

## MAYFLIES (EPHEMEROPTERA), STONEFLIES (PLECOPTERA), AND OTHER INTERESTING BIOTA OF WILDCAT CREEK, SOUTH CAROLINA, A BIODIVERSITY REFERENCE STREAM<sup>1</sup>

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**ABSTRACT:** The Wildcat Creek catchment, in the upper Piedmont region of South Carolina, is being considered for special protection to preserve its biological diversity. To help assess this diversity, specimens of mayfly (Ephemeroptera) and stonefly (Plecoptera) nymphs were collected and identified to the lowest taxonomic level possible with currently published information. Additional records were obtained from the Clemson University Arthropod Collection, Clemson University graduate student theses, and publications. A total of 35 mayfly species and 24 stonefly species are reported from the stream.

Wildcat Creek is located nine km northwest of the campus of Clemson University, Clemson, South Carolina. Its watershed encompasses approximately 204 ha (504 ac), the lower 96 ha (236 ac) of it owned by Clemson University. The University property is under commercial timber management by the Clemson University Experimental Forest. Private lands on the upper half of the watershed, held by 28 landowners, are mostly devoted to residential and agricultural uses. The stream's watershed is being considered for special protection as a natural area with exemplary biological diversity.

The land on which the Experimental Forest and Wildcat Creek now lies was acquired by the United States government in 1933, during the depression, as a result of federal programs designed to stop land degradation. When first obtained, the land, managed by the Clemson University Forestry Department, consisted of "eroded hills patched with stunted and decadent hardwoods, the farms gullied, desperate with poverty" (Sorrells 1984). Clemson University became the steward of the forest in 1954 and, since 1933, has developed it as a model of managed forest property (Sorrells, 1984).

Wildcat Creek is a clear, cold, first-order stream of the upper Piedmont region (about 245-275 m [800-900 ft] elevation above mean sea level [EAMSL]), with a sand and gravel substrate and generally closed forest

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canopy. The riparian vegetation is mixed hardwoods, with pine stands on higher slopes; occasional wildlife plots occur in the watershed and a picnic shelter and shaded recreation area are located near the mouth. The stream enters Six Mile Creek about 500 m above its confluence with Lake Issaqueena.

The area is used for teaching and research by Clemson University groups. Field laboratories for courses in biological sciences, entomology, and forestry are regularly taught here. Research for several M.S. theses and Ph.D. dissertations in the University's Department of Entomology has been completed in the watershed since the mid 1960's and a dissertation research project is in progress here for the Department of Biological Sciences. The site is open to the public each year from March through October and is a popular recreation area for picnicking, hiking and horseback riding.

Seven species of macroinvertebrates in the watershed have been designated by The Invertebrate Taxa Review Committee of the South Carolina Heritage Trust Program as endangered or threatened in South Carolina or the United States (Morse *et al.* 1979, and unpublished data):

1. *Sphodros coylei* Gertsch and Platnick, 1980 (Arachnida: Araneae: Atypidae). Endangered in the United States, this spider is known only from Clemson and the Wildcat Creek area, South Carolina. The habitat of this spider is thought to be woodlands (Gertsch and Platnick 1980, Gaddy and Morse 1985). An intensive search for specimens of this species in the Wildcat Creek watershed, funded by the South Carolina Heritage Trust Program, resulted in discovery of one specimen (K.M. Hoffman pers. comm.).
2. *Macromia margarita* Westfall, 1947 (Insecta: Odonata: Macromiidae). This species is threatened in South Carolina, where Wildcat Creek is the only known locality. Specimens have also been found in North Carolina and Georgia. Nymphs are found in cold running water with rocky bottom and low organic content (Westfall 1947, T.R. White pers. comm.).
- 3-7. The following species of caddisflies (Trichoptera) were considered threatened in South Carolina and will be discussed in more detail in a subsequent publication:  
*Polycentropus carlsoni* Morse (Polycentropodidae),  
*Wormaldia thyria* Denning (Philopotamidae),  
*Pseudogoera singularis* Carpenter (Odontoceridae),  
*Psilotreta frontalis* Banks (Odontoceridae), and  
*Agarodes griseus* Banks (Sericostomatidae).

The Wildcat Creek drainage also is the type locality for one species of black fly (Diptera: Simuliidae), *Simulium loerchae* Adler (1987), and is the site of two undescribed species in the *S. tuberosum* complex (Adler pers. comm.). Furthermore, the plant *Nestronia umbellula* Rafinesque (Santalaceae), North American sandalwood, has been labeled as a species for national concern by the Advisory Commission for South Carolina Rare and Endangered Plants (Rodgers *et al.* 1979).

Due to the occurrence of these unusual plants and animals, the South Carolina Wildlife and Marine Resources Department (SCWMRD) approached Clemson University to designate its lands in the Wildcat Creek watershed as a Registered Heritage Site. The purpose was to protect the area from pollution, sedimentation, clearcutting, or sales to private developers. The University's Forest Advisory Committee also is considering other alternative protective agreements.

Another important reason for protecting the habitat and fauna of the stream is the likelihood that Wildcat Creek may serve as a reference stream for pollution assessment in the upper Piedmont. The United States Environmental Protection Agency (US EPA) (Plafkin *et al.* 1989) and the cooperating South Carolina Department of Health and Environmental Control (SC DHEC) regularly monitor populations of aquatic insects, especially pollution-intolerant mayflies, stoneflies, and caddisflies ("EPT") to detect changes in water quality. One or more reference streams in a given "ecoregion" are important standards against which to compare others in the same ecoregion.

No comprehensive taxonomic study of the macroinvertebrates of Wildcat Creek has been made. McCaskill (1967, 1973) and McCaskill and Prins (1968) included Wildcat Creek stoneflies in their research on Plecoptera of northwestern South Carolina. Three species of *Tallaperla* were cited from Wildcat Creek by Stark (1983). Carlson (1971) studied emergence patterns of Wildcat Creek mayflies, creating a partial list of its species. He also collected stoneflies and caddisflies, depositing them in the Clemson University Arthropod Collection. White *et al.* (1979) published a report on the emergence patterns of stoneflies of northwestern South Carolina, including data from Wildcat Creek. Students from the Clemson University Aquatic Insects course (ENT 469/669) and Taxonomy of Immature Insects course (ENT 808) have collected and identified specimens from the stream since 1959, many of which specimens and records are now in the Clemson University Arthropod Collection. A separate study of the caddisflies of Wildcat Creek is in progress (M.A. Floyd pers. comm.).

## MATERIALS AND METHODS

Research was initiated in the summer of 1991 to collect and identify mayflies and stoneflies from Wildcat Creek and to combine the resulting data with those from the above-mentioned other resources to develop comprehensive lists for these insect orders. Collections were accomplished with the semi-quantitative sampling equipment and techniques recommended by the US EPA (Plafkin *et al.* 1989) in anticipation of comparative use of the resulting data in water quality assessments of other upper Piedmont streams. Identifications were accomplished for genera of Ephemeroptera and Plecoptera with the keys of Merritt and Cummins (1984) and Stewart and Stark (1988), except in cases where generic names have changed since these publications. Identifications for species were accomplished by specialists mentioned in the Acknowledgments or, for nymphs, were determined or confirmed by us with the keys of Unzicker and Carlson (1982) and Unzicker and McCaskill (1982) for mayflies and stoneflies, respectively.

Specimens and records in the Clemson University Arthropod Collection were combined with the results of the above sampling and literature search.

## RESULTS AND DISCUSSION

Thirty-five species of mayflies (Table 1) and 24 species of stoneflies (Table 2) are reported from Wildcat Creek.

The diversity of mayfly and stonefly species from Wildcat Creek is comparable with that of faunas of other streams surveyed in similar or nearby ecoregions of North and South Carolina (Table 3), exceeding the numbers of total species and unique species (among these streams only) for most of these other streams. Among these streams, only Upper Three Runs Creek, Aiken County, South Carolina, has larger total and unique numbers of stoneflies. (Upper Three Runs Creek ranks among streams with the highest recorded insect species diversity in the world and its environmental characteristics are quite different from those of Wildcat Creek [Morse *et al.* 1980, 1983].) Furthermore, the number of mayfly and stonefly species alone (59, not including caddisflies) is greater than the EPT taxa richness criterion for "excellent" classification by North Carolina Division of Environmental Management (NC DEM) standards for either Piedmont (>31 taxa) or Mountain (>41 taxa) ecoregion streams (Lenat, 1988). Although more extensive investigation techniques were used to estimate the total mayfly and stonefly fauna in Wildcat Creek than are usually employed in NC DEM biomonitoring procedures, the

Wildcat Creek taxa richness numbers nevertheless are valuable for demonstrating the high biodiversity of the stream.

For these reasons, we are convinced that the Wildcat Creek watershed is an exemplary biodiversity resource for South Carolina, not only for mayflies and stoneflies but also for other plants and animals. As such, it deserves special protection from habitat alteration, and the stream's macroinvertebrate fauna should be used by biological monitoring agencies as a standard for detecting freshwater perturbations. The watershed and its biota have been an excellent biological research and teaching environment for many years and efforts to maintain the habitat and continue that use as their primary function are appropriate.

Table 1. Mayflies (Ephemeroptera) of Wildcat Creek, Pickens County, South Carolina. Dates refer to range of capture times for imago or subimago specimens (only nymphs were collected where no dates are provided). Classification is according to McCafferty (1991). Determinations are by P.H. Carlson (PHC), S.M. Daniels (SMD), J.C. Morse (JCM), and W.L. Peters (WLP).

Suborder RETRACHEATA

Infraorder LANCEOLATA

Superfamily Leptophlebioidea

Family Leptophlebiidae

*Habrophlebia vibrans* Needham. 20 Apr - 28 Aug. PHC, WLP.

*Habrophlebiodes americana* (Banks). 20 Apr - 8 Oct. PHC, WLP.

*Leptophlebia austrina* (Traver). 15 Mar - 7 Apr. PHC, WLP.

*Paraleptophlebia guttata* (McDunnough). 5 Apr - 14 Oct. PHC, WLP.

Superfamily Ephemeroidea

Family Epemeridae

*Ephemera blanda* Traver. 13 May - 22 Aug. PHC, WLP.

*Hexagenia limbata* (Serville). PHC, WLP.

Infraorder PANNOA

Superfamily Caenoidea

Family Ephemerellidae

*Ephemerella catawba* Traver. 14 May - 14 Jun. PHC, WLP.

*Ephemerella dorothea* Needham. 8 Apr - 4 Sep. PHC, SMD, JCM, WLP.

*Ephemerella inconstans* Traver. PHC, WLP.

*Ephemerella septentrionalis* McDunnough. PHC, WLP.

*Euryophella bicolor* (Clemens). PHC, WLP.

*Euryophella funeralis* (McDunnough). PHC, WLP.

*Euryophella prudentialis* (McDunnough). 6 May - 29 Jul. PHC, WLP.

*Euryophella temporalis* (McDunnough). PHC, WLP.

*Serratella deficiens* (Morgan). SMD, JCM.

Family Caenidae

*Caenis amica* Hagen. 15 Sep. PHC.

Superfamily Baetiscoidea

Family Baetiscidae

*Baetisca carolina* Traver. PHC.

**Suborder SETISURA**

## Family Isonychiidae

*Isonychia (I.) bicolor* (Walker). 26 May - 29 Jun. PHC, WLP.*Isonychia (Prionodes) georgiae* McDunnough. 27 Jul - 5 Sep. PHC, WLP.

## Family Heptageniidae

*Epeorus dispar* (Traver). SMD, JCM.*Epeorus rubidus* (Traver). 10 Apr - 30 Jul. PHC, WLP.*Leucrocota aphrodite* (McDunnough). 14 Apr - 12 Sep. PHC, WLP.*Stenacron interpunctatum* (Say). 22 Apr - 25 Sep. PHC, WLP.*Stenonema carlsoni* Lewis. SMD, JCM (and Lewis, 1974, type locality).*Stenonema mexicanum integrum* (McDunnough). 22 May - 29 Sep. PHC, WLP.*Stenonema pudicum* (Hagen). 25 Apr - 11 Oct. PHC, WLP.*Stenonema terminatum* (Walsh). JCM.**Suborder PISCIFORMA**

## Infraorder IMPRIMATA

## Family Baetidae

*Acentrella ampla* Traver. 20 Mar - 29 Mar. PHC, WLP.*Baetis tricaudatus* Dodds. JCM.*Procloeon bellum* (McDunnough). 4 May - 26 May. PHC.*Procloeon quaesitum* McDunnough. PHC.*Procloeon rivulare* Traver. 26 May. PHC.*Procloeon rubropictum* (McDunnough). 12 Jun - 30 Jun. PHC.

## Family Siphonuridae

*Ameletus* sp. 15 Mar - 3 May. PHC, WLP.*Siphonurus mirus* Eaton. Apr. PHC, WLP.

Table 2. Stoneflies (Plecoptera) of Wildcat Creek, Pickens County, South Carolina. Dates refer to range of capture times for adult specimens (only nymphs were collected where no dates are provided). Classification is according to Stark *et al.* (1986). Determinations are by S.M. Daniels (SMD), V.H. McCaskill (VHM), J.C. Morse (JCM), an anonymous reviewer (ANR), W.E. Ricker (WER), H.H. Ross (HHR), B.P. Stark (PBS), and T.R. White (TRW).

## Group EUHOLOGNATHA

## Family Capniidae

*Allocapnia aurora* Ricker. 23 Nov - 12 Apr. BPS, WER, HHR.*Allocapnia recta* (Claassen). 23 Nov - 12 Apr. BPS, WER.

## Family Leuctridae

*Leuctra ferruginea* (Walker). 23 Nov - 12 Apr. BPS.

## Family Nemouridae

*Amphinemura wui* (Claassen). 31 May. WER.

## Family Taeniopterygidae

*Taeniopteryx maura* (Pictet). 23 Nov - 12 Apr. PBS.

## Group SYSTELLOGNATHA

## Family Peltoperlidae

*Tallaperla cornelia* (Needham & Smith). 1 Jun. (Stark 1983).*Tallaperla laurie* (Ricker). 10 May - 22 Jun. WER (also, Stark 1983).*Tallaperla maria* (Needham & Smith). 25 Apr. (Stark 1983).

## Family Perlidae

- Acroneuria abnormis* (Newman). SMD, JCM, WER, TRW.  
*Acroneuria arenosa* (Pictet). SMD, JCM.  
*Beloneuria stewarti* Stark & Szczytko. SMD (and Stark and Szczytko 1976.)  
*Eccoptura xanthenes* (Newman). SMD, JCM, TRW.  
*Paragnetina* prob. *ichusa* Stark & Szczytko. SMD, JCM.  
*Paragnetina immarginata* (Say). SMD.  
*Perlesta frisoni* Banks. WER.

## Family Perlodidae

- Clioperla clio* (Newman). WER.  
*Diploperla duplicata* (Banks). SMD, JCM.  
*Isoperla dicala* Frison. 31 May. WER.  
*Isoperla holochlora* (Klapálek). SMD.  
*Isoperla similis* (Hagen). SMD.  
*Isoperla* sp. A. SMD.  
*Remenus bilobatus* (Needham and Claassen). WER.  
*Yugus bulbosus* (Frison). WER.

## Family Pteronarcyidae

- Pteronarcys biloba* Newman. VHM, WER.

Table 3. Total (tot) and unique (uniq) numbers of mayfly (Eph) and stonefly (Ple) species in selected streams of similar or nearby ecoregions of North (NC) and South Carolina (SC). WC = Wildcat Creek, Pickens County, SC, 1st order stream, upper Piedmont; BC = Broadway Creek, Anderson County, SC, 3rd order stream, upper Piedmont (unpublished data); CC = Coley Creek, Oconee County, SC, and Transylvania County, NC, 1st order stream, Mountains (Morse *et al.* 1989); UC = Upper Three Runs Creek, Aiken County, SC, 3rd order stream, Sandhills (Morse *et al.* 1980); FS = Fourholes Swamp, Berkeley and Dorchester Counties, SC, 3rd order stream, Coastal Plain (unpublished data); CP = entire Coastal Plain in South Carolina (Carlson, 1981).

	WC		BC		CC		UC		FS		CP	
	tot	uniq	tot	uniq	tot	uniq	tot	uniq	tot	uniq	tot	uniq
Eph	35	15	21	6	18	8	25	14	—	—	18	14
Ple	24	11	12	2	21	9	28	14	2	0	5	0

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