

Reprinted from the JOURNAL OF THE TENNESSEE ACADEMY OF SCIENCE
Vol. 24, No. 4, October, 1949.

NOTES ON THE MAYFLIES OF EASTERN TENNESSEE

MIKE WRIGHT

*Department of Biology, Tusculum College, Greeneville Tennessee
and*

LEWIS BERNER

Department of Biology, University of Florida, Gainesville

It has only been within the last fifteen years that the mayflies of the southeastern United States have received the attention of investigators who desired to do more than collect an occasional specimen that might have been accidentally encountered. The groundwork for future studies of the mayflies of this geographic area was laid by Jay R. Traver with the publication of the results of her research on the mayflies of North Carolina (1932-1933). With the publication, in 1935, of "The Biology of Mayflies" by Needham, Traver, and Hsu, the taxonomic and distributional data on North American Ephemeroptera were brought together in a single book. A close examination of the above mentioned book, as well as of all other literature recording species of mayflies in the southeastern United States, shows that relatively little of this exceedingly interesting faunistic area has been investigated. This is especially emphasized by the fact that, to date, only eighteen species of this group have been listed as occurring within the boundaries of Tennessee, with seventeen of these records from the eastern part of the state.

The senior author first became interested in these insects while conducting stream surveys in eastern Tennessee, and arranged with the junior author for the identification of his specimens. This paper is the outgrowth of an increasing interest in the problem on the part of both of the writers. The first collections were made in April, 1945, and additional and enlarged collections have been made during the years 1945-1948. Mayflies were taken in ten counties in Tennessee, although intensive surveys and repeat collections were limited to Greene and Cocke counties.

In addition to presenting a list of the species of Ephemeroptera occurring in eastern Tennessee, the authors felt that it would be well to include observations on habitats as well, in the hope that this discussion might be of some value to aquatic biologists. A great deal is yet to be learned about these very interesting insects, not only concerning the taxonomic placement of the Tennessee forms, but also about their habits, life histories, and habitats.

The writers wish to express their sincere appreciation to the students and assistants of Tusculum College who aided in the collecting of the mayfly material from the counties of eastern Tennessee. Without their help, the collections would have been considerably reduced, both in numbers of individuals and species. Special thanks are due Mr. Harold F. Mercer of Camp Creek, who, as a biology major at

Tusculum College, was a constant field companion of the senior author, and who built and maintained the several rearing cages used at Camp Creek. Mr. Mercer also took care of the rearing cages and operated the light trap during the senior author's absence from this area in the summer of 1947. Thanks are also due Mr. James E. Bishop, Tusculum College, for collecting and rearing numbers of mayflies during the spring and summer of 1948, and for operating the light trap at Franks Creek during the summer of 1947. Collections and stream descriptions from Unicoi and Johnson counties were made by Mr. John L. Johnson, Principal of Valdese Elementary School, Valdese, North Carolina.

COLLECTING METHODS

SUBIMAGOES AND ADULTS

(1). *Light trap.* A standard New Jersey mosquito light trap was operated in the vicinity of Franks Creek on the Tusculum College campus, Greene County, during the spring, summer, and fall of 1946. The trap was moved to Camp Creek near the Mount Zion Mission, Greene County, during the spring and summer of 1947.

(2). *Netted while in mating flight.* This method of collecting adults was possible on a number of occasions at dusk or in heavily shaded portions of the streams. The only specimens of *Cinygmula atlantica* collected during this survey were taken while they were mating over English Creek at Carson's Spring, Cocke County, before noon on a bright, sunny day. They were flying over a portion of the creek that was so heavily shaded by overhanging trees as to simulate dusk. Eight males and three females were collected, although there were many more in flight.

(3). *Taken by hand from resting places.* Numerous individuals, many of them subimagoes, resting on the underside of leaves of trees overhanging streams, were easily collected by hand picking.

(4). *Rearing.* During the spring and summer of 1948, a number of nymphs were reared to the adult state. Rearing was carried on in cages kept in flowing water.

NYPHHS

(1). *Dredge-net.* A heavy, leaded dredge-net was used to sweep through vegetation, silt sandy areas, and dredge among the small rubble below and above the riffles.

(2). *Seine.* A twenty foot seine was stretched across a creek just below a riffle and weighted with large rocks. The members of the collecting party went a distance above the riffle and with sticks, feet, and hands overturned rocks and boulders and stirred up the surrounding sandy or gravel areas causing attached insects to release their hold. The usually rapid current of the stream plus the collectors fast pace kept the flotage moving into the net. The seine was then removed and the entrapped specimens were placed in vials for preservation. This method of collecting was very efficient for capturing many kinds of aquatic animals, and, in fact, produced a species of mayfly nymph of which only a single specimen had previously been taken. Prior to the use of the seine, *Baetisca thomsenae* was represented in the collection by one nymph taken at Paint Creek; repeated searching had failed to produce additional specimens. When the seine was removed after the first trial at Paint Creek, more than thirty nymphs of *Baetisca thomsenae* were found in it. Additional specimens were taken on the two following seine hauls.

(3). *Hand-picking of rocks and boulders.* Rocks and boulders at or near riffles were turned over or removed to the stream bank, and the flattened,

closely-clinging species of mayflies were removed with forceps. The majority of the specimens of *Steonema* and *Heptagenia* were obtained in this way.

DESCRIPTIONS OF HABITATS

Listed below by counties are the various streams from which mayflies were collected during this investigation. The chemical analyses, given in the descriptions of the streams,¹ were obtained from the stream survey party of the Tennessee Division of Game and Fish, under the leadership of Dr. C. S. Shoup of Vanderbilt University. The following chemical data are included: (1) pH, (2) free CO₂ as estimated in parts per million (ppm.), (3) dissolved oxygen in parts per million, and (4) total alkalinity (carbonates and bicarbonates) in parts per million.

GREENE COUNTY

(1). *Camp Creek* was the most interesting and productive stream encountered during this study. Collections were made in the middle region of the creek, usually in the vicinity of the Mount Zion Church and School. The creek runs through a natural gorge with many ledges of bare rock along the banks and some in the bed of the stream as well. The bottom is composed of sand and fine gravel with large numbers of rocks of varying sizes distributed over the floor, being particularly concentrated at the riffles. The stream is fed by springs along its entire length, and maintains a low water temperature during even the hottest weeks of the summer. Camp Creek consists of a series of pools, varying from a few inches to five feet in depth, connected by riffles, none being over a three foot drop. Due to the springs, adequate water depth is maintained throughout the year. There is little or no vegetation, but considerable amounts of debris collect in quiet portions and along the banks. The creek has an over-all average depth of 9 inches and a width of 15 feet; the volume of flow is 14 C.F.S. with a velocity of 1.4 F.P.S. Camp Creek flows into the Nolichucky River and, like all the streams in Greene and Cocke counties, is a part of the French Broad River system of the Tennessee River watershed. Chemical analysis: pH, 7.4-8; dissolved oxygen, 9 ppm.; free CO₂, 4-5 ppm.; total alkalinity 55-62 ppm.

(2). *Franks Creek* is a small, wandering stream that flows through the relatively level land in the vicinity of Tusculum, about four miles east of Greeneville. The creek runs through the west portion of the Tusculum College campus, and has been studied in some detail since September, 1945. Franks Creek is spring-fed and so maintains a rather constant water level in all seasons. In the area studied, there is a large spring that feeds into the main creek through a branch some sixty yards long. This spring branch averages about three feet in width and from three to six inches in depth. It is heavily vegetated with water cress for about one-third of its length, beginning at the spring site. The bottom contains a considerable amount of mud, some gravel, and a few rocks. There are two riffles along its course with the lower end relatively free from vegetation and with a more rapid flow of water. Chemical analysis: pH, 7.2-7.6; free CO₂, 5 ppm.; total alkalinity, 83 ppm.

Franks Creek is a fairly typical stream of the level areas of this part of eastern Tennessee, with large, quiet pools connected by low riffles. The bottom in the greater portion of the creek is composed of bedrock overlain by sand, gravel, and some larger rocks. There are sections where accumulations of silt, caused by erosion of nearby farm lands, have formed. The creek varies from four to twelve feet in width and from a few inches to two feet in depth. Chemical analysis: pH, 7.8-8.0; free CO₂, 1 ppm.; dissolved oxygen, 6.5 ppm.; total alkalinity, 80 ppm.

¹With the exception of Camp and Franks creeks.

(3). *Paint Creek* originates near the top of Big Bald Mountain, and descends as a typical mountain stream—rapid drop, many riffles and few pools, swift flow, and bottom with numerous large boulders. Very few aquatic insects were found in the more rapidly descending portions of the stream. About midway between Greeneville, Tennessee, and Hot Springs, North Carolina, *Paint Creek* levels out for a mile or so along the ledge bearing state road 70. Here, the creek is made up of a series of pools and low riffles, forming excellent habitats for aquatic insects. It is almost devoid of shade (waterside trees, etc.) and has practically no aquatic vegetation. The bottom is composed of sand and gravel with many rocks strewn throughout its length. Chemical analysis: pH, 7.3; dissolved oxygen, 8.6 ppm.; free CO_2 , 2.5 ppm.; total alkalinity, 12 ppm.

(4). *Horse Creek*, a typical mountain stream with rapid drops and many riffles, is located southeast of Greeneville. The bottom is composed of bed-rock covered with sand and contains numerous loose rocks and large boulders. Many of the boulders were overgrown above the water line with mosses and liverworts. There appeared to be no other vegetation in the stream. During the fall of the year, the creek dries up to a series of pools, leaving the stream bed completely dry in some areas. Chemical analysis: pH, 7.6; dissolved oxygen, 9 ppm.; free CO_2 , 3 ppm.; total alkalinity, 57 ppm.

(5). *Mud Creek* (or *Sinking Creek*) is located southeast of Tusculum. In part of its course, *Mud Creek* parallels the Erwin highway and empties, finally, into the Nolichucky River near Brown's Bridge. This is a small, sand-and-gravel-bottom stream that runs for a considerable distance through cultivated fields which contribute a large amount of silt to its bed. Just before its junction with the Nolichucky River, *Sinking Creek* forms a beautiful waterfall of about fifty feet. Numerous aquatic insects were found on the ledges and vegetation of the falls. Other parts of the stream also have rich growths of vegetation. Chemical analysis: pH, 8.1; dissolved oxygen, 8.9 ppm.; free CO_2 , 0 ppm.; total alkalinity, 196 ppm.

(6). *Miscellaneous*. (a). *Cedar Creek* was visited only once during this survey, and no notes were taken as to the physical and chemical conditions of the stream. (b). *Afton Cave* is located near the small community of Afton, and consists of a series of large underground caverns in which an underground stream flows. Isolated pools are also present in the cave. It is of interest to note that a nymph of *Hexagenia* sp. was taken from a pool about one-fourth mile inside the cave and that a subimago of *Isonychia* sp. was caught in the same area. Adult *Hexagenia carolina* females have also been collected three-fourths of a mile inside the cave. (c). *Nolichucky River*. This river has been discussed by Wright (1948) and therefore a description will not be included here.

COCKE COUNTY

(7). *English Creek* at *Carson's Spring* is a beautiful, little mountain stream descending *English Mountain*, located several miles southwest of Newport. Almost a week was spent at *Carson's Spring* and several additional trips were made to collect in this stream. Various portions of the stream were sampled for productivity. The most prolific area was found to be in that part of the creek that runs through relatively level land and where large pools with quiet water were formed. In such places, debris consisting of leaves, sticks, etc. accumulated along the edges of the pools producing ideal habitats for trash-loving species. Many of the pools in this level area were very heavily shaded so that even on bright sunny days little sunlight reached the water. The bottom of the stream was of sand and gravel interspersed with many rocks, especially at the riffles. In the more quiet areas, there were large stretches of sand, without rocks, providing excellent situations for burrowing mayfly nymphs. There was very little aquatic vegetation, although weeds and shrubs grew down to the water line furnishing good resting places for adults of the small *Habrophlebiodes americana*. *English Creek* has many springs along its

course, but it was found to dry up considerably during the fall. The last collecting trip to the stream was made in October, 1947, when it was found that the creek was less than one-fourth its normal summer width and depth. Large areas of the pools were completely dry, and aquatic insects were very scarce. Chemical analysis: pH, 6.6-7.0; dissolved oxygen, 9 ppm.; free CO₂, 2 ppm.; total alkalinity, 7 ppm.

(8). *Sinking Creek* flows through level ground west of Newport. Collections were made near the Knoxville highway about one mile west of Newport in a portion of the creek where it was sluggish and where there were few riffles. The stream bed was composed mostly of mud mixed with gravel. Debris accumulated in many places and the masses of exposed rootlets afforded good habitats for any species of aquatic animals. Chemical analysis: pH, 8; dissolved oxygen, 6.2 ppm.; free CO₂, 2 ppm.; total alkalinity, 81 ppm.

(9). *Big Creek* lies near the Asheville highway a short distance east of Newport. Only a single collection was taken from this stream, and, because of its being in flood, no chemical analysis was made.

UNICOI COUNTY

(10). The *Government Fish Hatchery* is located on U. S. Highway 19-23, about four miles north of Erwin, Tennessee. There are several rearing pools with a diameter ranging from thirty to fifty feet. The water, which averages about three feet in depth, flows through them rather slowly as it moves through the vegetation consisting mostly of water lilies and algae. The bottoms of the pools are of sand and gravel. Water is supplied from a large limestone spring connected to all pools by sluiceways.

(11). *Limestone Cove Creek* flows from Iron Mountain westward to empty into the Nolichucky River. It parallels Tennessee Highway 107 and is crossed by U. S. Highway 19-23 at Unicoi. Insect collections were made just above the Johnson City waterworks filter plant. At this location, the water flow was very rapid and the bottom consisted mainly of rocky ledges with sand and gravel in the eddies and pools. Cove Creek averaged about eight feet in width and two or three inches in depth. It is fed in large part from limestone springs at the foot of the mountain. Aquatic vegetation was scant, consisting of algae and mosses, while waterside shade was formed by a dense growth of rhododendron interspersed with spruce, pines, maples, and birches.

JOHNSON COUNTY

(12). *Doe Creek* parallels Tennessee Highway 67 between Mountain City and Hampton, and flows in a southwesterly direction through a prosperous farming section. Collections of mayflies were made near the head of an old mill pond. The stream at this point averaged about eighteen feet in width and three or four inches in depth. The bottom was of sand and mud. Algae were abundant in the water.

(13). *Roans Creek*. This creek also runs along U. S. Highway 421 between Trade and Shouns, Tennessee. The water flows rapidly, descending over many falls and large boulders. The bottom consists of large limestone rocks, sand, and gravel. The stream averages about ten feet in width and has little aquatic vegetation.

OTHER COUNTIES

Those streams listed below as being located in Overton, Putnam, Fentress, and Sullivan counties were described in detail by Wright and Shoup (1945), and, therefore, only their more salient features will be included here.

(14). *Cowan Branch*. West Fork of Obey River, Overton County. Shallow, flows over bedrock; limestone slabs with rocks at riffles and scattered throughout the pools. Sand and silt along banks and in pools. Little vegetation in stream. Chemical analysis: pH, 8.2; total alkalinity, 150 ppm.

(15). *Mill Creek* at Standing Stone State Park, Overton County. Collections made just below the main dam of Kelly Lake. Slab and rock bottom; numerous riffles and small waterfalls. Water fairly warm as it comes from surface of lake over top of dam. Stream shaded; no vegetation in stream, but abundant on shore. Chemical analysis: pH, 8.0; total alkalinity, 121 ppm.

(16). *Big Hurricane Creek* on the Monterey-Clark Range road, Putnam County. Slab bottom with medium to large rocks; some open areas of sand and silt. Flow moderate. Almost no vegetation. Chemical analysis: pH, 6.8; total alkalinity, 6 ppm.

(17). *Meadow Creek*, six miles east of Monterey, Putnam County. Slab bottom with many rocks, especially at the riffles; edges of sand and silt. Some vegetation along banks and particularly in pools. Chemical analysis: pH, 4.8; total alkalinity, negligible. Evidences of acid mine pollution. It is interesting to note the collection of a nymph of *Ephemerella lutulenta* from this highly acid stream.

(18). *Little Crab Creek*. East Fork of Obey River, Fentress County. Floor of bedrock with abundance of loose rocks; silt and sand along shoreline. Noticeable amount of silt deposited on rocks in stream. Small amount of vegetation along banks of stream. Chemical analysis: pH, 8.0; total alkalinity, 138 ppm.

(19). *Miscellaneous*. The two ponds in Anderson and Hawkins counties, and a stream near Kingsport, Sullivan County, were examined by persons other than the authors and no data concerning their physical and chemical characteristics were taken.

TAXONOMY

In the course of this study of the mayflies of eastern Tennessee, at least sixty species were found, forty-three of which could be identified with considerable certainty. A survey of the literature shows that of the seventeen species of mayflies recorded from this part of the state the collections herein reported duplicated the species previously listed in only six cases. Wherever such duplication exists, an asterisk is placed beside the name of the species. Admittedly this list is small when compared with that of neighboring North Carolina; however, additional work in the mountainous areas of eastern Tennessee will undoubtedly show that mayflies are just as varied there as in western North Carolina.

It is frequently true that only the male of a mayfly species can be identified with any degree of certainty. In many species, the nymphs, subimagos, and adult females cannot be determined beyond genus. A large part of the eastern Tennessee collection consisted of these last named forms, and, therefore, it was impossible to give the insects a specific name. Wherever there were real doubts as to the correctness of an identification, a question mark was placed after the specific name. When specific identifications could not be made, several species were lumped under the generic name.

Thus far, at least one new species has been collected. This was described as *Isonychia tusculanensis* by Berner (1948). Undoubtedly additional collecting will reveal many more new forms, particularly among the Baetinae, which appear to be poorly known from the southeastern mountains.

Symbols used in the following list to indicate the stage in the life cycle represented in the collections are as follows: N = nymph; S = subimago; F = female; A = adult, male or female (if determinable to species). The localities, grouped by counties, and the dates of the collections are given. Much additional collecting is necessary before the relative abundance of the various species can be estimated with any degree of accuracy.

FAMILY EPHEMERIDAE

**Ephoron leukon* Williamson. Greene County, Tusculum College, July, 1946 (A); Unicoi County, Government Fish Hatchery, July 24, 1948 (A).

Hexagenia atrocantata McDunnough. Unicoi County, Government Fish Hatchery, August 14, 1948 (A).

**Hexagenia bilineata* (Say). Greene County, Tusculum College, July, 1946 (A), June 1, 1948 (A), July 4, 1948 (A); Nolichucky River, June 26, 1946 (A). *Hexagenia carolina* Traver.² Greene County, Afton Cave, three-fourths mile inside, June 1, 1948 (F).

Hexagenia recurvata Morgan. Greene County, Camp Creek, March 13, 1947 (N).

Hexagenia Sp. Anderson County, Pond at Clear Creek (Norris Dam), July 21, 1946 (N); Greene County, Afton Cave, July 25, 1946 (N); Tusculum College, August 4, 1946 (F); July 4, 1948 (F); Franks Creek, February 17, 1948 (N).

Ephemera varia Eaton. Fentress County, Little Crab Creek, E. Fork of Obey River, April 29, 1945 (N); Greene County, Paint Creek, October 27, 1945 (N), April 24, 1947 (N); Camp Creek, March 29, 1946 (N), May 28, 1946 (N and A), June 4 and 10, 1947 (A), July 1 and 11, 1947 (A), May 10 and 11, 1948 (N and A); Franks Creek, September 30, 1948 (A); Overton County, Cowan Branch, W. Fork of Obey River, April 29, 1945 (N).

**Ephemera guttulata* Pictet. Greene County, Horse Creek, May 17, 1947 (N); Franks Creek, May 24, 1948 (A).

FAMILY HEPTAGENIIDAE

**Heptagenia hebe* McDunnough. Greene County, Camp Creek, May 10, 1948 (A).

Heptagenia sp. (close to *juno* McDunnough). Sullivan County, Creek near Kingsport, July 28, 1946 (N).

Stenonema amicum Traver. Greene County, Mud Creek, May 19, 1947 (A).

Stenonema heterotarsale. (McDunnough).³ Cocke County, Big Creek at Newport, April 17, 1946 (N); Greene County, Franks Creek, March 24, 1946 (N), May, 1947 (A), May 1, 13, 14, 1948 (A), September 9 and 30, 1948 (A); Camp Creek, May 11, 1948 (A); Mud (or Sinking) Creek, May 9, 1948 (A).

Stenonema ithaca (Clemens and Leonard). Greene County, Camp Creek, May 28, 1946 (A), June 22, 1946 (A), May 8, 11, 1947 (A), June 10 and July 1, 1947 (A), May 10 and 11, 1948 (N and A); Franks Creek, May, 1947 (A), March 20, 1948 (A), April 14 and 23, 1948 (A), May 1 and 14, 1948 (A); Mud (or Sinking) Creek, May 9, 1948 (A); Johnson County, Doe Creek, July 31, 1948 (N).

Stenonema pudicum (Hagen). Cocke County, English Creek, April 17 and June 7, 1946 (A); Greene County, Paint Creek, March 22, 1946 (N), April 24, 1947 (A); Camp Creek, April 24, 1947 (S).

²Spieth (1941) considers this form to be *Hexagenia munda marilandica*.

³Spieth (1947) called this species *S. interpunctatum heterotarsale*.

Stenonema spp. (includes several species). Cocke County, Big Creek at Newport, April 17, 1946 (S); English Creek, June 4, 1946 (F), October 18, 1947 (N); Greene County, Camp Creek, March 27 and 29, 1946 (N), May 28, 1946 (F), May 4, 1947 (S), May 8, 1947 (N, S, F), May 11, 1947 (S, F), June 4 and 10, 1947 (F), May 11, 1948 (N); Cedar Creek, February 22 and March 22, 1946 (N); Franks Creek, January 13, February 23, and March 15, 1946 (N), May 1, 1947 (N), March 20 and 24, 1948 (N), April 15, 1948 (S), May 1, 1948 (N); Mud (or Sinking) Creek, March 29, 1946 (N); Paint Creek, August 10, 1946 (N), April 24, 1947 (N); Tusculum College, July, 1946 (S); Johnson County, Roans Creek, July 31, 1948 (N); Overton County, Cowan Branch, W. Fork of Obey River, April 29, 1945 (N); Putnam County, Big Hurricane Creek, April 28, 1945 (N); Sullivan County, Creek near Kingsport, July 28, 1946 (N); Unicoi County, Limestone Cove Creek, August 15, 1948 (N).

Iron rubidus Traver. Cocke County, English Creek, June 8, 1946 (A); Sullivan County, Creek near Kingsport, July 28, 1946 (N).

Iron sp. Greene County, Camp Creek, May 11, 1948 (N); Paint Creek, August 10, 1946 (N); Johnson County, Doe Creek, July 31, 1948 (N); Roans Creek, July 31, 1948 (N); Unicoi County, Limestone Cove Creek, August 8, 1948 (N).

Cinygmula atlantica (McDunnough). Cocke County, English Creek, April 17, 1946 (A).

FAMILY BAETIDAE

Siphonurus quebecensis (Provancher) (?). Putnam County, Big Hurricane Creek, April 28, 1946 (N).

Ameletus lineatus Traver. Overton County, Madlock Branch West Fork of Obey River, April 29, 1945 (N).

Isonychia fattigi Traver. Cocke County, English Creek, June 3, 4, and 7, 1946 (A).

Isonychia obscura Traver (?). Greene County, Camp Creek, May 8, 1947 (F).

Isonychia pacoleta Traver (?). Greene County, Cedar Creek, March 22, 1946 (N); Camp Creek, May 8, 1947 (N).

Isonychia sadleri Traver. Greene County, Camp Creek, March 29, 1946 (N), March 13, 1947 (N), May 10, 1948 (A), May 11, 1948 (N); Franks Creek, May, 1947 (N); Mud (or Sinking) Creek, May 9, 1948 (A); Paint Creek, April 24, 1947 (N).

**Isonychia tusculanensis* Berner. Greene County, Camp Creek, May 28, 1946 (A), June 4 and 10, 1947 (A), July 1, 1947 (A), May 10, 1948 (A); Franks Creek, April 27, 1948 (A), May 1 and 3, 1948 (A); Mud (or Sinking) Creek, May 9, 1948 (A); Paint Creek, August 10, 1946 (N); Tusculum College, May 29, 1946 (A), June 24, 1946 (A), July 15, 1946 (A).

Isonychia sp. (includes several species). Cocke County, Big Creek at Newport, April 17, 1946 (N); Mud Creek, June 8, 1946 (N); Greene County, Afton Cave, July 25, 1946 (S); Camp Creek, March 29, 1946 (N), May 28, 1946 (N, S), June 18 and 22, 1946 (S), April 30, 1947 (N), May 4, 8, and 19, 1947 (S), June 10, 1947 (F), May 11, 1948 (N, S, F); Cedar Creek, February 22, 1946 (N); Franks Creek, January 13, February 15, March 15 and 17, April 13 and 20, May 4, 1946 (N), April 26, 1948 (N exuviae), May 1, 1948 (F); Paint Creek, October 27, 1945 (N), March 22, 1946 (N); Tusculum College, April 23, 1946 (F), August 19, 1946 (F), March 26, 1948 (S), June 1, 1948 (F); Johnson County, Roans Creek, July 31, 1948 (N); Overton County, Mill Creek, April 29, 1945 (S); Unicoi County, Limestone Cove Creek, August 8 and 15, 1948 (N).

Blasturus cupidus (Say). Greene County, Cedar Creek, February 22, 1946 (N); Sink near Afton Cave, February 5, 1947 (N); Pond at Tusculum College, March 17, 1947 (N); Hawkins County, Pond at Rogersville, April 3, 1946 (A).

Paraleptophlebia guttata (McDunnough). Greene County, Camp Creek, May 28, 1946 (A), June 4, 1947 (A), May 10 and 11, 1948 (S and A).

Paraleptophlebia sp. Greene County, Camp Creek, May 28 and June 22, 1946 (S), May 8 and June 10, 1947 (S), May 11, 1948 (N); Mud (or Sinking) Creek, May 9, 1948 (S, F).

Habroptlebiodes americana (Banks). Cocke County, English Creek, June 4, 1946 (A); Greene County, Camp Creek, May 28 and June 18, 1946 (A), May 8 and June 10, 1947 (A); Franks Creek, April 14, 15, 17, 27, 1948 (A), May 14, 1948 (A).

Ephemerella bicolor Clemens (?). Greene County, Franks Creek, April 13 and 20, 1946 (N).

Ephemerella catocoba Traver. Cocke County, Big Creek at Newport, April 17, 1946 (N); Greene County, Paint Creek, April 24, 1947 (N).

Ephemerella cornutella McDunnough. Greene County, Camp Creek, May 8, 1947 (N), May 10 and 11, 1948 (N); Sullivan County, Creek near Kingsport, July 28, 1946 (N).

Ephemerella coxalis McDunnough (?). Greene County, Franks Creek, March 17, 1946 (N); Camp Creek, March 27, 1946 (N).

Ephemerella doris Traver. Cocke County, Big Creek at Newport, April 17, 1946 (N).

**Ephemerella dorothea* Needham. Cocke County, English Creek, June 8, 1946 (A).

**Ephemerella lutulenta* Clemens (?). Putnam County, Meadow Creek, East Fork of Obey River, April 28, 1945 (N).

Ephemerella minimella McDunnough (?). Greene County, Franks Creek, April 7, 1946 (N).

Ephemerella vernalis Banks. Greene County, Camp Creek, April 30, 1947 (A).

Ephemerella sp. No. 3 Traver (1937). Greene County, Cedar Creek, February 22, 1946 (N); Paint Creek, April 24, 1947 (N).

Ephemerella spp. (includes at least two species). Cocke County, English Creek, June 4 and 7, 1946 (F); Greene County, Camp Creek, May 28, 1946 (S), May 4, 8 and 11, 1947 (S), June 4 and 10, 1947 (S), July 11, 1947 (S); Franks Creek, April 14, 1948 (S); Paint Creek, April 24, 1947 (N).

Baetisca thomsonae Traver. Greene County, Paint Creek, July 15, 1946 (N), April 24, 1947 (N); Camp Creek, May 8, 1947 (N).

Coenis sp. Greene County, Franks Creek, April 18, 1946 (N); Sullivant Pond, March 23, 1946 (N); Overton County, Cowan Branch, West Fork of Obey River, April 29, 1945 (N).

Callibaetis sp. Greene County, Franks Creek, April 18, 1946 (N); Sullivant Pond, March 23, 1946 (N).

Baetis flavistriga McDunnough. Greene County, Franks Creek, May 10 and 13, 1948 (A); Tusculum College, May 29, 1946 (A).

Baetis frondalis McDunnough. Greene County, Franks Creek, April 16 and 23, 1948 (A), May 1, 1948 (A), September 9, 1948 (A).

Baetis incertans McDunnough. Greene County, Franks Creek, March 24, 1946 (A), March 20, 1948 (A); Tusculum College, April 23, 1946 (A).

Baetis levitans McDunnough. Greene County, Franks Creek, May 1948 (A), September 9, 1948 (A).

Baetis parvus Dodds (?). Greene County, Franks Creek, September 9, 1948 (A).

Baetis sp. (*pygmaeus* group). Greene County, Franks Creek, February 22, 1946 (N), March 15 and 17, 1946 (N), April 7 and 13, 1946 (N).

Baetis sp. Greene County, Cedar Creek, February 22, 1946 (N); Franks Creek, January 13, 1946 (N), February 22, 1946 (N), March 16, 1946 (S), April 7, 13, and 20, 1946 (N), April 2, 1947 (F), May 1, 1947 (N), March 20, 1948 (N, F), April 10, 1948 (N), April 17 and 24, 1948 (S), May 1, 1948 (S), May 14, 1948 (S, A), September 30, 1948 (S); Mud (or Sinking) Creek, May 19, 1947 (F); Tusculum College, May 29, 1946 (S); Branch of Nolichucky River, May 28, 1946 (F); Stream two miles south of Tusculum, May 10, 1948 (N).

Pseudocloeon sp. Greene County, Camp Creek, May 10, 1948 (N); Sullivan County, Creek near Kingsport, July 28, 1946 (N).

Cloeon sp. Greene County, Franks Creek, April 7, 1946 (F), May 10, 1948 (F), May 19, 1948 (N).

Neocloeon alamañce Traver. Greene County, Franks Creek, March 15 and 23, 1946 (N), April 24, 1948 (S).

Centroptilum sp. Cocke County, English Creek, June 7, 1946 (F); Greene County, Mud (or Sinking) Creek, May 9, 1948 (F); Tusculum College, May 29, 1946 (F).

HABITATS AND RELATIVE ABUNDANCE

In only two streams, Camp Creek and Franks Creek, were collections of mayflies made frequently enough and over a sufficiently long period of time to draw conclusions as to relative abundance correlated with habitat. The conclusions are based on nymphal collections, light trap catches, and adults caught by other methods; frequency of occurrence is expressed as rare, occasional, common, and abundant.

Camp Creek. A total of twenty collections was made in this stream from March, 1946, to May, 1948. The light trap was run from May through July, 1947, and collections of nymphs and adults were made at irregular intervals during the study. Based on these collections and observations, the various species of mayflies from Camp Creek are grouped below according to frequency of occurrence.

Abundant: *Ephemera varia*; *Stenonema ithaca*; *Stenonema* sp.; *Isonychia* sp.; *Habroplebiodes americana*.

Common: *Isonychia tusculanensis*; *Ephemerella* sp.

Occasional: *Isonychia sadleri*; *Paraleptophlebia guttata*.

Rare: *Hexagenia recurvata*; *Stenonema pudicum*; *S. heterotarsale*; *Heptagenia hebe*; *Isonychia obscura*; *Isonychia pacoleta*; *Paraleptophlebia* sp.; *Ephemerella cornutella*; *Ephemerella coxalis*; *Ephemerella vernalis*; *Baetisca thomsenae*; *Pseudocloeon* sp.

Camp Creek has many different habitats suitable for mayfly nymphs, but aquatic vegetation, an important factor in many streams, is missing. A total of twenty-one species was taken during the study, five of which were collected in sufficient numbers to be classed as abundant. Without doubt, additional species of mayflies will be found in future collecting; many of the species, here listed as rare, certainly must occur more frequently than the number of specimens represented in the collections indicate. Further work in the stream

will reveal populations overlooked, or habitats accidentally missed during the survey. Obviously, this is true, for adults of *Habrophlebiodes americana* were common, but not a single nymph of this species was taken from the stream.

Neither nymphs nor adults of the genus *Baetis* were represented in the collections from Camp Creek, yet they were the most abundant of all mayfly nymphs taken from Franks Creek (see discussion below). It is possible that the lack of heavily vegetated areas in Camp Creek may be a factor responsible for the scarcity of the nymphs. Additional collecting in this stream will undoubtedly produce individuals of *Baetis*, for, in similar streams in the mountains of North Carolina, nymphs have been collected from the underside of rocks in swift water. It is quite likely that during the collecting these small nymphs were simply overlooked as the larger *Stenonema* scrambled about and attracted the attention of the collector.

Franks Creek is a relatively level, slow stream of the lowlands, which, with its richly vegetated, spring-fed branches, affords a sharp contrast to the swift, upland Camp Creek. Thirty-eight collections were made in Franks Creek from February, 1946, through September, 1948. Most of the adults represented in these collections were caught in the light trap or reared in cages kept in the stream.

During the course of this investigation, twenty-five species of mayflies were collected from Franks Creek and its tributaries. These are listed below according to their relative abundance.

Abundant: *Stenonema* spp.; *Baetis* sp. (*pygmaeus* group).

Common: *Stenonema heterotarsale*; *Isonychia* spp.; *Habrophlebiodes americana*.

Occasional: *Cacnis* sp.; *Neoclocon alamance*; *Baetis frondalis*.

Rare: *Iphoron leukon*; *Ephemera guttulata*; *E. varia*; *Hexagenia bilineata*; *Hexagenia* sp.; *Isonychia tusculeuensis*; *Ephemerebella bicolor*; *E. coxalis*; *E. minimella*; *Callibaetis* sp.; *Baetis flavistriga*; *B. incertans*; *B. levitans*; *B. parvus*; *Centropilum* sp.; *Cloeon* sp.

Franks Creek offers many different habitats for mayfly nymphs, several types of which are not found in Camp Creek. *Hexagenia* nymphs were found in the muddy, silt-covered bottom of pools as well as in the sandy open areas. Much of the silt deposit can be accounted for by the fact that the stream flows through farm land where erosion is heavy. The vegetation filled tributaries, in particular, have considerable amounts of fine silt deposited in their beds. In such streams, *Hexagenia* nymphs were most commonly dredged from silt and mud where it accumulated beneath the undercut banks.

In the main stream, and to a lesser extent in the spring branches, the rocks at riffles were usually well populated with the various species of *Stenonema*. Occasionally a nymph of *Baetis* could be found on these rocks, as well. *Isonychia* was found commonly in the open areas of pools and at riffles; now and then a specimen could be taken from the vegetation, but the open water furnished a much better collecting area for these nymphs.

In the vegetation-filled tributaries there are two chief habitats in which mayfly nymphs were found. The large mats of plants, with the almost level stream bed, resulted in a slow current, and ideal conditions were thus produced for those nymphs which climb over the submerged vegetation or hide close to the bottom. *Baetis*, *Callibaetis*, *Cloeon*, and *Neocloeon* nymphs were taken easily by rapid sweeps through the plant masses with an aquatic dip net. Often fifteen or more *Baetis* nymphs were taken with a single scoop. The second of the habitats was occupied by *Ephemerella* and *Caenis*, which prefer a slow current, detritus, and silt deposits. Such conditions were produced by the presence of the vegetation mats.

A comparison of the mayflies of the two creeks shows, then, the following:

- 1). Species common to both streams (forms identifiable to species only).
Ephemerella varia; *Stenonema heterotarsale*; *Isonychia tusculanensis*; *Habrophlebiodes americana*; *Ephemerella coxalis*.
- 2). Genera common to both streams:
Ephemerella, *Hexagenia*, *Stenonema*, *Isonychia*, *Habrophlebiodes*, *Ephemerella*.
- 3). Genera present in Camp Creek but not found in Franks Creek.
Heptagenia, *Paraleptophlebia*, *Baetisca*, *Pseudocloeon*.
- 4). Genera present in Franks Creek but not found in Camp Creek:
Ephoron, *Baetis*, *Callibaetis*, *Centroptilum*, *Cloeon*, *Neocloeon*.
- 5). Total number of genera: Franks Creek, 11; Camp Creek, 10.
- 6). Total number of species (so far as identifiable); Franks Creek, 25; Camp Creek, 21.

REFERENCES

- Berner, Lewis. 1948. A new species of mayfly from Tennessee. *Ent. News*, 59 (5): 117-120. 3 figs.
- Needham, J. G., J. R. Traver, and Yin-Chi Hsu. 1935. *The biology of mayflies*. Ithaca, Comstock Publishing Co.
- Spieth, H. T. 1941. Taxonomic studies on the Ephemeroptera. II. The genus *Hexagenia*. *Amer. Mid. Nat.*, 24 (2): 233-280. 50 figs., 12 maps.
- Spieth, H. T. 1947. Taxonomic studies on the Ephemeroptera. IV. The genus *Stenonema*. *Ann. Ent. Soc. Amer.*, 40 (1): 87-122. Pls. 1-2, figs. 29-31. 4 this.
- Traver, J. R. 1932. Mayflies of North Carolina. *Jour. Elisha Mitchell Sci. Soc.*, 47: 85-236. Pls. 5-12.
- Traver, J. R. 1933. Mayflies of North Carolina. Pt. III. *Jour. Elisha Mitchell Sci. Soc.*, 48: 141-206. Pl. 15.
- Traver, J. R. 1937. Notes on mayflies of the southeastern states (Ephemeroptera). *Jour. Elisha Mitchell Sci. Soc.*, 53: 27-86. Pl. 6.
- Wright, M. 1948. Notes on swarming of certain species of insects. *Jour. Tenn. Acad. Sci.*, 23: 255-258.
- Wright, M., and C. S. Shoup. 1945. Dragonfly nymphs from the Obey River drainage and adjacent streams in Tennessee. *Jour. Tenn. Acad. Sci.* 20 (3): 266-278.