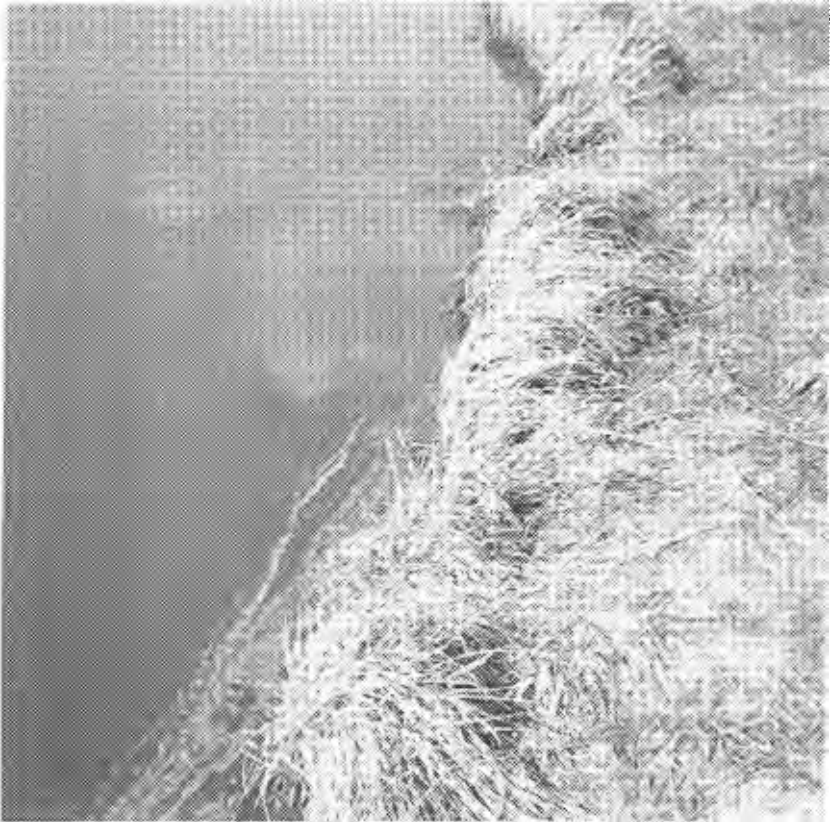


FIGURE 7. Waste lagoon in Blacksburg which served as a breeding ground for large numbers of *Culex pipiens pipiens* larvae.

Culex restuans Theobold:—This typical culicine has one or two pairs of small white dots on the dorsum of the thorax according to King, *et al.* (1960). However, no specimens of the two-spotted variety were ever encountered in the Smith Mountain survey. Light-trap collections produced only 2.8% *C. restuans* adults in the total catch from two years of sampling in the Smith Mountain area. On the other hand, larval collections indicated a much higher population density for this species as opposed to the data provided by light traps.

There has been considerable discrepancy among some workers (King, *et al.*, 1960; Headlee, 1921; and Michener, 1947) over the anthropophilic feeding tendencies of *C. restuans*. However, not a single female of this species was taken in 10 one-hour biting collections conducted by the authors in an area where heavy breeding was noted.

Culex salinarius Coquillett:—*C. salinarius* was the dominant mosquito species found breeding in association with Smith Mountain Lake (Bedford, Campbell, Franklin, Pittsylvania, and Roanoke Counties). This mosquito constituted over 50% of the total catch from light-trap collections taken in the reservoir area. The observations of Dorer, *et al.* (1944) attest to its common presence and distribution in other portions of Virginia. They found it very abundant in water chestnut areas of Potomac.

The eggs of *C. salinarius* are deposited in rafts on the surface of fairly clean freshwater sites, and Horsfall (1955) quotes from Mitchell (1907) that each raft contains 50-55 eggs. Dyar (1922) states that larvae live in permanent pools in marshes containing grass and *Lemna*, and that they are frequently very abundant near the seashore, and hence are appropriately named. However, they also occur inland, occasionally even in water barrels.

In Oklahoma, Rozeboom (1942) found *C. salinarius* breeding in artificial containers, pools in streams, springs, and seeps. Owen (1937) reports that this species occupies the margins of semi-permanent ponds, marshes, and temporary rainpools in Minnesota. Dorsey (1944), while conducting a mosquito survey near Williamsburg, Virginia, collected *C. salinarius* larvae in every type of breeding location encountered, including tree holes and brackish water, but they were most numerous in quiet, freshwater pools in streams and channels. Dorsey also analyzed the frequencies of association of *C. salinarius* with larvae of other mosquito species, and from a total of 346 collections he found *C. salinarius* associated with: (1) *C. restuans*, 88 times; (2) *C. territans*, 74 times; (3) *A. punctipennis*, 72 times; (4) *C. salinarius* alone in "pure culture," 55 times; and with other species very rarely.

Wallis and Spielman (1953) successfully colonized *C. salinarius* and found that the eggs of this species hatched within two days after oviposition and that the larval stage lasted eight days in the laboratory at a temperature of $27^{\circ} \pm 3^{\circ}$ C. No mention was made of the length of the pupal period.

According to Carpenter and LaCasse (1955), larval development of this species under natural conditions begins early in the season and continues at a rather uniform rate during the summer and early fall throughout most of its range. Larvae and adults may be found anytime during the year in the extreme South, but inseminated females overwinter in hibernation farther north.

King, *et al.* (1960) state that adults may disperse quite widely from their breeding places. Some indication of their flight range was shown

by MacCreary and Stearns (1937) when they collected *C. salinarius* in light traps in Delaware Bay about eight miles from the nearest shore.

The females are troublesome biters outdoors in the vicinity of their breeding places. Biting collections made by the authors produced more *C. salinarius* than any other mosquito in Franklin County.

Culex territans Walker:—Relatively little economic importance can be attributed to this culicine, since it apparently does not feed upon man or other warm-blooded animals. Large numbers of larvae were encountered in various standing water situations sampled in the Smith Mountain survey. The most notable of these breeding habitats was water contained in a small oxbow basin, which was formed by a meandering stream that emptied into the reservoir. This basin supported heavy algae growth throughout most of the summer months and larvae of *C. territans* were collected most often in "pure culture" from this site.

Peak of flight activity studies conducted by the writers indicated that adults of this species are decidedly most active during the crepuscular hours of dawn and dusk.

GENUS CULISETA FELT

Culiseta inornata (Williston):—This species of fairly large mosquitoes was represented in the Smith Mountain study by only three female adults captured by light trap in Franklin County during the 1965 season. In view of the extensive sampling conducted in the 1965-1966 survey, this points to the relative scant distribution of *C. inornata* in southwestern Virginia. On the other hand, Dorer, *et al.* (1944) report that this mosquito is fairly common in the Cape Henry area (Virginia Beach).

According to King, *et al.* (1960), adults are usually encountered only during the cooler months in the extreme southern states, but farther north they occur throughout the summer.

Culiseta melanura (Coquillett):—This mosquito is a common inhabitant of the freshwater swamps prevalent in eastern Virginia (Chesapeake and Nansemond Counties). King, *et al.* (1960) indicate that the most common breeding situation of *C. melanura* is that of the acidic water present around the bases of trees and stumps.

The economic importance of this species must be considered quite high, since it is now known to be the primary vector in the maintenance of the bird-to-bird cycle of eastern equine encephalitis.

No specimens of *C. melanura* were taken from the five counties involved in the authors' survey in southwestern Virginia.

GENUS MANSONIA BLANCHARD

Mansonia perturbans (Walker):—*M. perturbans* is the only representative of its genus in Virginia. The larval habits of the species of *Mansonia* are unique in that upon hatching from the egg, the larva attaches its air tube to the roots or stems of an aquatic plant below the surface of the water. The pupa or "tumbler" is also equipped with breathing tubes which attach to aquatic plants and enable the developing mosquito to obtain air.

Adults were collected from June through September in southwestern Virginia (Franklin and Pittsylvania Counties). Peak of flight activity studies revealed that this mosquito is most active during the early evening hours from dusk until about 11 p.m., after which time flight subsides to generally low levels. However, no flight activity was observed for this species during the full daylight hours.

In eastern Virginia this species often appears in highly annoying numbers. Dorer, *et al.* (1950) found *M. perturbans* most frequently associated with the aquatic plant arrowhead (*Sagittaria* sp.) in Seashore State Park (Virginia Beach), Va. At Smith Mountain Lake, however, the species appeared to breed most commonly in association with aquatic sedges (*Carex* spp.).

GENUS TOXORHYNCHITES THEOBALD

Toxorhynchites rutilus (Coquillett):—*T. rutilus rutilus* and *T. rutilus septentrionalis* are the two subspecies that comprise this species. The larvae usually develop in tree-hole cavities, often in the company of other tree-hole mosquitoes such as *A. triseriatus*, which may provide food for the predacious *Toxorhynchites*.

The adult is large, brightly metallic colored, and chiefly a diurnal flier. The females do not take blood meals and both sexes are believed to be nectar feeders; consequently, the species is of little economic significance.

This species was taken on one occasion (Aug. 18, 1966) by the authors from a Malaise trap maintained in Franklin County throughout the 1966 season.

GENUS ORTHOPODOMYIA THEOBALD

Orthopodomyia alba Baker:—Although not noted in the list of Virginia mosquitoes by Dorer, *et al.* (1944), one larva of *O. alba* was collected from a tree hole near Williamsburg by Dorsey (1944). This is the only known record of the occurrence of this species within Virginia.

King, *et al.* (1960) quote from Jenkins and Carpenter (1946) that *O. alba* is frequently associated with the larvae of the closely related species *O. signifera* in the tree-hole breeding habitat; however, *O. alba* is much less commonly encountered. Very little is known of the feeding habits of the adults. It is unlikely that they partake of human blood to any significant degree, since Wilkins and Breeland (1951) could not induce caged adults to feed when offered the exposed arms of the authors.

Orthopodomyia signifera (Coquillett):—Not a single specimen of either *O. alba* or *O. signifera* was collected in the two-year Smith Mountain Reservoir survey. Adults reared from larvae collected from tree-hole water in Giles County could only be identified as *Orthopodomyia* spp. by the writers. Dorer, *et al.* (1944) classify the occurrence of *O. signifera* as "rare" in Virginia, but collections of this species have been made in the Hampton Roads area and northern Virginia.

GENUS PSOROPHORA ROBINEAU-DESVOIDY

Psorophora ciliata (Fabricius):—"The Shaggy-Legged Gallinipper" is the name often applied to this very large mosquito. To the authors' knowledge, there is no pest mosquito in North America that is comparable in size to *P. ciliata*. It is often frightening for an individual to sense an insect biting and look down to discover that a mosquito of such dimensions is feeding upon him.

The females are painful, persistent biters and are considered pests. However, the larvae of *P. ciliata* are effectively predacious upon larvae of associated species. In light of their predatory larval habits, they may be considered somewhat beneficial.

Light-trap collections produced a total of only 10 specimens of *P. ciliata* from Franklin County in two summers of sampling. In addition, no larval specimens of this species were ever taken from any of the temporary floodwater situations sampled during the study. Two females were taken in biting collections conducted in Pittsylvania County, but no adults were captured in a Malaise trap maintained in the same area. The scant numbers of *P. ciliata* encountered in the survey indicate that this mosquito is relatively uncommon in southwestern Virginia.

Psorophora confinnis (Lynch-Arribalzaga):—*P. confinnis* constitutes a severe pest problem in the rice growing regions of Arkansas, where Schwaradt (1939) estimates that the species comprises about 80 to 90% of the mosquito fauna of that region. The Everglades region of Florida also suffers from periodic plagues of this mosquito; Bishopp (1933) has reported the death of over 150 head of livestock attributed to an outbreak of *P. confinnis*. Although fairly common, it is usually considered

to be of secondary pest importance throughout the remainder of its range. Adults may disperse a considerable distance from their breeding grounds, since Horsfall (1942) trapped marked individuals up to 9 miles from their release point.

Large numbers of *P. confinnis* larvae were collected from numerous temporary rainpools (Fig. 1) in Franklin County. Adults bit readily and persistently in full daylight when the vegetation about their breeding sites was disturbed. In the five counties included in the survey, *P. confinnis* comprised 3.2% of the total mosquito population as determined by light-trap collections. Larvae were collected in Franklin County as early as May 7, 1966, and adults were active from May 27 until September 21.

Psorophora cyanescens (Coquillett):—According to Carpenter, *et al.* (1946), this species is more abundant in certain areas of Alabama, Mississippi, Louisiana, and Arkansas than in the Atlantic coastal plains. *P. cyanescens* is quite rare in Virginia. The only existing record of its collection in the state prior to the authors' survey was that of Dorer, *et al.* (1944), who reported a single female from Lee County on August 10, 1943. However, a Malaise-trap sample taken by the authors on August 31, 1966, produced a single female from Pittsylvania County.

Carpenter, *et al.* (1946) state that larvae are found in temporary rain-filled pools in the southern states from May to October, and that adults are often so plentiful following rains that they seriously annoy livestock and interfere with farm work.

Psorophora discolor (Coquillett):—*P. discolor* is another extremely rare species in Virginia. The only record of its occurrence in the state is that of Dyar (1922), who reports its collection from Grassymead on May 24 (the year was not given).

Psorophora ferox (Humboldt):—*P. ferox* is easily recognized as the "white-footed woods mosquito" due to the presence of white scales on segments 4 and 5 of the hind tarsi. This mosquito was frequently encountered in the Smith Mountain survey while attempting to bite during late afternoon. A total of only 12 specimens was taken from six light traps operated for two summers in the Smith Mountain lake region. On the other hand, over 100 *P. ferox* were collected during the 1966 season alone from a single Malaise trap which was operated in the same general vicinity as one of the light traps. This indicates that *P. ferox* either exhibits a weak phototactic response or is primarily active during the diurnal and crepuscular periods of the day.

The seasonal occurrence of the adults appears to be generally restricted to August and September in southwestern Virginia. Over 95% of the

total *P. ferox* specimens from a Malaise trap maintained in Pittsylvania County were collected during these two months in 1966.

Psorophora horrida (Dyar and Knab):—This species is yet another *Psorophora* that is almost unknown in Virginia. Dorer, *et al.* (1944) list its collection from Woodstock (Shenandoah County) by F. C. Pratt in 1904. Very little is known of the bionomics of this mosquito species.

Psorophora howardi (Coquillett):—No specimens of *P. howardi* were collected in the Smith Mountain survey; however, they are often encountered in eastern Virginia. King, *et al.* (1960) state that *P. howardi* is similar to *P. ciliata* in general appearance and habits and that the larvae are predacious on other mosquitoes.

Psorophora varipes (Coquillett):—Dorer, *et al.* (1944) report *P. varipes* from biting collections conducted in Virginia Beach and Camp Lee, Prince George Co., Virginia. This is the only known record of its occurrence within the state.

GENUS URANOTAENIA LYNCH-ARRIBALZAGA

Uranotaenia sapphirina (Osten-Sacken):—This small, dark mosquito is readily recognized by the presence of extremely bright blue scales on the wings and thorax. *U. sapphirina* is of no economic importance since it has never been known to attack man or other warm-blooded animals.

U. sapphirina represented 1.6% of total light-trap collections and 1.1% of total Malaise-trap collections in the Smith Mountain area. Adults were collected from July until September, but were most active from mid-August through mid-September. The most productive breeding habitat for *U. sapphirina* found in the survey was an impounded creek which contained an abundance of fallen timber (Fig. 4). This site also supported larval populations of *A. crucians*, *A. quadrimaculatus*, *A. punctipennis*, *C. restuans*, and *C. territans*.

LITERATURE CITED

- BICKLEY, W. E. 1957. Notes on the distribution of mosquitoes in Maryland and Virginia. *Mosq. News.* 17(1): 22-25.
- BISHOPP, F. C. 1933. Mosquitoes kill livestock. *Science.* 77: 115-16.
- BRADLEY, G. H. and W. V. KING. 1941. Bionomics and ecology of nearctic *Anopheles*. *Amer. Assoc. Adv. Sci. Publ. No. 15:* 79-87.
- CARPENTER, S. J. 1941. The mosquitoes of Arkansas. 2nd ed. Ark. State Board of Health; Little Rock, Ark. 87 p., 15 plates, 1 table.
- CARPENTER, S. J., W. W. MIDDLEKAUFF, and R. W. CHAMBERLAIN. 1946. The mosquitoes of the southern United States east of Oklahoma and Texas. The Univ. Press, Notre Dame, Ind. *Amer. Midl. Nat. Monog. No. 3:* 292 p., illus.
- CARPENTER, S. J. and W. J. LACASSE. 1955. Mosquitoes of North America (north of Mexico). University of California Press; Berkeley and Los Angeles, vi + 360 p., illus.
- CHAMBERLAIN, R. W., R. K. SIKES, D. B. NELSON, and W. D. SUDIA. 1954. Studies on the North American arthropod-borne encephalitides. VI. Quantitative determinations of virus-vector relationships. *Amer. J. Hyg.* 60: 278-85.
- DARSIE, R. F., D. MACCREARY, and L. A. STEARNS. 1951. An annotated list of the mosquitoes of Delaware. *Proc. of the 38th Annu. Meeting N. J. Mosq. Exterm. Assoc.*, p. 137-46.
- DORER, R. E., W. E. BICKLEY, and H. P. NICHOLSON. 1944. An annotated list of the mosquitoes of Virginia. *Mosq. News.* 4(1): 48-50.
- DORER, R. E., R. G. CARTER, and W. E. BICKLEY. 1950. Observations on the pupae of *Mansonia perturbans* (Walk.) in Virginia. *Proc. of the 37th Annu. Meeting N. J. Mosq. Exterm. Assoc.*, p. 110-12.
- DORSEY, C. K. 1944. Mosquito survey activities at Camp Peary, Virginia. *Ann. Entomol. Soc. Amer.* 37(3): 376-87.
- DYAR H. G. 1922. The mosquitoes of the United States. *Proc. U. S. Nat Mus.* 62: 1-119.
- FREEBORN, S. B. 1926. The mosquitoes of California. *Agric. Expt. Sta. Tech. Bull.* 3: 127 p.
- HEADLEE, T. J. 1921. The mosquitoes of New Jersey and their control. *N. J. Agric. Expt. Sta. Bull. No. 343:* 229 p., illus.
- HORSFALL, W. R. 1942. Biology and control of mosquitoes in the rice area. *Ark. Agric. Expt. Sta. Bull. No. 427:* 46 p.
- HORSFALL, W. R. 1955. Mosquitoes—their bionomics and relation to disease. The Ronald Press Co., New York. Viii + 723 p., 206 tables.

- JENKINS, D. W. and S. J. CARPENTER. 1946. Ecology of the tree hole breeding mosquitoes of Nearctic North America. *Ecol. Monog.*, 16: 33-48.
- KING, W. V., G. H. BRADLEY, C. N. SMITH, and W. C. McDUFFIE. 1960. A handbook of the mosquitoes of the Southeastern United States. U. S. Dept. of Agric. Handbook No. 173: 188 p., 25 figs., 10 plates.
- MACCREARY, D. and L. A. STEARNS. 1937. Mosquito migration across Delaware Bay. *Proc. of the 24th Annu. Meeting N. J. Mosq. Exterm. Assoc.*, p. 188-97.
- MATHESON, R. 1966. Handbook of the mosquitoes of North America. 2nd ed. Hafner Publishing Co., New York and London. viii + 314 p., 41 figs., 33 plates.
- MICHENER, C. D. 1947. Mosquitoes of a limited area in southern Mississippi. *Amer. Midl. Nat.* 37: 325-74.
- MITCHELL, E. G. 1907. Mosquito life. G. P. Putnam's Sons, Salem, Mass. 281 p.
- OWEN, W. B. 1937. The mosquitoes of Minnesota, with special reference to their biologies. *Minn. Agric. Expt. Sta. Tech. Bull.* No. 126: 75 p.
- ROZEBOOM, L. E. 1942. The mosquitoes of Oklahoma. *Okla. Agric. Expt. Sta. Tech. Bull.* No. 16: 56 p.
- SCHLISSMANN, D. J. 1964. The *Aedes aegypti* eradication program of the U. S. *Mosq. News.* 24(2): 124-32.
- SCHWARDT, H. H. 1939. Biologies of Arkansas rice field mosquitoes. *Ark. Agric. Expt. Sta. Bull.* No. 377: 22 p.
- STEARNS, L. A., D. MACCREARY, and N. P. NEWHOUSE. 1933. The problem of mosquito control in Delaware. *Del. Agric. Expt. Sta. Bull.* No. 181: 106 p.
- TOWNES, H. 1962. Design for a Malaise trap. *Proc. Entomol. Soc. Wash.* 64(4): 253-62.
- WALLIS, R. C. and A. SPIELMAN. 1953. Laboratory rearing of *Culex salinarius*. *Proc. Entomol. Soc. Wash.* 55(3): 140-42.
- WILKINS, O. P. and O. P. BRELAND. 1951. The larval stages and the biology of the mosquito, *Orthopodomyia alba* Baker (Diptera: Culicidae). *J. N. Y. Entomol. Soc.* 59: 225-40.