

THE MOSQUITOES OF TENNESSEE¹

ARTHUR SHLAIFER

Passed Assistant Sanitarian (R), United States Public Health Service Assigned to Tennessee

AND

DELMA E. HARDING

Assistant Entomologist, United States Public Health Service Formerly Assigned to Tennessee, Now in the Office of Malaria Control in War Areas, Atlanta, Georgia

INTRODUCTION

Recent interest in public health activities relative to mosquitoes and the part they play in disease transmission has necessitated a critical appraisal of mosquito fauna. King, Bradley, and McNeel (1944) have presented general information about the mosquitoes of the southeastern United States. The present report is restricted to an account of those species found in Tennessee, their abundance, distribution, and larval associations. It is based chiefly on data collected during the period 1942-45 by the Tennessee Department of Public Health, while engaged cooperatively with the United States Public Health Service and the United States Army in malaria mosquito control activities. Data from other sources are indicated by references to the publications in which they occur.

Methods used in collecting mosquitoes included the operation of New Jersey-type mechanical light traps; the inspection of adult mosquito resting places such as barns, bridges, chicken houses, etc.; the securing of biting records; and the inspection of water areas for mosquito larvae.

Results are based upon records of thousands of collections. Since most of the data were obtained in, and within the vicinity of, various important war areas, the geographical distribution records are somewhat limited. West Tennessee is the section represented most frequently.

GEOGRAPHICAL DISTRIBUTION AND RELATIVE ABUNDANCE OF MOSQUITOES RECORDED FOR TENNESSEE

Mosquito records are available for 26 of the 95 counties in Tennessee. According to location, the counties are classified as West, Middle, or East Tennessee counties. Records are given by counties, except for those in the Norris Reservoir area. No specific county

¹From the Division of Preventable Diseases, Tennessee Department of Public Health. The authors express their appreciation for the assistance of Mr. G. H. Bradley, Senior Entomologist (R), U. S. Public Health Service, Malaria Control in War Areas; Mr. T. E. McNeel, Sanitarian (R), U. S. Public Health Service, Malaria Control in War Areas; and associates in the program of Malaria Control in War Areas in the State of Tennessee.

data are available for the Norris area which consists of sections of Anderson, Campbell, Claiborne, Grainger, and Union counties.

Names of all mosquitoes known to occur in the state appear in Table 1. A + symbol indicates that at least one adult or larval specimen of the species was found. Relative abundance of each species is based upon records for the total number of specimens obtained, rather than upon the number of counties for which the species is recorded. For the state as a whole, abundance is rated in decreasing order as: 1, very abundant; 2, less numerous; 3, 4, and 5, rare.

Melanoconion, a subgenus of *Culex*, is listed in addition to *Culex erraticus*, although most records of the subgenus probably are of *C.*

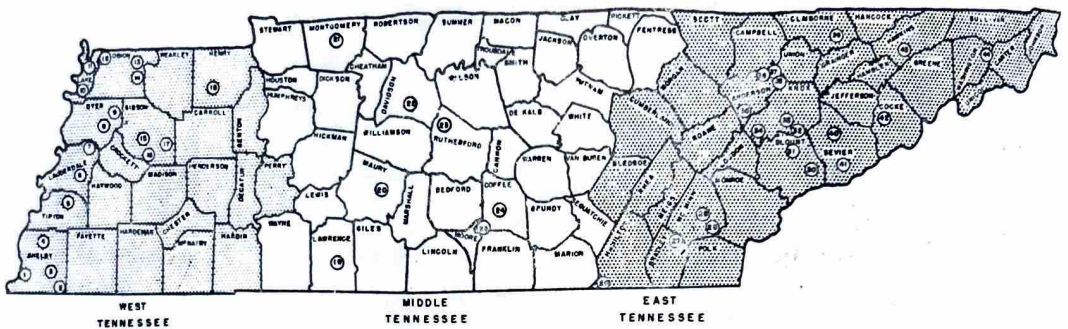


Fig. 1. A county map of Tennessee showing mosquito collection localities. 1, Memphis; 2, Collierville; 3, Cordova; 4, Millington (all of the preceding in Shelby County); 5, Covington (Tipton County); 6, Ripley; 7, Halls (Lauderdale County); 8, Dyersburg; 9, Newbern (Dyer County); 10, Ridgley; 11, Tiptonville (Lake County); 12, Walnut Log; 13, Union City; 14, Rives (Obion County); 15, Trenton; 16, Humboldt; 17, Milan (Gibson County); 18, Paris (Henry County); 19, Lawrenceburg (Lawrence County); 20, Columbia (Maury County); 21, Clarksville (Montgomery County); 22, Nashville (Davidson County); 23, Smyrna (Rutherford County); 24, Manchester; 25, Tullahoma (Coffee County); 26, Chattanooga (Hamilton County); 27, Charleston (Bradley County); 28, Etowah; 29, Athens (McMinn County); 30, Kinzel Springs; 31, Alcoa-Maryville (Blount County); 32, Neubert Springs; 33, Knoxville; 34, Concord (Knox County); 35, Oak Ridge; 36, Lake City; 37, Norris Dam; 38, Norris (Anderson County); 39, Tazewell (Claiborne County); 40, Sevierville; 41, Gatlinburg (Sevier County); 42, Newport (Cocke County); 43, Rogersville (Hawkins County); 44, Johnson City (Washington County).

erraticus. This procedure was necessary because many adult specimens were not identified to species, and the county distribution and the relative abundance of *Melanoconion* differ considerably from those of known *C. erraticus* identifications. When no attempt was made to distinguish between *Culex quinquefasciatus* and *Culex pipiens*, these species are referred to as *Culex quinquefasciatus-pipiens*.

Forty-four species of mosquitoes included in nine different genera have been found in Tennessee. A comparison of county or regional representation of species is omitted because of the variation in entomological investigation for individual counties and regions. Inspection in West Tennessee has been more extensive than in the other

two regions. Thirteen of the 43 species recorded for West Tennessee are not recorded for Middle Tennessee, but each of these is classed as rare. Each of the 30 species listed for Middle Tennessee is listed for West Tennessee. Although investigation in East Tennessee was less extensive than elsewhere, 29 species are reported from this region. With the exception of *Aedes atropalpus*, all species found in East Tennessee were also found in West Tennessee.

In terms of relative abundance, most of the species collected are classed as rare, and only one species, *Aedes vexans*, as very abundant. Species recorded from only a few counties are classed as rare. Additional investigation will probably furnish an increase in the number of county records for most species.

MONTHLY OCCURRENCE OF MOSQUITOES RECORDED FOR TENNESSEE

The occurrence of the various species by months is listed in Table 2. Distribution records for each month of the year are available because the Tennessee Department of Public Health continued to make inspections for mosquitoes during the winter in an attempt to gather data bearing on control.

Species records are further divided to show whether adult or larval specimens were collected. An "A" indicates that at least one adult was found during the month, and an "L" the occurrence of at least one larva. No larval data are given for *Melanoconion* as all larvae obtained in this subgenus were identified to species.

An analysis of Table 2 indicates the April-October period as the breeding season for most species of mosquitoes. Combined adult and larval data show an average of 29 mosquito species recorded per month during this period. Twenty-eight of these represent adult records; 18 are larval records. During the November-March period, an average of 12 species per month was recorded; 11 of these were adult records, and 9 larval. With the exception of April, general averages for each month were quite consistent.

Of the four major genera of mosquitoes represented, the monthly distribution range for *Aedes* and *Psorophora* is distinctly more limited than that of *Anopheles* and *Culex*. Although species of the latter two are represented frequently in the November-March period, such monthly occurrences are very rare in the genus *Aedes* and completely absent for *Psorophora*.

LARVAL ASSOCIATIONS

Larval associations for 28 of the species known to occur in Tennessee are listed in Table 3. Larvae of these species were collected one or more times in association with at least one other species. The number of times that a species was taken alone is not indicated. All figures, with the exception of those in the last vertical column, refer to the number of times the two species concerned were found in association.

TABLE 1. The geographical distribution by county and the relative abundance of the mosquitoes recorded for Tennessee

GENUS AND SPECIES	POLITICAL SUBDIVISION AND COUNTY																												RELATIVE ABUNDANCE ²
	WEST TENNESSEE								MIDDLE TENNESSEE								EAST TENNESSEE												
	CARROLL	DYER	GIBSON	HENRY	LAKE	LAUDERDALE	OBION	SHELBY	TIPTON	COFFEE	DAVIDSON	LAWRENCE	MAURY	MONTGOMERY	RUTHERFORD	ANDERSON	BLOUNT	BRADLEY	CLAIBORNE	COCKE	HAMILTON	HAWKINS	KNOX	MCMINN	SEVIER	WASHINGTON	NORRIS RESERVOIR AREA ¹		
<i>Aedes aegypti</i>	+						+			+				+														+	5
<i>A. atropalpus</i>	+																											+	5
<i>A. canadensis</i>	+		+				+																						5
<i>A. cinereus</i>			+				+																						5
<i>A. dupreei</i>				+			+																						5
<i>A. fulvus pallens</i>			+				+																						5
<i>A. grossbecki</i>																													5
<i>A. infirmatus</i>																													5
<i>A. mitchellae</i>																													5
<i>A. sticticus</i>	+		+				+							+															2
<i>A. thibaulti</i>	+		+				+																						5
<i>A. triseriatus</i>	+		+				+																						4
<i>A. trivittatus</i>	+		+				+																						5
<i>A. vexans</i>	+		+				+																						1
<i>Anopheles barberi</i>	+		+				+																						5
<i>A. crucians</i>	+		+				+																						5
<i>A. pseudopunctipennis</i>	+		+				+																						5
<i>A. punctipennis</i>	+		+				+																						2

¹Includes portions of Anderson, Campbell, Claiborne, Grainger, and Union counties.
²The higher the number, the less abundant the mosquito: 1 indicates a very abundant species and 5 a rare species.

TABLE 2. The recorded monthly occurrence of mosquitoes found in Tennessee

GENUS AND SPECIES	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
<i>Aedes aegypti</i>						A ¹	A	A	AL	A		
<i>A. atropalpus</i>					L ²							
<i>A. canadensis</i>			L	AL	AL	A	A			L		
<i>A. cinereus</i>				A	A	A	A	A	A			
<i>A. dupreei</i>					A	A	A	A		A		
<i>A. fulvus pallens</i>				A								
<i>A. grossbecki</i>												
<i>A. infirmatus</i>						A						
<i>A. mitchellae</i>					A	A						
<i>A. sticticus</i>			AL	AL	AL	A	A	A	A	A		
<i>A. thibaulti</i>					A							
<i>A. triseriatus</i>				AL	AL	AL	AL	AL	AL	A		
<i>A. trivittatus</i>						A						L
<i>A. vexans</i>			AL	AL	AL	AL	AL	AL	AL	AL	A	
<i>Anopheles barberi</i>				A	AL	AL	A	A	A			
<i>A. crucians</i>	L	AL	AL	AL	AL	A	AL	AL	A	AL	AL	AL
<i>A. pseudopunctipennis</i> ³												
<i>A. punctipennis</i>	AL	AL	AL	AL	AL	AL	AL	AL	AL	AL	AL	AL
<i>A. quadrimaculatus</i>	A	A	AL	AL	AL	AL	AL	AL	AL	AL	AL	AL
<i>A. walkeri</i>						A	AL	AL	A			
<i>Culex apicalis</i>	AL	A	A	AL	AL	AL	AL	AL	AL	AL	AL	AL
<i>C. erraticus</i>					L	AL	AL	AL	AL	A		
<i>C. Melanoconion</i>	A		A	A	A	A	A	A	A	A	A	A
<i>C. nigripalpus</i>					A			AL				
<i>C. peccator</i>				L		A	A	A	AL	A		
<i>C. pipiens</i>		A	A	A	A	A	A	A	A	A	A	A
<i>C. quinquefasciatus</i>		A	A	A	A	A	A	A	A	A	A	A
<i>C. quinquefasciatus-pipiens</i>	AL	A	A	A	AL	AL	AL	AL	AL	AL	AL	AL
<i>C. restuans</i>	AL	A	AL	AL	AL	AL	AL	AL	AL	AL	AL	AL
<i>C. salinarius</i>	AL	AL	A	A	AL	AL	AL	AL	AL	AL	AL	AL
<i>C. tarsalis</i>					A	A		A	AL	AL	A	
<i>Culiseta inornata</i>	L	L	AL	AL	AL			A	A	AL	AL	AL
<i>C. melanura</i>						A	A		AL	A		
<i>Mansonia perturbans</i>												
<i>Megarhinus sp.</i> ⁴					L	A		A	A			
<i>M. septentrionalis</i> ⁵		L										
<i>Orthopodomyia signifera</i>	L	L	L	L	A	AL	AL	AL	AL	AL		
<i>Psorophora ciliata</i>					AL	AL	AL	AL	AL	AL		
<i>P. confinnis</i>				L	AL	AL	AL	AL	AL	AL		
<i>P. cyanescens</i>					A	A	A	AL	AL	A		
<i>P. discolor</i>					A	AL	AL	AL	AL	A		
<i>P. ferox</i>				A	A	AL	AL	AL	AL	A		
<i>P. horrida</i>					AL	AL	AL	AL	AL			
<i>P. howardii</i>					A							
<i>P. signipennis</i> ³					AL	AL	AL		AL			
<i>P. varipes</i>												
<i>Uranotaenia sapphirina</i>	A			A	A	AL	AL	AL	AL	A	A	A

¹Adult(s) recorded. ²Larva (e) recorded. ³No data on month of occurrence. ⁴Probably *M. septentrionalis*. ⁵No specific monthly data; recorded during the summer.

Data presented in Table 3 show that *Culex restuans* was found in association with 18 other species. Closely following this record, larvae of *Aedes vexans*, *Anopheles punctipennis*, and *Culex apicalis* were taken in association with 17 species, and *Culex quinquefasciatus* with 16 species.

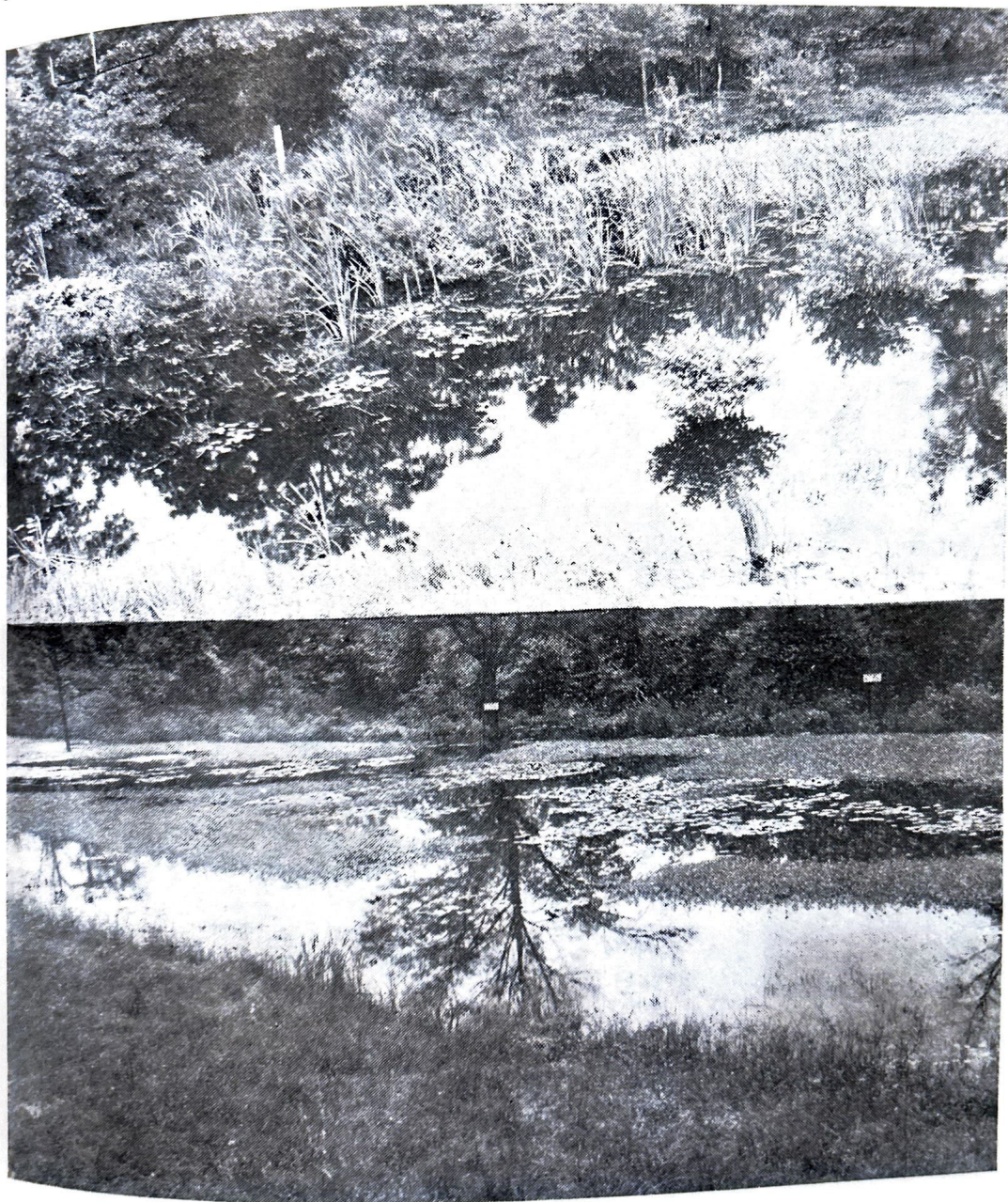


Fig. 2. Typical breeding places of *Anopheles quadrimaculatus*.

A comparison of data from Table 3 with those in Table 1 shows a rather close correlation between the relative abundance of a species and the number of species with which it is found in larval association.

TABLE 3. The occurrence of larval associations

GENUS AND SPECIES	A. A.	A. C.	A. S.	A. T.	A. V.	A. B.	A. G.	A. F.	A. Q.	A. P.	C. A.	C. H.	C. N.	C. P.	C. O.	C. P.	C. R.	C. S.	C. T.	C. I.	M.	O. S.	P. C.	P. C.	P. C.	P. D.	P. F.	P. H.	U. S.	TOTAL NO. SP.
	<i>Aedes aegypti</i>															2 ²														
<i>A. canadensis</i>			2	1	15			6		3							10			11										10
<i>A. sticticus</i>	2			5			1										3			3										6
<i>A. triseriatus</i>	1				1			1							2		3			4										5
<i>A. vexans</i>	15		5	1				32	3	23	3				3		44		5	9			1	4	29	3	7	1		17
<i>Anopheles barberi</i>																	1				10					1				1
<i>A. crucians</i>								5	3	4	1																			2
<i>A. punctipennis</i>	6	1	32			5		48	146	15					2	37	100	29	24					1		2	1			10
<i>A. quadrimaculatus</i>			3			3		48	18	16					11		8	7						1	8					10
<i>Culex apicalis</i>	3	1	23			4		146	18	13					3	27	105	34	19				1	5		1	2			9
<i>C. erraticus</i>						1		15	16	13					1		3	2						1						6
<i>C. nigripalpus</i>																	1	2												3
<i>C. peccator</i>	3							2		3							2	1												7
<i>C. quinquefasciatus-pipiens</i>	2		2	3				3	11	2	1				1		4	1												15
<i>C. restuans</i>	10	3	3	44	1			100	8	105	3	2	4	73	29	2	12							2	11		1			18
<i>C. salinarius</i>	1			5		1		29	7	34	2	1	1	29	38															14
<i>C. tarsalis</i>															2															1
<i>Culiseta inornata</i>	11	3	9			10		24	19					1	12	34	5													11
<i>Megarhinus</i> sp. ³																														1
<i>Orthopodomyia signifera</i>	1		4	1					1																					7
<i>Psorophora ciliata</i>								1																						6
<i>P. confinnis</i>								8	2	5	1			2	1															12
<i>P. cyanescens</i>																														6
<i>P. discolor</i>																														1
<i>P. ferox</i>						3		1	2																					5
<i>P. howardii</i>						7		1																						2
<i>Uranotaenia sapphirina</i>						1		2	10	5	9	6																		6

¹The abbreviation A. A. at the head of this column is for *Aedes aegypti*, the first name in the column at the extreme left; the other abbreviations in the second column to the right of this column is for the second name in the left-hand column. Similarly, all the other abbreviations in the vertical columns are for the names in the left vertical column.
²The figures represent the number of times the two species were taken together.
³Probably *M. septentrionalis*.
⁴Total No. sp. represents the number of species that have been found associated with the mosquito whose name is in the left-hand vertical column.

Representatives of *Aedes* and *Psorophora* are found in larval association with a smaller average number of species than are representatives of *Anopheles* and *Culex*.

The data presented indicate no clear-cut larval association groups. In only two instances is one of two associated species restricted to virtually the same associations as the other. This pattern occurs in the *Culex apicalis*-*Anopheles punctipennis*, and the *Culex erraticus*-*Anopheles quadrimaculatus* associations.

NOTES ON SPECIES

Aedes aegypti (L.). This species is classified as rare, which may be due to the methods used in collecting and the places investigated being generally unsuited for it. Records show that it is found in West, Middle, and East Tennessee. Adults have been collected from June through October, but larvae, which occur in artificial containers in the vicinity of human habitations, were collected only in September. Larval association was only with *Culex quinquefasciatus-pipiens*. It has been found at Athens (Arnold, 1940), Clarksville, Knoxville (Dyar, 1922), Memphis, Milan, Nashville, the Norris Reservoir area (Shields, 1938), and Tullahoma. *Aedes aegypti* attacks quietly and bites mainly during the daylight hours. Thus, it is seldom taken in light traps. It is a vector of yellow fever and dengue fever, and so is of major public health importance.

Aedes atropalpus (Coq.). This is a rare species collected only from East Tennessee in May. Larvae were found in rock holes along streams, but no data are available on their associations with other mosquito larvae. *Atropalpus* is said to be a strong biter in the vicinity of its breeding places. Records are from Kinzel Springs (Shields, 1938), Knoxville (Shields, 1938), and Neubert Springs (Arnold, 1940).

Aedes canadensis (Theob.). Although classed as rare, *Aedes canadensis* may be collected in some abundance during the early spring. Records are from West, Middle, and East Tennessee. The adults are persistent biters and have been taken from April through July, and larvae during March, April, and May. United States Army data show one larval record for October near Halls, Tennessee. *Aedes canadensis* larvae occur in temporary pools and have been found in association with larvae of 10 species, most commonly with *Aedes vexans*. Collection localities include Cordova, Halls, Manchester, Memphis, Milan, Millington, the Norris Reservoir area (Shields, 1938), Paris, Tullahoma, and Union City.

Aedes cinereus Meig. This is a rare species recorded only from Memphis (Middlekauff and Carpenter, 1944) in Shelby County, West Tennessee. Adults were found in April and May. Larvae occur in early spring pools but have not been reported for Tennessee.

Aedes dupreii (Coq.). This is a rare species collected in two West Tennessee counties and one Middle Tennessee county, the localities being Cordova, Memphis, Millington, Paris, and Smyrna. Adults have been recorded from May through October. Larvae occur in temporary rain puddles but have not been reported for Tennessee.

Aedes fulvus pallens Ross. Collections from only two counties in West Tennessee contained this rare species. These were made during April, June, July, and August, in Cordova, Memphis, and Milan. No larval data are available.

Aedes grossbecki D. and K. This is another rare species, recorded only from Memphis in Shelby County, West Tennessee. Adults were collected in April. Larvae which are said to occur in early spring pools, have not been reported.

Aedes infirmatus D. and K. Apparently this vicious biter is rare in the State. It has been collected in only two counties, one in West and one in East Tennessee. Adults are recorded for the month of June and are from Memphis and Sevierville (Arnold, 1940). Larvae occur in temporary rain pools but are not recorded for Tennessee.

Aedes mitchellae (Dyar). From Memphis and Millington in Shelby County, West Tennessee, come the only records for the rare *Aedes mitchellae*. Adults have been collected in May and June, but no larvae have been secured. The species breeds in rain-water pools and is a rather severe biter.

Aedes sticticus (Meig.). This species is relatively abundant, especially during the spring and early summer months. It has been collected in West, Middle, and East Tennessee. Adults bite freely and are recorded from March through October, while larvae are recorded from March through May. Larvae are found in floodwaters and have been taken in association with 6 other species, mainly *Aedes vexans*. Records are from Athens (Arnold, 1940), Clarksville, Cordova, Dyersburg, Halls, Humboldt, Memphis, Milan, Millington, Nashville, Paris, Rives (Dyar, 1922), Trenton, Tullahoma, and Union City.

Aedes thibaulti D. and K. This is a rare species recorded only from Paris (Carpenter, Chamberlain, and Wanamaker, 1945) in Henry County, West Tennessee. The single monthly record for an adult is in May. No larval data are available. Breeding occurs in stump holes.

Aedes triseriatus (Say). Although this painful biter is not abundant, it has been collected in West, Middle, and East Tennessee. Adult records for *Aedes triseriatus* are positive from April through October, and larval records from April through September. One larva, however, was collected in December. Breeding occurs principally in tree holes but may occur in artificial containers. Larvae have been found in association with 5 species, chiefly *Orthopodomyia signifera*. Locality records include Athens (Arnold, 1940), Chattanooga (Dyar, 1922), Clarksville, Cordova, Dyersburg, Knoxville (Arnold, 1940), Memphis, Milan, Millington, the Norris Reservoir area (Shields, 1938), Paris, Smyrna, Tullahoma, and Union City.

Aedes trivittatus (Coq.). This is a rare species recorded only from Paris (King, Roth, Toffaleti, and Middlekauff, 1943) in Henry County, West Tennessee. One adult was collected in June but no larvae have been reported.

Aedes vexans (Meig.). This species is classed as the most abundant mosquito in the state. It is a very annoying biter and an important pest in some areas. Collections are from West, Middle, and East Tennessee. Adults are recorded from March through November; larvae from March through October. Larvae are found in rain pools and floodwaters and have been taken in association with 17 other species, chiefly *Culex restuans*, *Anopheles punctipennis*, *Psorophora fonnimis*, and *Culex apicalis*. Locality records are numerous and include Chattanooga, Clarksville, Cordova, Dyersburg, Halls, Humboldt, Knoxville (Arnold, 1940), Manchester, Memphis, Milan, Millington, Nashville, the Norris Reservoir area (Shields, 1938), Paris, Reelfoot Lake (Brown and Pearson, 1938), Rives (Dyar, 1922), Smyrna, Trenton, Tullahoma, and Union City.

Anopheles barberi (Coq.). This rare species has been collected in West, Middle, and East Tennessee. Adults have been found from April through September; larvae only in May and June. *Anopheles barberi* breeds mostly in tree holes but has been found in artificial containers. It has been taken in larval association only with *Culex restuans*, and this occurred in an artificial container. Locality records include Dyersburg, Memphis, Norris (Shields, 1938), Oak Ridge, Paris, Reelfoot Lake (Brown and Pearson, 1938), Smyrna, and Tazewell (Arnold, 1940). *A. Barberi* has been reported to be a severe biter.

Anopheles crucians Wied. This species is comparatively rare but has been collected in a number of West and Middle Tennessee counties. Adults bite freely and have been found during every month except January; larvae every month except June and September. Larvae occur in swamps, marshes, and stagnant pools and have been taken in association with 8 species, chiefly *Culiseta inornata*. Collection localities include Clarksville, Cordova, Covington, Halls, Humboldt, Memphis, Milan, Millington, Nashville, Newbern, Paris, Smyrna, Trenton, Tullahoma, and Walnut Log on Reelfoot Lake (Johnson, 1936).

Anopheles pseudopunctipennis Theob. This is a rare species recorded only from Memphis (Dyar, 1928) in Shelby County, West Tennessee. Monthly distribution data for adults and larvae are not available. *A. pseudopunctipennis* breeds in warm, sunny pools.

Anopheles punctipennis (Say). This abundant species has been collected in West, Middle, and East Tennessee. According to available data, it is the only mosquito which has been found in both the adult and larval stages during every month of the year. It does not feed extensively on human beings under natural conditions. Larvae occur in a variety of temporary and permanent situations and are found frequently along the margins of flowing streams; they have been taken in association with 17 species, especially *Culex apicalis* and *Culex restuans*. Abundant locality records include Alcoa-Maryville, Chattanooga, Clarksville, Collierville, Cordova, Covington, Dyersburg, Halls, Humboldt, Knoxville (Arnold, 1940), Lawrenceburg, Manchester, Memphis, Milan, Millington, Nashville, Newbern, Norris (Arnold, 1940), the Norris Reservoir area (Shields, 1938), Oak Ridge, Paris, Reelfoot Lake (Brown and Pearson, 1938), Ridgley, Ripley, Smyrna, Tiptonville, Trenton, Tullahoma, and Union City.

Anopheles quadrimaculatus Say. This, the common vector of malaria in the Southeastern United States, is considered the most important mosquito in Tennessee. (The other Tennessee anophelines are susceptible to infection with malaria parasites but are not considered important in the transmission of the disease.) Specimens are abundant and frequently are referred to as "quads." The species has been collected from West, Middle, and East Tennessee. Adults are recorded for every month of the year, and larvae for every month except January and February. Adults found during the winter months are generally in a "hibernating" position, *i.e.*, their bodies are parallel to the surface upon which they are resting rather than at an angle to it. Females are active principally at night and will seek blood meals in dwellings. Available data indicate that *A. quadrimaculatus* ordinarily does not breed in Tennessee during the winter, but is carried over to the spring season by hibernating females. Breeding occurs in many situations such as ponds, freshwater pools, lakes, swamps, and in vegetation in slow-flowing streams. Larvae have been taken in association with 10 species, chiefly *Anopheles punctipennis*. Locality records are identical with those for *A. punctipennis*, except that *A. quadrimaculatus* has not been reported from Knoxville and Norris, and has been collected at Rives (Dyar, 1922).

Anopheles walkeri Theob. Although this mosquito is classified as rare, it may be abundant locally (Bang, Quinby, and Simpson, 1943). It is recorded only from Obion County in West Tennessee, where it was collected at Walnut Log on Reelfoot Lake (Johnson, 1936). Adults, which bite man readily, have been taken in June, July, August, and September, and larvae in July and August. *A. walkeri* breeds in freshwater marshes.

Culex apicalis Adams. This species is fairly abundant and has been collected in West, Middle, and East Tennessee. Apparently it does not bite man, but lives on cold-blooded animals. Adults have been collected during every month of the year; larvae every month except February and March. Larvae are found in grassy pools, swamp areas, and along the edges of ponds containing

aquatic vegetation. *C. apicalis* has been taken in association with larvae of 17 species, chiefly *Anopheles punctipennis* and *Culex restuans*. Records are from Chattanooga, Clarksville, Cordova, Dyersburg, Gatlinburg (Arnold, 1940), Halls, Knoxville (Arnold, 1940), Manchester, Memphis, Milan, Millington, Nashville, the Norris Reservoir area (Shields, 1938), Paris, Reelfoot Lake (Brown and Pearson, 1938), Smyrna, Tullahoma, and Union City.

Culex erraticus (D. and K.). This species is not abundant but is found in West, Middle, and East Tennessee. Adults, which may be annoying biters, have been recorded from June through October, and larvae from May through September. Larvae occur in permanent bodies of water containing aquatic vegetation and have been found in association with 10 species, chiefly *Anopheles quadrimaculatus*. Locality records include Halls, Memphis, the Norris Reservoir area (Shields, 1938), Paris, Reelfoot Lake (Brown and Pearson, 1938), Rives (Dyar, 1922), Smyrna, and Tullahoma.

Specimens of the subgenus *Melanoconion*, most of which are probably *C. erraticus*, have been collected in abundance. They have been taken in West, Middle, and East Tennessee. Adults are recorded for every month except February, but specimens found during the colder months are probably overwintering forms. Locality records include Chattanooga, Clarksville, Cordova, Dyersburg, Halls, Humboldt, Manchester, Memphis, Milan, Millington, Nashville, Paris, Smyrna, Trenton, Tullahoma, and Union City.

Culex nigripalpus Theob. This rare species is not a troublesome biter. It has been collected from two counties in West Tennessee and one in Middle Tennessee. Adults have been found in May and August, larvae only in August. Breeding occurs in grassy pools. *C. nigripalpus* has been taken in larval association with *Culex quinquefasciatus-pipiens*, *Culex restuans*, and *Culex salinarius*. Records are from Memphis (Middlekauff and Carpenter, 1944), Paris, and Tullahoma (Middlekauff and Carpenter, 1944).

Culex peccator D. and K. This species is comparatively rare but has been collected in West, Middle, and East Tennessee. Adult records extend from June through October; larvae were taken only during April and September. Breeding occurs in permanent bodies of water containing aquatic vegetation. *Culex peccator* has been taken in larval association with 7 species, mainly with *Culex restuans*. Locality records include Charleston (Arnold, 1940), Halls, Memphis, Paris, Rives (Dyar, 1922), and Tullahoma.

Culex pipiens L. The common northern house mosquito is a troublesome biter. It is fairly abundant and has been taken in West, Middle, and East Tennessee. Adult records include every month except January and are from Clarksville, Concord (Shields, 1938), Halls, Knoxville (Arnold, 1940), Memphis, Nashville, Paris, Smyrna, Tazewell (Shields, 1938), Tullahoma, and Union City. *C. pipiens* is capable of transmitting filariasis, and may be a vector of equine encephalitis.

Culex quinquefasciatus Say. The common southern house mosquito is also a troublesome biter. It is fairly abundant and is recorded from West, Middle, and East Tennessee. Adults have been found during every month except January. Collection localities include Clarksville, Columbia (Dyar, 1922), Cordova, Gatlinburg (Arnold, 1940), Halls, Knoxville (Arnold, 1940), Memphis, Milan, Millington, Nashville, Paris, Reelfoot Lake (Brown and Pearson, 1938), Smyrna, Tullahoma, and Union City. *C. quinquefasciatus* is a vector of filariasis.

Culex quinquefasciatus Say or *Culex pipiens* L. *Culex quinquefasciatus-pipiens* has been collected in abundance and is found in West, Middle, and East Tennessee. Adults were collected during every month of the year, and larvae every month except February, March, and April. Larvae are found in a variety of situations, including artificial receptacles and ground pools; they have been taken in association with 16 species, mainly with *Culex restuans*,

curs in marshes and lakes containing aquatic plants; larvae attach themselves to the roots by their air-tubes. *M. perturbans* has been found at Halls, Paris, Reelfoot Lake (Brown and Pearson, 1938), Sevierville (Arnold, 1940), and Trenton.

Megarhinus septentrionalis D. and K. Larval keys make no attempt to separate the two species of *Megarhinus* found in the United States. Larval specimens from Tennessee, identified as *Megarhinus*, probably are *septentrionalis* since *rutilus* is a very rare species and is not recorded for Tennessee. *M. septentrionalis* has been taken only in West and East Tennessee, and is classed as rare. Larvae have been collected in February; no monthly data are available for adults. Females do not bite animals but feed on nectar found in flowers. Larvae occur in tree holes and artificial receptacles and are predaceous upon other mosquito larvae; they have been taken in association with one species, *Orthopodomyia signifera*. Locality records include Coal Creek (now named Lake City) (Shields, 1938), Knoxville (Dyar, 1922), Memphis, Norris (Arnold, 1940), Reelfoot Lake (Brown and Pearson, 1938), and Tazewell (Shields, 1938).

Orthopodomyia signifera (Coq.). This species is comparatively rare but has been collected in West, Middle, and East Tennessee. Adults are recorded from May through October; larvae every month but May, November, and December. Larvae occur principally in tree holes but occasionally in artificial containers, and have been taken in association with 7 species, chiefly *Aedes triseriatus*. Locality records include Clarksville, Coal Creek (Shields, 1938), Cordova, Memphis, Milan, Millington, Norris Dam (Arnold, 1940), Paris, Reelfoot Lake (Brown and Pearson, 1938; Shields, 1938), Smyrna, and Tullahoma.

Psorophora ciliata (F.). This large species, known as the "shaggy-legged gallinipper," is a severe biter. Although comparatively rare, it has been collected in a number of counties from West and Middle Tennessee and in one county from East Tennessee. Adults have been taken from May through October, and larvae the same months except during August. Larvae occur in temporary rain pools and are predaceous upon other mosquito larvae; they have been found in association with 6 species, chiefly *Psorophora confinnis*. *P. ciliata* records are from Clarksville, Cordova, Dyersburg, Halls, Memphis, Milan, Millington, Nashville, Norris (Arnold, 1940), Paris, Reelfoot Lake (Brown and Pearson, 1938), Smyrna, Tullahoma, and Union City.

Psorophora confinnis (L.-Arr.). The Florida glades mosquito is an abundant species found in West, Middle, and East Tennessee. Adults are fierce biters and have been collected from May through October; larvae from April through October. Larvae occur in temporary rain pools and have been found in association with 12 species, chiefly *Aedes vexans*. Locality records include Chattanooga, Clarksville, Cordova, Dyersburg, Halls, Knoxville (Arnold, 1940), Manchester, Memphis, Milan, Millington, Nashville, the Norris Reservoir area (Shields, 1938), Paris, Rives (Dyar, 1922), Smyrna, Tullahoma, and Union City.

Psorophora cyanescens (Coq.). This species is comparatively rare but has been found in West, Middle, and East Tennessee. Adults, which may be annoying biters, have been taken from May through October, larvae during August and September. Breeding occurs in temporary rain pools. Larvae have been found in association only with *Psorophora confinnis*. Locality records include Chattanooga, Clarksville, Cordova, Memphis, Milan, Millington, Norris (Arnold, 1940), Paris, Reelfoot Lake (Brown and Pearson, 1938), Smyrna, Tullahoma, and Union City.

Psorophora discolor (Coq.). This fairly abundant species has been recorded from West, Middle, and East Tennessee. Adults have been collected from April through October, larvae from June through September. *Psorophora*

discolor breeds in temporary rain pools and has been found in association with larvae of 6 species, mainly *Aedes vexans* and *Psorophora confinnis*. Records are from Chattanooga, Clarksville, Cordova, Dyersburg, Halls, Memphis, Milan, Millington, Nashville, the Norris Reservoir area (Shields, 1938), Paris, Smyrna, Tullahoma, and Union City.

Psorophora ferox (Humb.). The white-footed woods mosquito is a vicious biter. It is comparatively rare, but has been collected in West, Middle, and East Tennessee. Adults are recorded from May through October, larvae from May through September. Larvae are found in temporary rain pools and have been taken in association with 5 species, chiefly *Aedes vexans*. Locality records include Athens (Dyar, 1922), Clarksville, Cordova, Etowah (Arnold, 1940), Gatlinburg (Arnold, 1940), Halls, Humboldt, Memphis, Milan, Millington, Nashville, Paris, Reelfoot Lake (Brown and Pearson, 1938), Smyrna, Trenton, and Tullahoma.

Psorophora horrida (D. and K.). This is a rare species recorded from one county in West Tennessee and one in East Tennessee. It has been collected in the adult stage in May, but there are no larval data. Records are from Chattanooga (Dyar, 1922) and Memphis.

Psorophora howardii (Coq.). This is a large mosquito known as "Howard's gallinipper." It is comparatively rare but has been recorded from West, Middle, and East Tennessee. Adults and larvae have been collected in May, June, July, and September. Larvae, which occur in temporary pools and are predaceous upon other mosquito larvae, have been found in association with *Aedes vexans* and *Psorophora confinnis*. Records are from Charleston (Arnold, 1940), Chattanooga, Halls, Knoxville (Arnold, 1940), Memphis, Milan, the Norris Reservoir area (Shields, 1938), Reelfoot Lake (Brown and Pearson, 1938), and Tullahoma.

Psorophora signipennis (Coq.). This is a rare species recorded from West Tennessee (Meleney, Bishop, and Roberts, 1929) and is said to bite humans readily. Specific county data, monthly distribution records, and larval association data are not available. Breeding occurs in temporary rain pools.

Psorophora varipes (Coq.). This rare species has been collected in two counties in West Tennessee and one in Middle Tennessee. It is a severe biter. Adults have been found during May, June, and August, but no larval data are available. *P. varipes* breeds in temporary rain pools. Records are from Clarksville, Memphis, Millington, and Reelfoot Lake (Brown and Pearson, 1938).

Uranotaenia sapphirina (O.-S.). This mosquito is fairly abundant and has been collected in West, Middle, and East Tennessee. Adults are recorded for every month but February and March; larvae only from June through September. Females have been collected in large numbers from hollow trees during the colder months; they are said to bite man only occasionally. Larvae occur in pools, ponds, lakes, and swamps containing vegetation, and have been taken in association with 6 species, chiefly *Anopheles punctipennis* and *Culex apicalis*. Locality records include Chattanooga, Clarksville, Concord (Shields, 1938), Cordova, Dyersburg, Halls, Maryville (Arnold, 1940), Memphis, Milan, Millington, Nashville, Norris (Arnold, 1940), Paris, Reelfoot Lake (Brown and Pearson, 1938), Smyrna, Tazewell (Shields, 1938), Tullahoma, and Union City.

SUMMARY

1. Forty-four species of mosquitoes included in nine different genera have been recorded for Tennessee.
2. County distribution data for recorded species show that more species have been collected in West Tennessee than in Middle or East Tennessee.

3. The relative abundance of each species is given.
4. Monthly adult and larval distribution records are given for each mosquito species. Data for species of the four major genera show the monthly distribution range of *Aedes* and *Psorophora* to be distinctly more limited to the warmer months than the range for *Anopheles* and *Culex*.
5. Larval associations are shown for the twenty-eight species for which data are available. In general, larvae of *Aedes* and *Psorophora* species are found in association with a smaller number of species than are *Anopheles* and *Culex* species. From available data no clear-cut larval association groups can be determined.
6. Miscellaneous biological notes are presented for each species.

REFERENCES

- Arnold, F. T., Jr. 1940. "The mosquitoes of East Tennessee." Unpublished master's thesis, University of Tennessee, Knoxville. Pp. 1-80.
- Bang, F. B., G. E. Quinby, and T. W. Simpson. 1943. Studies on *Anopheles walkeri* Theobald conducted at Reelfoot Lake, Tennessee, 1935-1941. *Amer. Jour. Trop. Med.*, 23: 247-273.
- Brown, F. R., and J. W. Pearson. 1938. Some Culicidae of the Reelfoot Lake Region. *Jour. Tenn. Acad. Sci.*, 13: 126-132.
- Carpenter, S. J., R. W. Chamberlain, and J. F. Wanamaker. 1945. New distribution records for the mosquitoes of the southeastern states in 1944. *Jour. Econ. Ent.*, 38: 401-402.
- Dyar, H. G. 1922. The mosquitoes of the United States. *U. S. Nat'l. Mus. Proc.*, 62, art. 1, 119 pp.
- Dyar, H. G. 1928. The mosquitoes of the Americas. *Carnegie Inst. Wash. Pub.*, 387, 616 pp., illus.
- Johnson, H. A. 1936. Notes on the occurrence of *A. walkeri*. *South. Med. Jour.*, 29: 856-857.
- King, W. V., G. H. Bradley, and T. E. McNeel. 1944. The mosquitoes of the southeastern states. *U. S. Dept. Agric.*, Misc. Pub. No. 336, pp. 1-96.
- King, W. V., L. Roth, J. Toffaleti, and W. W. Middlekauff. 1943. New distribution records for the mosquitoes of the southeastern United States during 1942. *Jour. Econ. Ent.*, 36: 573-577.
- Meleney, H. E., E. L. Bishop, and F. L. Roberts. 1929. Observations on the malaria problem of West Tennessee. *South. Med. Jour.*, 22: 382-394.
- Middlekauff, W. W., and S. J. Carpenter. 1944. New distribution records for the mosquitoes of the southeastern United States in 1943. *Jour. Econ. Ent.*, 37: 88-92.
- Quinby, G. E. 1941. Additions to the mosquitoes (*Culicidae*) of the Reelfoot Lake Region. *Jour. Tenn. Acad. Sci.*, 16: 17-21.
- Shields, S. E. 1938. Tennessee Valley mosquito collections. *Jour. Econ. Ent.*, 31: 426-430.

Received May 21, 1946.