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THE EPHEMEROPTERA OF SPRING CREEK, OKLAHOMA, WITH REMARKS ON NOTABLE RECORDS[1]

W. P. McCafferty[2], R. K. Heth[3], R. D. Waltz[4]

ABSTRACT: A total of 40 nominal species of mayflies are reported from nine sites on Spring Creek, a cold-water, western Ozarkian stream in Cherokee, Delaware, and Mayes Counties, Oklahoma. Of these species, 28 represent new state records, bringing the published total for Oklahoma to 59. The essential geographic affinity of the Spring Creek fauna is eastern North America. Many of the species were predictably found, being part of a typical pattern that includes the Ozarks and Ouachita Mountains of Arkansas, the southern Appalachians and the Cumberland Plateau. A large number are also known from eastern and midwestern North America in general. A few are transcontinental, or previously known only from eastern Canada and northeastern and north-central USA. Most new state records also represent westernmost range extensions. The notable geographic records of *Ephemerella rotunda, Nixe flowersi, Paraleptophlebia jeanae, P. moerens, Rhithrogena impersonata, R. jejuna,* and *Stenonema vicarium* are discussed.

Oklahoma is one of several states in the USA that have been very poorly documented with respect to their mayfly fauna (McCafferty *et al.* 1990). The previous first published reports of 31 nominal Ephemeroptera species in the state are as follows: Traver (1934): *Choroterpes oklahoma* Traver [= *Neochoroterpes oklahoma* (Traver)] and *Habrophlebiodes annulata* Traver; Traver (1935): *Caenis delicata* Traver [= *C. latipennis* Banks] and *Tricorythodes fictus* Traver; Spieth (1938): *Ephemera traverae* Spieth; Spieth (1941): *Hexagenia bilineata* (Say), *H. limbata* (Serville), and *H. rigida* McDunnough; Allen and Edmunds (1965): *Ephemerella excrucians* Walsh; McKinley *et al.* (1972): *Caenis simulans* (McDunnough) [= *C. amica* Hagen] and *Stenonema tripunctatum* (Banks) [= *S. femoratum* (Say)]; Lewis (1974): *Stenonema interpunctatum* (Say) [= *Stenacron interpunctatum* (Say)]; Reisen (1975): *Baetis bicaudatus* Dodds and *Dactylobaetis mexicanus* Traver and Edmunds [= *Camelobaetidius mexicanus* (Traver and Edmunds)]; Wilhm *et al.* (1978): *Heptagenia diabasia* Burks, *H. maculipennis* Walsh [= *Leucrocuta maculipennis* (Walsh)], and *Stenonema ares* Burks [= *Stenonema terminatum terminatum* (Walsh)]; Morihara and McCafferty (1979): *Baetis quilleri* Dodds [= *Fallceon quilleri* (Dodds)]; Bednarik and McCafferty (1979): *Stenonema exiguum* Traver and *S. mediopunctatum arwini* Bednarik and McCafferty; Wilhm *et al.* (1979): *Stenonema luteum* (Clemens); Magdych (1979): *Baetis*

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[2] Department of Entomology, Purdue University, West Lafayette, IN 47907.

[3] 2136 Faculty Row, Bacone College, Muskogee, OK 74403.

[4] IDNR, Division of Entomology and Plant Pathology, 402 West Washington, Rm W-290, Indianapolis, IN 46204.

flavistriga McDunnough; Pescador and Berner (1981): *Baetisca lacustris* McDunnough; Henry and Kondratieff (1982): *Leptophlebia bradleyi* (Needham); Kondratieff and Voshell (1984): *Isonychia rufa* McDunnough; Provonsha (1990): *Caenis anceps* Traver, *C. hilaris* (Say), and *C. punctata* McDunnough; Bae and McCafferty (1991): *Anthopotamus neglectus disjunctus* (Traver); McCafferty (1994): *Ephemera simulans* Walker; and Waltz *et al.* (1996): *Baetis intercalaris* McDunnough. Of these published records, only the report of the western species *B. bicaudatus* from south-central Oklahoma by Reisen (1975) is improbable.

We can account for an additional 28 nominal species in Oklahoma based on identification of larval and adult Ephemeroptera collected during a study of Spring Creek in Cherokee, Delaware, and Mayes Counties in the western Ozarks (Table 1, Fig. 1). Many of these species were predictably found in Oklahoma based on their known continental ranges, and particularly if previously known from the Ozark and Ouachita Mountains of Arkansas (McCafferty and Provonsha 1978). Moreover, several of these predictable species have also been collected in southeastern Oklahoma by D. E. Baumgardner (pers. comm.). Some of the new records from Spring Creek, however, constitute significant species range extensions, disjunctions, or reports of poorly known species. The mayflies of Spring Creek are mainly northeastern or southeastern species or both, in terms of the North American geographic regional affinities of McCafferty and Waltz (1990).

As pointed out by Jester *et al.* (1988) in their study of the ecology of Spring Creek, the stream is representative of large creeks in the western Ozarks that have diverse communities of unique cool-water fish species and ubiquitous warm-water fish species. We have found that the mayflies of Spring Creek (Table 1) also constitute a mixture of faunal elements, being composed of 1) several species that are found in the southern Appalachians, Cumberland Plateau and the Ozark-Ouachita Mountains; 2) some species that are basically midwestern fauna typical of low gradient, warm-water habitats; 3) a few species that were previously only known from cold-water trout streams of eastern Canada and northeastern and north-central USA; and 4) some species that are ubiquitous and transcontinental. None of the species were indigenous to western North America.

Sites at which taxa were collected are described below, and their locations along Spring Creek are shown in Figure 1. Additional physical and chemical data associated with Spring Creek and many of our sites may be found in Jester *et al.* (1988). Table 1 gives the site distribution of all species taken at Spring Creek. Following the description of sites, we present a distributional analysis of those species representing significant range extensions or disjunctions based on their discovery in Oklahoma. Voucher specimens are deposited in the Purdue Entomological Research Collection, West Lafayette, Indiana, and at Northeastern State University, Tahlequah, Oklahoma.

DESCRIPTION OF SAMPLE SITES (FIG. 1)

Site A — Delaware County, Coppage Farm, 322m elevation. Spring Creek is a first order stream at this site; it is a ford approximately 2-3m in width; substrate consists of cobble, gravel, and sand; there is partial shading; and there are no backwater areas.
Site B — Delaware County, Oaks Mission, 305m elevation. Spring Creek is a first order stream at this site; it is approximately 3m wide; substrate consists of cobble and gravel; there is complete shade cover; and no backwater areas are present.
Site C — Cherokee County, Rocky Ford, 277m elevation. Spring Creek is a second order stream at this site; it is approximately 9 m wide with bedrock and mixed sand and gravel; there is partial shade present.
Site D — Cherokee County, Teresita at bridge, 256m elevation. Spring Creek is a second order stream at this site; it is very diverse with various currents and backwater areas; it ranges from approximately 6-8m in width; substrate consists of cobble, gravel, and sand; and there is partial shade.
Site E — Cherokee County, Cherokee Cattle Company, 232m elevation. Spring Creek is a third order stream at this site; it ranges from approximately 5-8m in width; substrate consists of small cobble, gravel, and sand; there was partial shade present; some backwater areas are present; and cattle are often present.

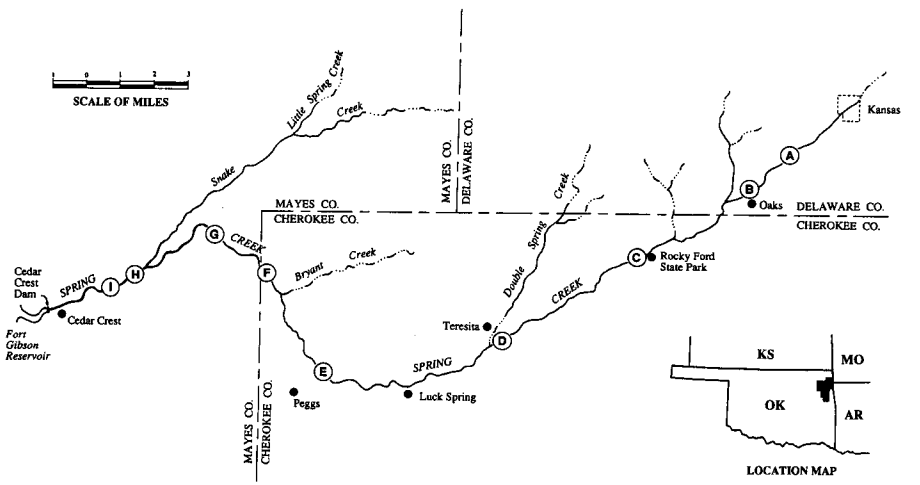

Fig. 1. Spring Creek, Oklahoma study area, with lettered collection sites indicated (described in List of Sites in the text and referred to in Table 1). Location map with Cherokee, Delaware, and Mayes Counties, Oklahoma darkened.

Site F — Cherokee County, Timbercreek Ranch, 213m elevation. Spring Creek is a third order stream at this site; it is at a ford approximately 10m wide; substrate consists of coarse gravel; there is no shade; and backwater areas are present.
Site G — Mayes County, Camp Garland, 194m elevation. Spring Creek is a third order stream at this site; it is approximately 3-4m wide; substrate consists of gravel; it is partially shaded; and there are backwater areas present.
Site H — Mayes County, Twin Bridges, 183m, elevation. Spring Creek is a third order stream at this site; it is approximately 10m wide; substrate consists of gravel; it has full exposure to sun; and there are backwater areas present.

SIGNIFICANT RECORDS

Ephemerella rotunda Morgan — This species is known from eastern Canada, eastern USA along the Appalachians from Maine to Georgia, but also extending into Florida (Berner 1958, 1977). It has also been reported from Kentucky, Michigan, and Wisconsin (Allen and Edmunds 1965). It has not been known west of Wisconsin and Kentucky. Its presence in the Oklahoma Ozarks represents a considerable range extension westward, but as for so many other Ozark species, it is a common Appalachian species also occurring in Kentucky. The larvae of this species cannot consistently be told from those described as *E. inconstans* Traver. Thus, there remains the possibility that the Oklahoma record of *E. rotunda* is attributable to *E. inconstans*, assuming the latter name is not a junior synonym of the former. *Ephemerella inconstans* has been recorded from Georgia, Kentucky, North Carolina, Tennessee, and Virginia (see Allen and Edmunds 1965, Berner 1977). Larvae of *E. rotunda* were collected on III-14,18-1995 and V-18-1996.

Nixe flowersi McCafferty — The discovery of *N. flowersi* in Oklahoma is significant because the species was previously known only from the type locality in Indiana. The species was described from adults (McCafferty 1982) and reared larvae that had previously been described as the larvae of *Heptagenia persimplex* McDunnough (McCafferty 1977). In Indiana, the species occurs in the far south central unglaciated area of the Ohio River Basin. Several mayflies from this latter area appear to be more typical of other southern unglaciated areas of North America, including the Ozarks and Smoky Mountains. Adults of *N. flowersi* were taken on VI-29-1996.

Paraleptophlebia jeanae Berner — Berner (1955, 1975) reported this species from Alabama, South Carolina, and Virginia. It was recently discovered in far southern Indiana (Randolph and McCafferty 1996) in the unglaciated area of the Ohio River Basin, and therefore may occur in Kentucky. Its presence in the Oklahoma Ozarks reflects a common distributional pattern (i.e., western Ozark-Oauchita and eastern Cumberland Plateau-Appalachian pattern) pointed out by McCafferty and Provonsha (1978) for much of the Ozark-Oauchita mayfly fauna. Harris (1990) considered this species among rare and possibly

endangered mayflies in Alabama, as did Kondratieff and Kirchner (1991) for Virginia, and Morse *et al.* (1996) generally. The fact that its larvae were not identifiable prior to the time of the larval description by Randolph and McCafferty (1996) may account in part for its not having been reported from mountainous Arkansas and the fact that it has sometimes been considered rare. At least one species of *Paraleptophlebia, P. calcarita* Robotham and Allen, known from the Ozarks (Robotham and Allen 1988), remains undescribed as larvae. Adults of *P. jeanae* were taken on V-21-1996.

Paraleptophlebia moerens (McDunnough) — This is an eastern and midwestern North American species that has not been previously reported from the Ozarks or any areas adjacent to Oklahoma. Oklahoma represents the westernmost known range of the species. This species apparently fits the second element of the Ozark mayflies identified by McCafferty and Provonsha (1978). That is those that range generally into the Midwest, are widely adapted, and common in the East and states such as Indiana and Illinois. It has been rarely reported from the Southeast (Berner 1975, Harris *et al.* 1996). Larvae of *P. moerens* were taken on I-25-1996 and V-21-1996.

Rhithrogena impersonata (McDunnough) — This species has been reported from northeastern North America and north-central USA, including Michigan and Wisconsin, where it is relatively common in northern counties (see Leonard and Leonard 1962, Flowers and Hilsenhoff 1975, Yanoviak and McCafferty 1996). Its presence in western Oklahoma evidently represents a significant disjunct range extension, as does its previously unreported presence in Kentucky (Randolph and McCafferty, unpublished). It has not been reported from other areas of the Midwest, including adjacent mountainous areas of Missouri and Arkansas. Larvae of *R. impersonata* were taken on V-18-1996.

Rhithrogena jejuna Eaton — The distribution of this species is essentially the same as that of *R. impersonata.* Moreover, Leonard and Leonard (1962) found the two species cohabiting in Michigan. Its presence in western Oklahoma also represents a significant disjunct range extension. It has not been reported from adjacent areas of Missouri and Arkansas. Larvae of *R. jejuna* were taken on III-21-1995.

Stenonema vicarium (Walker) — This is mainly a northeastern and midwestern species in North America (Bednarik and McCafferty 1979), although it has been reported recently from Alabama by Harris *et al.* (1996). Its presence in Oklahoma represents a notable southwestern disjunction, having not been found in Arkansas, or confirmed from Missouri. Larvae of *S. vicarium* were taken on III-13-14, 18, 21-1995, VII-14-15-1995, X-17-1995, and I-16-17-1996.

Table 1. Alphabetical listing of Ephemeroptera collected at Spring Creek sites. Sites are described in the text and shown in Figure 1. Asterisks indicate new Oklahoma records.

SPECIES	COLLECTING SITES								
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
*Acentrella turbida	A	B	C	D	E	F	G	H	I
*Acerpenna pygmaea	A	B	C	D	E	F	G	H	I
Baetis flavistriga	A	B	C	D	E		G		I
Baetis intercalaris	A		C	D			G		
*Callibaetis floridanus									I
Caenis anceps	A		C	D				H	
Caenis latipennis	A		C					H	I
*Choroterpes basalis		B			E				I
*Diphetor hageni	A	B		D	E				
Ephemera traverae	A	B	C						
*Ephemerella rotunda			C	D	E	F			
*Eurylophella bicolor		B		D	E	F	G		I
*Eurylophella enoensis									I
*Eurylophella macdunnoughi						F			
Heptagenia sp.		B		D		F	G	H	I
Hexagenia bilineata							G	H	I
Hexagenia limbata								H	I
*Isonychia bicolor								H	
*Isonychia sicca									I
*Leptophlebia nebulosa				D	E			H	I
*Leucrocuta hebe								H	I
*Leucrocuta minerva									I
*Nixe flowersi					E				
*Nixe inconspicua									I
*Nixe perfida					E		G		I
*Paraleptophlebia guttata						F			I
*Paraleptophlebia jeanae				D					
*Paraleptophlebia moerens				D					
*Paraleptophlebia mollis			C		E				I
Paraleptophlebia sp.				D					
*Procloeon rubropictum				D	E	F			I
*Rhithrogena impersonata						F			
*Rhithrogena jejuna									I
*Siphlonurus marshalli				D	E				
Stenacron interpunctatum	A	B			E				I
*Stenonema bednariki									I
Stenonema femoratum				D	E				I
Stenonema luteum		B							
Stenonema m. arwini							G		I
*Stenonema modestum					E				I
Stenonema t. terminatum		B						H	
*Stenonema vicarium				D	E				
Tricorythodes sp.		B			E		G	H	I

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LITERATURE CITED

Allen, R. K. and G. F. Edmunds, Jr. 1965. A revision of the genus *Ephemerella* (Ephemeroptera, Ephemerellidae) VIII. The subgenus *Ephemerella* in North America. Misc. Publ. Entomol. Soc. Am. 4: 243-282.

Bae, Y. J. and W. P. McCafferty. 1991. Phylogenetic systematics of the Potamanthidae (Ephemeroptera). Trans. Am. Entomol. Soc. 117: 1-143.

Bednarik, A. F. and W. P. McCafferty. 1979. Biosystematic revision of the genus *Stenonema* (Ephemeroptera: Heptageniidae). Can. Bull. Fish. Aquat. Sci. 201: 1-73.

Berner, L. 1958. A list of the mayflies from the lower Apalachicola River drainage. Quart. J. Fla. Acad. Sci. 21: 25-31.

Berner, L. 1975. The mayfly family Leptophlebiidae in the southeastern United States. Fla. Entomol. 58: 137-156.

Berner, L. 1977. Distributional patterns of southeastern mayflies (Ephemeroptera). Bull. Fla. St. Mus. Biol. Sci. 22:1-55.

Flowers, R. W. and W. L. Hilsenhoff. 1975. Heptageniidae (Ephemeroptera) of Wisconsin. Gr. Lakes Entomol. 8: 201-218.

Harris, S. C.1990. Preliminary considerations on rare and endangered invertebrates in Alabama. J. Alabama Acad. Sci. 61: 64-92.

Harris, S. C., B. C. Kondratieff, and B. P. Stark. 1996. New records of Ephemeroptera, Plecoptera and Trichoptera from Alabama. Entomol. News 107: 237-242.

Henry, B. C. and B. C. Kondratieff. 1982. New state records of the mayfly *Leptophlebia bradleyi* Needham. Entomol. News 93:125-126.

Jester, D. B., E. M. Grigsby, P. D. Powell, B. Carroll, J. Fowlkes, L. Lehman, L. Lindley, W. Meads, and B. Stone. 1988. Ecology of Spring Creek, a large Ozark creek in Oklahoma. Okla. Wat. Res. Brd. Publ. No. TR88-3: 1-116.

Kondratieff, B. C. and R. F. Kirchner. 1991. Mayflies. pp. 194-197. *In: K.* Terwilliger [ed.], Virginia's endangered species. McDonald and Woodward Publ. Co., Blacksburg, Va.

Kondratieff, B. C. and J. R. Voshell, Jr. 1984. The North and Central American species of *Isonychia* (Ephemeroptera: Oligoneuriidae). Trans. Am. Entomol. Soc. 110: 129-244.

Leonard, J. W. and F. A. Leonard. 1962. Mayflies of Michigan trout streams. Cranbrook Inst. Sci. Bloomfield Hills, Mich.

Lewis, P. A. 1974. Taxonomy and ecology of *Stenonema* mayflies (Heptageniidae: Ephemeroptera). U. S. E. P. A. Environ. Monit. Ser. Rep. EPA-670/4-74-006: 1-81.

Magdych, W. P. 1979. The microdistribution of mayflies (Ephemeroptera) in *Myriophyllum* beds in Pennington Creek, Johnston County, Oklahoma. Hydrobiol. 66: 161-175.

McCafferty, W. P. 1977. Newly associated larvae of three species of *Heptagenia* (Ephemeroptera: Heptageniidae). J. Georgia Entomol. Soc. 12: 350-358.

McCafferty, W. P. 1982. A new species of *Nixe* from Indiana (Ephemeroptera: Heptageniidae). Gr. Lakes Entomol.15: 227-229.

McCafferty, W. P. 1994. Distributional and classificatory supplement to the burrowing mayflies (Ephemeroptera: Ephemeroidea) of the United States. Entomol. News 105: 1-13.

McCafferty, W. P. and A. V. Provonsha. 1978. The Ephemeroptera of mountainous Arkansas. J. Kans. Entomol. Soc. 51: 360-379.

McCafferty, W. P. and R. D. Waltz. 1990. Revisionary synopsis of the Baetidae (Ephemeroptera) of North and Middle America. Trans. Am. Entomol. Soc. 116: 769-799.

McCafferty, W. P., B. P. Stark, and A. V. Provonsha. 1990. Ephemeroptera, Plecoptera, and Odonata. pp. 43-58. *In:* M. Kosztarab and C. Schaefer [eds.], Systematics of the North American insects and arachnids: status and needs. Va. Agr. Exp. Stat. Inform. Ser. No. 90-1, Va. Polytech. Inst. St. Univ., Blacksburg.

McKinley, R. E., R. Prins, and L. E. Jech. 1972. Occurrence and distribution of arthropods in Travertine Creek, Platt National Park, Murray County, Oklahoma. Proc. Okla. Acad. Sci. 52: 49-52.

Morihara, D. K. and W. P. McCafferty. 1979. The *Baetis* larvae of North America (Ephemeroptera: Baetidae). Trans. Am. Entomol. Soc. 105: 139-221.

Morse, J. C., B. P. Stark, W. P. McCafferty, and K. J. Tennessen. 1996. Southern Appalachian and other southeastern streams at risk: implications for mayflies, dragonflies and damselflies, stoneflies, and caddisflies. *In:* G. W. Benz and D. E. Collins [eds.], Aquatic fauna in peril: the southeastern perspective. Special Publ. No. 1, Southeast Aquat. Res. Inst., Lenz Design & Communications, Decatur, Georgia, in press.

Pescador, M. L. and L. Berner. 1981. The mayfly family Baetiscidae (Ephemeroptera). Part II biosystematics of the genus *Baetisca*. Trans. Am. Entomol. Soc. 107: 163-228.

Provonsha, A. V. 1990. A revision of the genus *Caenis* in North America (Ephemeroptera: Caenidae). Trans. Am. Entomol. Soc. 116: 801-884.

Randolph, R. P. and W. P. McCafferty. 1996. First larval descriptions of two species of *Paraleptophlebia* (Ephemeroptera: Leptophlebiidae). Entomol. News 107: 225-229.

Reisen, W. K. 1975. The ecology of Honey Creek, Oklahoma: Spatial and temporal distributions of the macroinvertebrates. Proc. Okla. Acad. Sci. 55: 25-31.

Robotham, C. D. and R. K. Allen. 1988. *Paraleptophlebia calcarica,* n. sp. (Ephemeroptera: Leptophlebiidae) from western Arkansas. J. Kans. Entomol. Soc. 61: 317-320.

Spieth, H. T. 1938. Taxonomic studies on Ephemerida, I: Description of new North American species. Am. Mus. Novitates 1002: 1-11.

Spieth, H. T. 1941. Taxonomic studies on the Ephemeroptera II. The genus *Hexagenia.* Am. Midl. Natural. 26: 233-280.

Traver, J. R. 1934. New North American species of mayflies (Ephemerida). J. Elisha Mitchell Sci. Soc. 50: 189-254.

Traver, J. R. 1935. Part II. Systematic, pp. 239-739 *In:* J. G. Needham, J. R. Traver and Y.-C. Hsu [eds.], The biology of mayflies with a systematic account of North American species. Comstock Publ. Co., Ithaca, New York.

Waltz, R. D., D. E. Baumgardner, and J. H. Kennedy. 1996. An atypical larval color form of *Baetis intercalaris* (Ephemeroptera: Baetidae) from Pennsylvania and the Kiamichi River Basin of southeastern Oklahoma. Entomol. News 107: 83-87.

Wilhm, J., J. Cooper, and S. Burks. 1979. Species composition of algae and benthic macroinvertebrates in the Blue and Kiamichi Rivers. Proc. Okla. Acad. Sci. 59: 85-88.

Wilhm, J. H., H. Namminga, and C. Ferraris. 1978. Species composition and diversity of benthic macroinvertebrates in Greasy Creek, Red Rock Creek and the Arkansas River. Am. Midl. Natural. 99: 444-453.

Yanoviak, S. P. and W. P. McCafferty. 1996. Comparison of macroinvertebrate assemblages inhabiting pristine streams in the Huron Mountains of Michigan, USA. Hydrobiol. 330: 195-211.