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The Ephemeroptera, Plecoptera, and Trichoptera of Missouri State Parks, with Notes on Biomonitoring, Mesohabitat Associations, and Distribution

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ABSTRACT: Thirty-seven streams within 15 Missouri State Parks were sampled for immature and adult Ephemeroptera, Plecoptera, and Trichoptera (EPT) during 2002 and early 2003. Seven mesohabitats were sampled: riffle, run, leafpack, pool, no flow organic, bank, and silt/mud. Mesohabitat associations are reported for each species collected. All totaled, 34,251 EPT larvae were collected, all specimens of which were identified to the lowest taxon possible. Of approximately 70,000 adult specimens collected by blacklight and vegetation sweeping, 10,342 were examined and identified to the lowest taxon possible. Fifteen species endemic to the Interior Highlands and two species on the Missouri Species of Conservation Concern Checklist were collected. This research revealed a total of 213 species in 99 genera and 37 families of EPT in the designated state parks, representing 65% of the EPT fauna known from Missouri. Mesohabitat associations are reported for all species of larvae collected. Richness of mayflies and stoneflies was significantly highest during the spring season whereas richness of caddisflies was significantly highest during the fall. Richness of all three orders was highest in the riffle mesohabitat, and lowest in the pool and no flow organic mesohabitats. Many distribution records are reported and *Serratella sordida* McDunnough (Ephemeroptera: Ephemerellidae) and *Triaenodes perna* Ross (Trichoptera: Leptoceridae) were collected in Missouri for the first time.
KEY WORDS: Ephemeroptera, Plecoptera, Trichoptera, Mesohabitat, Missouri State Parks, Interior Highlands

Missouri is uniquely situated between distinct eastern and western faunas, is influenced by southern and Gulf Coastal faunas, and harbors the fauna of the Ozark uplift which includes many endemic species (Allen, 1990). Of the approximately 800–1000 insect species within Missouri that have aquatic life stages, nearly half are found in three orders: Ephemeroptera (Sarver and Kondratieff, 1997), Plecoptera (Poulton and Stewart, 1991), and Trichoptera (Moulton and Stewart, 1996), collectively referred to as EPT.

Faunistically, the most poorly understood of the EPT orders in Missouri is Ephemeroptera, for which there has been no comprehensive statewide taxonomic survey. Sarver and Kondratieff (1997) recently published a list of Ephemeroptera of Missouri, adding 51 new state records and listing a total of 85 species now reported from the state. No survey of the Plecoptera of Missouri has been conducted, although the Plecoptera of the Ozark and Ouachita mountains (including parts of Arkansas, Illinois, Missouri, and Oklahoma) was treated by Poulton and Stewart (1991), who reported 88 species from the region, of which 71 were from Missouri. The most species rich order of Missouri's EPT is Trichoptera, and an extensive

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survey of the Trichoptera of the Interior Highlands (including parts of Arkansas, Illinois, Missouri, and Oklahoma) reported 229 total species, of which 163 were from Missouri (Moulton and Stewart, 1996).

Immature mayflies, stoneflies, and caddisflies are important members of the benthic community through their actions of nutrient cycling (Ross and Wallace 1983), coarse organic particle breakdown (Rhame and Stewart, 1976), and they are the partial or primary diet of many fish and other aquatic vertebrates (Borror *et al.*, 1992; Wiggins, 1996; Pflieger, 1997). Additionally, members of these three orders are generally considered to be intolerant of pollution (Rosenberg and Resh, 1993; Wiggins, 1996), although exceptions exist. Recent studies in Missouri have demonstrated the importance of benthic macroinvertebrates for biomonitoring programs (e.g., Berkman *et al.*, 1986; Rabeni *et al.*, 1997; Rabeni and Wang, 2001). Further, the EPT taxa represent an important component of the biodiversity and natural heritage of Missouri (Missouri Natural Heritage Program, 2004). However, many protected and natural areas remain unstudied or not sufficiently surveyed to generate an inventory of EPT taxa for those areas. The Missouri Species of Conservation Concern Checklist (Missouri Natural Heritage Program, 2004) lists 2 Ephemeroptera, 10 Plecoptera, and 6 Trichoptera species as imperiled in Missouri.

Presented herein are distribution records, including new state records, and mesohabitat associations for more than half of the known EPT fauna of the state. Further, species richness is compared among seasons and mesohabitats for each order.

Materials and Methods

Collection of Specimens

A suite of streams in 15 Missouri State Parks (Table 1; Fig. 1) was sampled for immature and adult mayflies, stoneflies, and caddisflies during 2002 and early 2003. Each stream was sampled during three seasons: spring (February–April 2002, 2003), summer (June 2002), and fall (September–October 2002) (Table 1).

Larvae were collected with a D-frame aquatic net, although the specific collecting method differed among mesohabitats. Typically, the net was held against the streambed while the substrate immediately upstream was disturbed by kicking, allowing the current to carry organic material, including insects, into the net. In addition, large rocks were handpicked for larval specimens. To maximize the number of species collected at each site, qualitative samples were taken separately from each of seven distinct mesohabitats: riffle, run, leafpack, bank, pool, no flow organic, and silt/mud. Stop rules were employed such that additional samples were taken until no recognizably new taxa were collected in two consecutive samples in each mesohabitat. Each sample was placed in a 250 ml container and preserved with 95% ethanol. All macroinvertebrates were sorted from debris in the laboratory and all Ephemeroptera, Plecoptera, and Trichoptera (excluding pupae) were identified to the lowest possible taxon. Specimens were labeled, preserved in 80% ethanol and deposited as vouchers in the Enns Entomology Museum, University of Missouri-Columbia.

Mesohabitat Descriptions

The seven mesohabitats sampled were visually determined (*sensu* Vadas and Orth, 1998) based chiefly on flow speed, depth, and substrate, and are qualitatively defined as follows:

RIFFLE: Fast and slow riffles were combined in our study, although Vadas and Orth (1998) recognized both riffle categories as distinct. Therefore, shallow, swiftly moving water with the majority of the surface broken by turbulence was considered riffle.

RUN: Vadas and Orth (1998) defined a run as a stretch of swiftly flowing water deeper than a riffle, with less than 50% of its surface broken by turbulence. However, their study showed that runs were often poorly differentiated from other mesohabitats. In order to more clearly differentiate runs from riffles, we defined a run as a stretch of swiftly flowing water, often above or below a riffle, which was deeper than the riffle and had little to no ($<10\%$) surface turbulence. This mesohabitat included, but was not limited to, glides.

LEAFPACK: Leafpacks were defined as an aggregation of leaves often naturally entrained on an inorganic substrate (e.g., rock, cobble, etc.) surrounded by flowing water.

POOL: Vadas and Orth (1998) differentiated between shallow (depth $\leq$ 55 cm) and medium (depth $>$ 90 cm) pools. However, very few of our study streams had pools with depths greater than 55 cm. Therefore, no distinction was made between shallow or medium pools and pools were defined as occurring in the deepest area of the stream, smooth surfaced, and with nearly immeasurable current.

NO FLOW ORGANIC: Burrowing mayflies (Ephemeridae, Polymitarcyidae, and Potamanthidae) as well as some casemaking caddisflies (e.g., Limnephilidae, Leptoceridae) have a strong affinity to areas of organic deposition (Edmunds and Waltz, 1996; Wiggins, 1996). Therefore, a mesohabitat (no flow organic) was designated and defined by 1) an aggregation of leaves, bark, stems, and other coarse organic material grading into an organic substrate such as mud, 2) often found in a small protective inlet, 3) with little to no water flow around or through, and 4) lowest layers of coarse organic material and mud anoxic for at least half of its depth.

BANK: Distinct species assemblages associated with river banks (Cogerino *et al.*, 1995), emergent vegetation (Vadas and Orth, 1998), and rootmats (Wood and Sites, 2002) have been reported. These areas were combined into a single mesohabitat designation, and when available, samples of each were taken and combined.

SILT/MUD: This mesohabitat was bordered by a run and the stream bank and was characterized by a thick layer of loose silt and mud, with little to no coarse organic material. This mesohabitat was designated to accommodate a unique and distinct area in Big Sugar Creek at Big Sugar Creek State Park.

When multiple instances of a particular mesohabitat were available in a stream, samples from each were taken and combined. In addition to collections of aquatic immature stages, adults, which are often needed for identification to the species level, were collected at each stream by sweeping and hand searching. Bucket style blacklight traps (bulb: Sylvania s178, 30cm, 8w) were left at each park for collection of winged adults (Table 2). Blacklights were placed at stream sites by park personnel in the evening and collected the following morning. All specimens were labeled and preserved in 80% ethanol.

Statistical Analysis

Only immatures collected during aquatic sampling were included in the statistical analyses. A generalized linear mixed-effects model (GLMM; Venables and Ripley, 2002) with the assumption of Poisson errors quantified the effects of date, mesohabitat, and their interaction on species richness. The GLMM was conducted

Table 1. State parks, their associated streams, and dates on which they were sampled* for aquatic larvae.

State Park		Stream		County	Spring (1)	Summer (2)	Fall (3)
1	Bennett Spring	1	Above Spring Creek	Dallas / LaClede	25 March 2002	18 June 2002	21 September 2002
		2	Bennett Spring		25 March 2002	18 June 2002	21 September 2002
		3	Niangua River		16 April 2002	18 June 2002	21 September 2002
2	Big Sugar Creek	4	Big Sugar Creek	McDonald	16 March 2002	21 June 2002	6 October 2002
3	Cuivre River	5	Cuivre River	Lincoln	7 April 2002	ns	8 September 2002
		6	Big Sugar Creek		7 April 2002	17 June 2002	8 September 2002
4	Ha Ha Tonka	7	Bank Branch	Camden	24 March 2002	18 June 2002	21 September 2002
		8	Spencer Creek		24 March 2002	21 June 2002	21 September 2002
5	Hawn	9	Pickle Creek	Ste. Genevieve	26 March 2002	8 June 2002	14 September 2002
		10	River Aux Vases		18 February 2003	21 July 2003	12 October 2002
6	Johnson Shut-Ins	11	Cope Hollow Branch	Reynolds	29 March 2002	4 June 2002	Dry
		12	Black River (E. Fork)		29 March 2002	4 June 2002	15 September 2002
		13	Leaking Creek		29 March 2002	4 June 2002	15 September 2002
7	Lake of the Ozarks	14	Coakley Hollow	Camden / Miller	16 April 2002	18 June 2002	20 September 2002
		15	Grandiglaze Creek		23 March 2002	21 June 2002	20 September 2002
		16	"Trail of 4 Winds" Creek		23 March 2002	6 June 2002	20 September 2002
8	Meramec	17	Beaver Creek	Franklin	27 March 2002	9 June 2002	28 September 2002
		18	Elm Spring Creek		27 March 2002	9 June 2002	28 September 2002
		19	Hamilton Creek		27 March 2002	9 June 2002	x
		20	Meramec River		9 April 2002	9 June 2002	28 September 2002
9	Montauk	21	Current River	Dent	28 March 2002	4 June 2002	28 September 2002
		22	Ingman Hollow		28 March 2002	8 June 2002	Dry
		23	Johnsons Branch		28 March 2002	4 June 2002	28 September 2002
		24	Pigeon Creek		28 March 2002	x	28 September 2002
10	Pershing	25	Locust Creek	Linn	6 April 2002	10 June 2002	22 September 2002
		26	Muddy Creek		6 April 2002	10 June 2002	22 September 2002

Table 1. Continued.

	State Park		Stream	County	Spring (1)	Summer (2)	Fall (3)
11	Prairie	27	Fleck Creek	Barton	17 March 2002	21 June 2002	6 October 2002
12	Roaring River	28	Dry Hollow	Barry	16 March 2002	21 June 2002	Dry
		29	Off Davis Creek		16 March 2002	21 June 2002	Dry
		30	Roaring River		16 March 2002	21 June 2002	6 October 2002
13	St. Francois	31	Big River	St. Francois	9 April 2002	3 June 2002	14 September 2002
		32	Coonville Creek		26 March 2002	3 June 2002	14 September 2002
14	Sam A. Baker	33	Big Creek	Wayne	30 March 2002	8 June 2002	14 September 2002
		34	Logan Creek		30 March 2002	3 June 2002	Dry
		35	Mudlick Creek		18 February 2003	3 June 2002	Dry
		36	St. Francis River		18 February 2003	8 June 2002	14 September 2002
15	Taum Sauk	37	Mina Sauk Falls	Iron	29 March 2002	ns	15 September 2002

* x= no samples taken; ns = samples taken yielded no specimens.

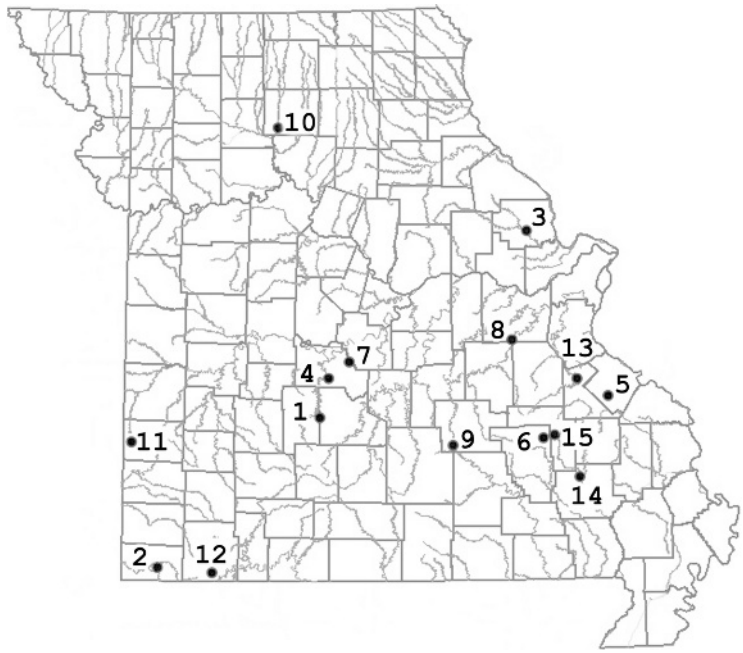

Fig. 1. Locations of state parks sampled. 1. Bennett Spring, 2. Big Sugar Creek, 3. Cuivre River, 4. Ha Ha Tonka, 5. Hawn, 6. Johnson Shut-Ins, 7. Lake of the Ozarks, 8. Meramec, 9. Montauk, 10. Pershing, 11. Prairie, 12. Roaring River, 13. St. Francois, 14. Sam A. Baker, 15. Taum Sauk Mountain.

using the R programming environment (R Development Core Team, 2005) and the MASS (Venables and Ripley, 2002) and nlme (Pinheiro and Bates, 2000) libraries. Date and mesohabitat were modeled as fixed within-subject factors, whereas streams were modeled as a random effect (i.e., a model II factor). *A posteriori* tests were performed separately for each significant factor to evaluate all possible pair-wise comparisons among dates or mesohabitats. *A posteriori* tests were conducted using the R programming environment and the multcomp library (Westfall, 1997). The mesohabitat silt/mud was removed from all analyses because of lack of replication.

Results

Biodiversity

In total, 34,251 EPT larvae were collected and identified to the lowest taxon possible (Table 3). Of approximately 70,000 adult specimens collected by blacklight and vegetation sweeping, 10,342 representative specimens were examined and identified to the lowest taxon possible. Fifteen species endemic to the Interior Highlands and three species on the Missouri Species of Conservation Concern Checklist were collected. This project revealed a total of 213 species in 99 genera and 37 families of EPT in the designated state parks, accounting for 65% of the EPT fauna known from Missouri. Specifically, 57 species in 35 genera and 13 families of Ephemeroptera, 42 species in 18 genera and 8 families of Plecoptera, and 114 species

Table 2. Dates when blacklight trapping* was conducted and streams by which they were placed.

State Park	Stream	County	Spring (1)	Summer (2)	Fall (3)
Big Sugar Creek	Big Sugar Creek	McDonald	9 April 2002	29 July 2002	
Cuivre River	Big Sugar Creek	Lincoln	15 April 2002	27 June 2002	9 September 2002
	General		11 April 2002		
Ha Ha Tonka	Spencer Creek	Camden	24 March 2002	22 June 2002	
Hawn	Pickle Creek	Ste. Genevieve	1 April 2002	10 June 2002	13 October 2002
Johnson Shut-Ins	Black River (E. Fork)	Reynolds	ns	4 June 2002	15 September 2002
Lake of the Ozarks	Coakley Hollow	Camden / Miller		19 June 2002	3 August 2002 20 September 2002
Meramec	Beaver Creek	Franklin	ns	9 July 2002	
	Hamilton Creek				13 & 30 August 2002
Montauk	Pigeon Creek	Dent	29 March 2002	13 July 2002	
	General			14 July 2002	
Pershing	Locust Creek	Linn			12 August 2002
Prairie	Fleck Creek	Barton		20 June 2002 16 & 25 July 2002	6 October 2002
Roaring River	Dry Hollow	Barry	12 April 2002	25 July 2002	
	Off Davis Creek		12 April 2002	24 July 2002	5 August 2002
	Roaring River		16 March 2002	6 June 2002	6 October 2002
St. Francois	Coonville Creek	St. Francois	27 March 2002	1 June 2002	11 September 2002
Sam A. Baker	Big Creek	Wayne		9 June 2002 16 June 2002 23 June 2002 7 July 2002	22 September 2002

* ns = samples taken yielded no specimens.

in 47 genera and 16 families of Trichoptera were collected. This accounted for 62%, 59%, and 70% of the Ephemeroptera, Plecoptera, and Trichoptera known from Missouri, respectively. Collection of aquatic larvae alone revealed 139 taxa (Tables 3, 4). The greatest EPT richness was found in the spring season (114 taxa) followed by the summer (90 taxa) and fall (76), with each seasonal collection yielding approximately 81%, 65%, and 55% of the total taxa of EPT larvae collected, respectively. The riffle mesohabitat showed the highest richness (115 taxa), followed by run (99 taxa), bank (84 taxa), leafpack (72 taxa), no flow organic (41 taxa), pool (37 taxa), and silt/mud (16 taxa) (Table 4). No single season, nor single mesohabitat, yielded the total EPT generic or species richness available.

Highest richness of EPT adults was obtained using blacklights, with which 119 taxa were collected. Blacklights were most effective during the summer season (104 taxa), followed by the fall (51 taxa), and were least effective in the spring (3 taxa). Hand searching and sweep netting were not nearly as productive as blacklighting, but accounted for 6 species not encountered in blacklight samples. The combined techniques yielded 125 EPT taxa of which 9%, 83%, and 42% were collected in the spring, summer, and fall, respectively.

Table 3. Taxa of Ephemeroptera, Plecoptera, and Trichoptera with state park, stream, mesohabitat, and season from which each was collected. Refer to Table 1 for state park, stream, and season number assignments.

Ephemeroptera							
Family	Genus	Species	State Park	Stream[§]	Mesohabitat[‖]	Season	L/A[#]
Ameletidae	*Ameletus*	*Ameletus lineatus* Traver	5,6,8,12,14,15	9,11–13,19,28–30,34,37	RF,RN,LP,NF,BK	1	L
		Ameletus sp.	1,6,12	3,11,30	RF,NF,BK	1	L
Baetidae	*Acentrella*	*Acentrella turbida* (McDunnough)	1,2,4–9,12–14	2–4,8,9,12–15,17–19,21, 23,24,28,30,31,33,34	RF,RN,LP,BN	1,2,3	L
		Acentrella sp.	8	19	RF	1	L
	Acerpenna	*Acerpenna* sp.	1–4,8–10,12,14	1,3–5,7,20,23,25,30,36	RF,RN,LP,NF,BK,SM	1,2,3	L
	Baetis	*Baetis* sp.	1–10,12–14	1–4,6–10,12,15,17–21,23–25, 28,30,32–34,36	RF,RN,LP,PO,NF,BK	1,2,3	L
		Baetis / *Barbaetis*	14	BL		2	A
	Callibaetis	*Callibaetis skokianus* Needham	3,10	BL		3	A
		Callibaetis sp.	1	1	NF	3	L
	Centroptilum	*Centroptilum ozarkensum* Wiersema & Burian[‡]	1,4,5,8,9,12,14	1–3,8,10,20–24,28,30,36	RF,RN,LP,PO,NF,BK	1,2,3	L
		Centroptilum sp.	1,5,7–9,14	1–3,10,15,18,22,34,BL	RF,RN,LP,PO,NF,BK	1,2,3	LA
	Diphetor	*Diphetor hageni* Eaton	1,7–9,12	3,14,18,19,21,23,24,28,30	RF,RN,LP,PO,NF,BK	1,2,3	L
	Labiobaetis	*Labiobaetis propinquus* (Walsh)	10	BL		3	A
	Procloeon	*Procloeon* sp.	1,2,4,5,8,10,12–14	3,4,7,9,10,18,20,25,29–31, 35,36	RF,RN,LP,NF,BK	1,2,3	L
	Pseudocentro-ptiloides	*Pseudocentroptiloides* or *Procloeon* sp.	11	BL		2	A
	Pseudocloeon	*Pseudocloeon* sp.	1,10,12	3,25,30	RF,RN,BK	1,2,3	L
Baetiscidae	*Baetisca*	*Beatisca lacustris* McDunnough	5,8,14	10,20,33,36	RF,RN,BK	1,3	L
Caenidae	*Brachycercus*	*Brachycercus flavus* Traver	3,14	5,36	RN,BK	3,2	L
	Caenis	*Caenis anceps* Traver	2,4,8,9,14	4,7,8,17,23,24,33	RF,RN,SM	1,3	L
		Caenis hilaris (Say)	1,2,4,7–10,13,14	3,4,7,15,20,23–25,32,36	RF,RN,LP,BK,SM	1,2,3	L
		Caenis latipennis (Banks)	1–14	1,3–12,14,15,17–21,24–27,30, 34,36	RF,RN,LP,PO,NF,BK,SM	1,2,3	L

Table 3. Continued.

Ephemeroptera							
Family	Genus	Species	State Park	Stream[§]	Mesohabitat[‖]	Season	L/A[#]
		Caenis punctata McDunnough	1,4,6,8,10,12,14	1,7,8,12,19,20,26,28,36	RF,RN,LP,PO,NF,BK	1,2,3	L
		Caenis tardata McDunnough	2	4	RN	2	L
		Caenis sp.	1–14	3–8,12,14–16,19,20,24,27, 30,32–34,36,BL	RF,RN,LP,PO,NF,BK,SM	1,2,3	LA
	Cercobrachys	*Cercobrachys serpentis* Soldan	10	25	RF,RN	3	L
Ephemerelli-dae	*Attenella*	*Attenella attenuata* (McDunnough)	8	20	BK	2	L
	Ephemerella	*Ephemerella invaria* (Walker)	1,2,7–9,11,14	3,4,15,20,21,27,33,34	RF,RN,LP,PO,BK,SM	1,3	L
		Ephemerella needhami McDunnough	1,7,8,14	3,15,20,33	RF,RN,LP,BK	1	L
		Ephemerella subvaria McDunnough	1,9	2,3,21,23	RF,RN,LP,BK	1,2,3	L
		Ephemerella sp.	5	9	BK	2	L
	Eurylophella	*Eurylophella aestiva* (McDunnough)	1,6	3,12	BK	2	L
		Eurylophella bicolor (Clemens)	1,2,4,6,8,9,12,14	3,4,8,12,20,23,30,34	RF,RN,LP,NF,BK,SM	1,2	L
		Eurylophella enoensis Funk	1	3	RN	1	L
		Eurylophella temporalis (McDunnough) ?	2,5–9,13,14	4,9,12,14,17–19,23,32–34,36	RF,RN,LP,PO,NF,BK	1,2	L
		Eurylophella sp.	1,2,4–9,12–14	2–4,8,9,12–14,17–20,24,30, 32–34,36	RF,RN,LP,PO,NF,BK,SM	1,2,3	L
	Serratella	*Serratella frisoni* McDunnough*	9	21,23	RF,RN,LP,BK	1,2,3	L
		Serratella sordida McDunnough[†]	8	20	RF	2	L
		Serratella sp.	1,9,14	2,21,23,36	RF,RN,LP,NF,BK	1,2,3	L
Ephemeridae	*Ephemera*	*Ephemera simulans* Walker	9,14	24,34	RF,RN,BK	1	L
		Ephemera sp.	1,2,10,12	3,4,25,30	RF,RN,BK,SM	1,2,3	L
	Hexagenia	*Hexagenia limbata* Serville	2,7,8,11	4,15,20,BL	NF,BK,SM	1,2,3	LA
		Hexagenia sp.	7,14	15,33	RN,BK	3	L

Table 3. Continued.

Ephemeroptera							
Family	Genus	Species	State Park	Stream[§]	Mesohabitat[‖]	Season	L/A[#]
Heptageniidae	*Heptagenia*	*Heptagenia diabasia* Burks	10	25	LP	2	L
		Heptagenia flavescens (Walsh)	1,2,4,6–9,12,14	3,4,7,12,15,19,20,23,33,36	RF,RN,LP,BK	1,2,3	L
		Heptagenia sp.	1,3,6,9,12,14	3,6,12,23,30,33,36	RF,RN,LP,NF	1,2,3	L
	Leucrocuta	*Leucrocuta* sp.	2	4	RF	3	L
	Nixe	*Nixe* sp.	2,12	BL		2,3	A
	Rhithrogena	*Rhithrogena pellucida* Daggy	2,8,14	4,20,34,36	RF,RN	1,2	L
	Stenacron	*Stenacron* sp.	1–14	3–5,7–10,12–15,17,19–21, 23–25,28,30–34,36,BL	RF,RN,LP,PO,NF,BK	1,2,3	LA
	Stenonema	*Stenonema bednariki* McCafferty	2	4	RF,RN,PO	1,2,3	L
		Stenonema exiguum Traver	1,8,10	2,3,17,20,25	RF,LP,BK	1,2,3	L
		Stenonema femoratum (Say)	1–15	1,3–10,12,14,15,17–19,21, 23–25,27,28,30–34,36,37	RF,RN,LP,PO,NF,BK,SM	1,2,3	L
		Stenonema mediopunctatum (McDunnough)	1,2,4,6–9,14	3,4,7,12,15,20,23,24,31,33, 34,36	RF,RN,LP,PO,BK,SM	1,2,3	L
		Stenonema modestum (Banks)	5	10	RF	1	L
		Stenonema pulchellum (Walsh)	8,12	17,30	RF,RN	1,2	L
		Stenonema terminatum (Walsh)	1,5,8,10,12	3,9,10,20,25,30	RF,RN,NF	1	L
		Stenonema vicarium (Walker)	6	13	RF,RN,BK	1,3	L
		Stenonema sp.	1–15	1–10,12–15,17,19–21,23–25, 30–34,36,37,BL	RF,RN,LP,PO,NF,BK,SM	1,2,3	LA
Isonychiidae	*Isonychia*	*Isonychia bicolor* (Walker)	2	BL		2	A
		Isonychia rufa McDunnough	10	BL		3	A
		Isonychia sp.	1,2,4–10,12–14	3,4,7–10,13,15,17,20,21, 23–25,30,31,33,34,36,BL	RF,RN,LP,PO,BK	1,2,3	LA
Leptohyphidae	*Tricorythodes*	*Tricorythodes cobbi* Alba-Tercedor & Flannagan	2,8,12	BL		2,3	A
		Tricorythodes sp.	1,2,4–10,12–14	3,4,7–9,12,15,17,19–21, 23–26,30,31,33,36	RF,RN,LP,PO,NF,BK	1,2,3	L

Table 3. Continued.

Family	Genus	Species	State Park	Stream[§]	Mesohabitat[‖]	Season	L/A[#]
Ephemeroptera							
Leptophlebiidae	*Choroterpes*	*Choroterpes basalis* (Banks)	1,2,4,6–9,14	1,3,4,7,8,12,15,23,24,33,BL	RF,RN,LP,NF,BK	2,3	LA
	Leptophlebia	*Leptophlebia* sp.	1,2,4–8,10,12–15	3,4,7–9,12,14,15,17–19, 25,26,30,32,36,37	RF,RN,LP,PO,NF,BK,SM	1,2,3	L
	Paraleptophlebia	*Paraleptophlebia guttata* (McDunnough)	7,12	14,30	RF,RN	1,2	L
		Paraleptophlebia mollis (Eaton)	1,2,7,12	2,3,4,15,30	RF,RN,LP	1,2,3	L
		Paraleptophlebia sp.	1,3–9,12,14	2,3,6,8,10–12,14,17,19, 21,23,28–30,34,35,BL	RF,RN,LP,PO,NF,BK	1,2,3	LA
Polymitarcyidae	*Ephoron*	*Ephoron album* (Say)	8,14	20,36	RF,RN	2	L
Potamanthidae	*Anthopotamus*	*Anthopotamus myops* (Walsh)	1,8,14	3,20,BL	RF,RN	1,2	LA
		Anthopotamus sp.	7,8	14,20	RF,RN	2	L
Siphlonuridae	*Siphlonurus*	*Siphlonurus marshalli* Traver	12,14	28,35	PO,BK	1,2	L
		Siphlonurus minnoi Provonsha & McCafferty	1,4	3,7	NF,BK	1	L
		Siphlonurus sp.	7,12	15,28,29	LF,BK	1	L
Plecoptera							
Capniidae	*Allocapnia*	*Allocapnia granulata* (Claassen)	1	SN		1	A
		Allocapnia mystica Frison	6	11	PO	1	L
		Allocapnia rickeri Frison	3	SN		1	A
		Allocapnia vivipara (Claassen)	3,8	SN		1	A
		Allocapnia sp.	2,5	4,10	RF	1	L
	Paracapnia	*Paracapnia angulata* Hanson	5	10		1	A
Chloroperlidae	*Alloperla*	*Alloperla caudata* Frison	3,6,7	6,12,14		2,3	A
		Alloperla sp.	2,3,7,8,14	4,6,16,19,36	RF,RN,PO	1	L
	Haploperla	*Haploperla brevis* (Banks)	6,7,12	BL		2	A
		Haploperla sp.	3,7,12	6,16,30	RF,RN,LP	1,2	L

Table 3. Continued.

Plecoptera							
Family	Genus	Species	State Park	Stream[§]	Mesohabitat[‖]	Season	L/A[#]
Leuctridae	*Leuctra*	*Leuctra tenuis* (Pictet)	6,14	SN		3	A
	Zealeuctra	*Zealeuctra claasseni* (Frison)	3,8,12	19,29,SN	RF,BK	1	LA
		Zealeuctra narfi Ricker and Ross	12	29	RF	1	L
		Zealeuctra sp.	1–4,6–9,11–14	1,4,6,8,11–14,17–19,22,23, 27–29,32,34	RF,RN,LP,PO,BK	1,2,3	L
Nemouridae	*Amphinemura*	*Amphinemura delosa* (Ricker)	7,14	BL		2	A
		Amphinemura sp.	1–9,12–14	3,4,6,8,9,12–20,24,28–30, 32–34	RF,RN,LP,PO,NF,BK	1,2	L
	Prostoia	*Prostoia* sp.	2,4–8,11,12,14,15	4,8–10,12,13,15,18,19,27,28, 36,37	RF,RN,LP,BK	1	L
Perlidae	*Acroneuria*	*Acroneuria frisoni* Klapalek	2,4–9,13,14	4,8,12,14–17,19,20,24,32, 34,BL	RF,RN,LP,PO,NF	1,2,3	LA
		Acroneuria internata (Walker)	5	BL		2	A
		Acroneuria perplexa Frison	3	BS		2	A
		Acroneuria sp.	1,3,5,7,8,11,13	2,3,14,17,18,27,BL	RF,RN	1,2,3	LA
	Agnetina	*Agnetina capitata* (Pictet)	1,12	2,3,30	RF	1,2,3	L
		Agnetina flavescens (Walsh)	2,8,14	4,20,33,36	RF,RN,LP,PO	1,2,3	L
		Agnetina sp.	1	3	RF	3	L
	Neoperla	*Neoperla choctaw* Stark and Baumann	11	27	RF,RN	2	L
		Neoperla falayah Stark and Lentz[‡]	2,14	4,33	RN,PO	1,2	L
		Neoperla harpi Ernst and Stewart[‡]	2,14	4,33	RF,RN	2	L
		Neoperla osage Stark and Lentz[‡]	2	4	RF,RN	1,3	L
		Neoperla sp.	1–4,6–8,11–14	3,4,7,12,17,20,33,BL,SN	RF,RN,PO	1,2,3	LA

Table 3. Continued.

Plecoptera							
Family	Genus	Species	State Park	Stream[§]	Mesohabitat[‖]	Season	L/A[#]
	Perlesta	*Perlesta brownii* Stark[‡]	7,8	20,BL	RF,RN	2	LA
		Perlesta cinctipes (Banks)	2,3	6,BL	RN	2	LA
		Perlesta decipiens (Walsh)	5–8,10,11,13	9,13,14,16,18,19,25,27,BL	RF,RN,LP,BK	1,2	LA
		Perlesta fusca Poulton and Stewart[‡]	5,6,11,12	9,12,27,29	RF,LP,BK	1,2	L
		Perlesta shubuta Stark	2,6,13	4,12,33,36	BK	2	L
		Perlesta sp.	2,3,5,6,8,11,13,14	4,6,12,18,20,33,BL	RF,RN,BK	1,2	LA
	Perlinella	*Perlinella drymo* (Newman)	2,3,8,12–14	4–6,20,28,32,33,BL,BS	RF,RN,LP,NF,BK	1,2	LA
		Perlinella ephyre (Newman)	2,5–7,13,14	4,12,36,BL	RN,PO,NF,BK	1,2,3	LA
Perlodidae	*Clioperla*	*Clioperla clio* (Newman)	3,5–7,12–14	6,9,13–16,28–30,32,34	RF,RN,LP,BK	1	L
	Isoperla	*Isoperla decepta* Frison	1–3,7,8,13,14	3,4,6,14–16,18,19,31,33,34	RF,RN,LP,BK	1	L
		Isoperla dicala Frison	9	21,23	RF,RN,LP,PO,BK	1,2,3	L
		Isoperla mohri Frison	7,11	16,27	RF,LP	1	L
		Isoperla namata Frison	1,2,4,6–8,12	2–4,8,12,14,16,18,28,30	RF,RN,LP,BK	1,2	L
		Isoperla ouachita Stark and Stewart[‡]	2,3,6–8,11,12,14	4,6,12,14,15,18,19,27–30, 33,34	RF,RN,LP,PO,NF,BK	1	L
		Isoperla signata (Banks)	2,13	4,33	RF,RN,LP,PO,BK,SM	1	L
		Isoperla sp.	2,3,7,12	4,6,15,16,29,30	RF,RN,LP	1	L
Pteronarcyidae	*Pteronarcys*	*Pteronarcys pictetii* Hagen	1,8,9,14	3,20,21,33	RF,RN,LP,BK	1,2,3	L
Taeniopterygidae	*Strophopteryx*	*Strophopteryx arkansae* Ricker and Ross[‡]	14	36	RF	1	L
		Strophopteryx cucullata Frison[‡]	12,15	28,29,37	RF,LP	1	L
		Strophopteryx fasciata (Burmeister)	2,7,9	4,15,24	RF,LP	1	L
	Taeniopteryx	*Taeniopteryx burksi* Ricker and Ross	8,10	25,SN	RF	1	LA
		Taeniopteryx metequi Ricker and Ross	5	10	RF	3	L
		Taeniopteryx parvula Banks	8	20		1	A
		Taeniopteryx sp.	8	20		1	A

Table 3. Continued.

Trichoptera							
Family	Genus	Species	State Park	Stream[§]	Mesohabitat[‖]	Season	L/A[#]
Brachycentridae	*Brachycentrus*	*Brachycentrus lateralis* (Say)	7,8	16,20	RF,RN,BK	2,3	L
	Micrasema	*Micrasema ozarkana* Ross and Unzicker[‡]	1	2,3	RF,RN,NF,BK	1,2,3	L
		Micrasema rusticum (Hagen)	5,14	10,34	RF,RN	1,3	L
Glossosomatidae	*Agapetus*	*Agapetus illini* Ross	5,7,12	BL,SN		1,2	A
		Agapetus sp.	1–4,6–8,12,14	3,4,6–8,13,14,16,18,19,29,34	RF,RN,LP,BK	1,2	L
	Glossosoma	*Glossosoma intermedium* (Klapalek)	9	21	RF,RN	2,3	L
	Protoptila	*Protoptila* sp.	1	3	RF	2,3	L
Helicopsychidae	*Helicopsyche*	*Helicopsyche borealis* (Hagen)	3,6–8,12–14	BL		2,3	A
		Helicopsyche sp.	1,2,4–9,12–14	2–4,7–10,12–15,17–20,24,28, 30,32–34,36	RF,RN,LP,PO,NF,BK,SM	1,2,3	LA
Hydropsychidae	*Ceratopsyche*	*Ceratopsyche bronta* (Ross)	6,7,14	BL		2	A
		Ceratopsyche morosa (Hagen)	6,12	BL,SN		2	A
		Ceratopsyche brontalmorose	1,4,6,8,11,14	2,3,8,12,20,27,33	RF,RN,LP,BK	1,2,3	L
		Ceratopsyche piatrix (Ross)*[‡]	9	21–23,SN	RF,RN,LP	1,2,3	LA
		Ceratopsyche slossonae (Banks)	12,13	30,32,BL	RF,LP,BK	1,2,3	LA
	Cheumatopsyche	*Cheumatopsyche aphanta* Ross	14	BL		2	A
		Cheumatopsyche minuscula (Banks)	14	BL		2	A
		Cheumatopsyche oxa Ross	9,12	BL		1,2,3	A
		Cheumatopsyche pettiti (Banks)	2	BL		2	A
		Cheumatopsyche rossi Gordon[‡]	6,9,14	BL		2,3	A
		Cheumatopsyche sordida (Hagen)	2,14	BL		2	A
		Cheumatopsyche sp.	1–14	2–4,6–10,12–14,16–21, 23–34,36,BL	RF,RN,LP,PO,NF,BK,SM	1,2,3	LA

Table 3. Continued.

Trichoptera							
Family	Genus	Species	State Park	Stream[§]	Mesohabitat[‖]	Season	L/A[#]
	Hydropsyche	*Hydropsyche arinale* Ross	6,9	13,23	RF	1,2	L
		Hydropsyche betteni Ross	5–8,14	10,13,14,17,34,BL	RF,LP	1,2,3	LA
		Hydropsyche bidens Bidens	10	25	RF,RN,LP,BK	2,3	L
		Hydropsyche rossi/simulans Flint, Voshell, and Parker / Ross	1,5,8,10	2,10,20,25	RF,RN	2,3	L
		Hydropsyche scalaris Hagen	9,14	23,BL	BK	1,2	LA
		Hydropsyche sp.	2,3,5,10,12,14	4,10,25,BL,SN	RF,LP	2,3	LA
	Potamyia	*Potamyia flava* (Hagen)	3,6,10,12,14	BL		2,3	A
Hydroptilidae	*Hydroptila*	*Hydroptila ajax* Ross	8,11	BL		2	A
		Hydroptila albicornis Hagen	8	BL		2	A
		Hydroptila amoena Ross	7,8	BL		2,3	A
		Hydroptila angusta Ross	11	BL		2	A
		Hydroptila armata Ross	6	BL		3	A
		Hydroptila broweri Blickle	13	BL		2	A
		Hydroptila consimilis Morton	5,7,8,11,12	BL		2,3	A
		Hydroptila grandiosa Ross	11,14	BL		2	A
		Hydroptila hamata Morton	5–7,12	BL		2,3	A
		Hydroptila oneili Harris	12	BL		3	A
		Hydroptila perdita Morton	6,8	BL		2,3	A
		Hydroptila sandersoni Mathis and Bowles	6	BL		2	A
		Hydroptila scolops Ross	6	BL		2	A
		Hydroptila waubesiana Betten	11	BL		2	A
		Hydroptila sp.	1–9,12,14	2,4,6–8,10,12,14–16,18–21, 23,24,30,33,34,36,BL	RF,RN,LP,PO,NF,BK	1,2,3	LA
	Ithytrichia	*Ithytrichia clavata* Morton	8	BL		2	A
		Ithytrichia sp.	8,13	20,31	LP,BK	1,3	L

Table 3. Continued.

Trichoptera							
Family	Genus	Species	State Park	Stream[§]	Mesohabitat[‖]	Season	L/A[#]
	Leucotrichia	*Leucotrichia* sp.	3	6	RN	1	L
	Mayatrichia	*Mayatrichia* sp.	11	BL		2	A
	Neotrichia	*Neotrichia vibrans* Ross	11	BL		2	A
		Neotrichia sp.	11	BL		2	A
	Ochrotrichia	*Ochrotrichia anisca* (Ross)	5–7	BL		2	A
		Ochrotrichia arva (Ross)	7	BL		2	A
		Ochrotrichia eliaga Ross	7	BL		2	A
		Ochrotrichia spinosa Ross	7	BL		3	A
		Ochrotrichia tarsalis (Hagen)	6	BL		3	A
		Ochrotrichia sp.	1–4,7–9,12,15	3,4,6–8,14,16,18,21,23,30, 37,BL	RF,RN,LP,PO,BK	1,2,3	LA
	Orthotrichia	*Orthotrichia aegerfasciella* (Chambers)	7,11,14	BL		2,3	A
		Orthotrichia cristata Morton	3,6	BL		2,3	A
	Oxyethira	*Oxyethira dualis* Morton	12	BL		2	A
		Oxyethira novasota Ross	5	BL		1,2,3	A
		Oxyethira pallida (Banks)	11	BL		2	A
		Oxyethira sp.	1,6,8,9,14,15	1–3,12,20,21,23,24,34,37	RF,RN,LP,NF,BK	1,2,3	L
Lepidosto- matidae	*Lepidostoma*	*Lepidostoma togatum* (Hagen)	13	BL		2	A
		Lepidostoma sp.	6,7,9,14,15	11,13,21,35,37	RF,RN,LP,NF,BK	1,2	L
Leptoceridae	*Ceraclea*	*Ceraclea ancylus* (Vorhies)	5	BL		2	A
		Ceraclea cancellata (Betten)	8	20	RF	2	L
		Ceraclea flava (Banks)	13	BL		2	A
		Ceraclea maccalmonti Moulton and Stewart[‡]	1	2	RF,RN	1	L
		Ceraclea maculata (Banks)	3,5,8,10,14	BL		2,3	A
		Ceraclea nepha (Ross)	12	BL		2	A

Table 3. Continued.

Trichoptera							
Family	Genus	Species	State Park	Stream[§]	Mesohabitat[‖]	Season	L/A[#]
		Ceraclea tarsipunctata (Vorhies)	6,13	BL		2	A
		Ceraclea transversa (Hagen)	1,5,14	2,3,BL	RF,BN	1,2,3	LA
		Ceraclea sp.	9,14	36,BL	RF	1,2	LA
	Leptocerus	*Leptocerus americanus* (Banks)	6,14	BL		2	A
	Mystacides	*Mystacides* sp.	5,7,10,14	10,15,25,33,36	RN,PO,BK	1,2,3	L
	Nectopsyche	*Nectopsyche candida* (Hagen)	2,3,10,14	BL		2,3	A
		Nectopsyche diarina (Ross)	11,14	BL		2	A
		Nectopsyche exquisita (Walker)	3,14	BL		2,3	A
		Nectopsyche pavida (Hagen)	13	BL		2	A
		Nectopsyche sp.	1,4,7,8,10,14	3,7,15,20,25,36	RF,RN,LP,BK	1,2,3	L
	Oecetis	*Oecetis avara* (Banks)	2	BL		2	A
		Oecetis cinerascens (Hagen)	3	BL		2,3	A
		Oecetis ditissa Ross	3,7,8	BL		2,3	A
		Oecetis inconspicua (Walker)	3,7,8,11,12,14	BL		2,3	A
		Oecetis nocturna Ross	8,11	BL		2,3	A
		Oecetis persimilis (Banks)	5,6,8,10,12	BL		2,3	A
		Oecetis sp.	2–8,13,14	4,5,7,9,10,12,15,20,31,33, 34,36	RF,RN,LP,NF,BK,SM	1,2,3	L
	Setodes	*Setodes oxapius* (Ross)[‡]	8,13	20,33,BL	RF,RN	2,3	LA
	Triaenodes	*Triaenodes ignitus* (Walker)	5,8,9	10,24,BL	RF,BK	2,3	LA
		Triaenodes injustus (Hagen)	13,14	BL		2	A
		Triaenodes perna (Ross)[†]	14	BL		2	A
		Triaenodes sp.	1–8,10–15	2–5,7,9,10,12,15,17,20,25,28, 31–33,36,37,BL	RF,RN,LP,PO,NF,BK	1,2,3	LA
Limnephilidae	*Frenesia*	*Frenesia missa* (Milne)	7	14	FEN	2	L
	Ironoquia	*Ironoquia* sp.	3,10–12,14	5,6,26–30,34	RF,RN,LP,NF,BK	1	L
	Pseudostenophylax	*Pseudostenophylax uniformis* (Betten)	5,7,8,13	10,14,17,32	RF,RN,NF,BK	1,2,3	L

Table 3. Continued.

Trichoptera							
Family	Genus	Species	State Park	Stream[§]	Mesohabitat[‖]	Season	L/A[#]
	Pycnopsyche	*Pycnopsyche guttifer* (Walker)	7,8	BL		2,3	A
		Pycnopsyche indiana Ross	11	BL		3	A
		Pycnopsyche lepida (Hagen)	5,7,13	BL		3	A
		Pycnopsyche rossi Betten	7	BL		3	A
		Pycnopsyche sp.	1,2,5–9,11,13,14	2–4,9,10,12–14,16–21,23,24, 27,32–34,36,BL	RF,RN,LP,PO,NF,BK	1,2,3	LA
Molannidae	*Molanna*	*Molanna belenda* (Sibley)	5,7	10,14,BL	RF,RN,BK	2,3	LA
Odontoceridae	*Marilia*	*Marilia flexuosa* (Ulmer)	2,14	4,33,36,BL	RF,RN,PO,NF,BK	1,2,3	LA
Philopotamidae	*Chimarra*	*Chimarra feria* Ross	3,5–9,12,14	30,BL,SN		1,2,3	A
		Chimarra moselyi Denning	13	BL		2	A
		Chimarra obscura (Walker)	2,3,5–14	BL		2,3	A
		Chimarra socia Hagen	6,14	BL		2,3	A
		Chimarra sp.	1,2,4–9,12–14	3,4,7–10,12–15,17–21,23,24, 29,30,32,34,36	RF,RN,LP,NF,BK	1,2,3	LA
	Wormaldia	*Wormaldia shawnee* (Ross)	6,7	BL		2	A
Phryganeidae	*Agrypnia*	*Agrypnia vestita* (Walker)	3,5,6	BL		3	A
	Phryganea	*Phryganea sayi* Milne	3,5,11	BL		2,3	A
	Ptilostomis	*Ptilostomis ocellifera* (Walker)	11	BL		2	A
		Ptilostomis sp.	3,11	BL		2,3	A
Polycentropodidae	*Cernotina*	*Cernotina calcea* Ross	3,11	BL		2,3	A
		Cernotina spicata Ross	5	BL		2	A
		Cernotina sp.	5	10		2	A
	Cyrnellus	*Cyrnellus fraternus* (Banks)	5,7,9,11,14	10,15,21,24,34,BL	RF,BK	1,2,3	LA
	Neureclipsis	*Neureclipsis crepuscularis* (Walker)	8,13,14	20,31,33	LP,BK	1,3	L

Table 3. Continued.

Trichoptera							
Family	Genus	Species	State Park	Stream[§]	Mesohabitat[‖]	Season	L/A[#]
	Paranyctiophylax	*Paranyctiophylax affinis* (Banks)	7,14	BL		2,3	A
		Paranyctiophylax moestus (Banks)	5,7,11	BL		2	A
		Paranyctiophylax serratus (Lago and Harris)	7	BL		2	A
		Paranyctiophylax sp.	3,8	17,BL	BK	2,3	LA
	Polycentropus	*Polycentropus centralis* Banks	3,5–8,11–14	BL		2,3	A
		Polycentropus confusus Hagen	6,13,14	BL		2,3	A
		Polycentropus harpi Moulton and Stewart	7,11,13,14	BL		2,3	A
		Polycentropus sp.	1–4,6–9,12–14	3,4,6,8,12,14,15,17–19,23,29, 31–33	RF,RN,LP,PO,NF,BK,SM	1,2,3	L
Psychomyii-dae	*Lype*	*Lype diversa* (Banks)	13	BL		2	A
	Psychomyia	*Psychomyia flavida* Hagen	1,2,6–9,12,14	3,14,20,21,23,28,30,BL,SN	RF,RN,PO	1,2,3	LA
Rhyacophilidae	*Rhyacophila*	*Rhyacophila fenestra* Ross	3,6,14	BL		2	A
		Rhyacophila fenestralledra	2,3,7,8,14	4,6,15–19,34	RF,RN,LP	1	L
		Rhyacophila glaberimma Ulmer	4,5	8,BL	RF	1,3	LA
		Rhyacophila kiamichi Ross[‡]	12	29	RF	1	L
		Rhyacophila lobifera Betten	3,11	6,27	RF,LP,BK	1	L
		Rhyacophila sp.	7	14	LP	1	L
Uenoidae	*Neophylax*	*Neophylax concinnus* MacLachlan	5,8,12,13,15	10,19,29,32,37	RF,LP	1,2	L
		Neophylax fuscus Banks	4,5,7,8,12–14	8,10,14,17,19,28,32,34	RF,RN,LP,BK	1,2,3	L

* Missouri Species of Conservation Concern.
† new state record.
‡ endemic to the Interior Highlands.
§ BL= blacklight, SN= sweep net, BS= Bruce Schuette (general collecting).
‖ RF= riffle, RN= run, LP= leaf pack, PO= pool, NF= no flow organic, BK= bank, SM= silt/mud.
L= larva, A= adult.

Table 4. Richness of EPT larvae* within mesohabitats for each season.

	Riffle			Run			Leafpack			Pool			No Flow Org			Bank			Silt/Mud			Total		
Season	F	G	S	F	G	S	F	G	S	F	G	S	F	G	S	F	G	S	F	G	S	F	G	S
Spring	33	62	87	32	57	74	27	47	64	21	32	35	22	32	34	28	47	56	12	13	16	34	71	114
Summer	22	44	57	24	41	51	16	24	26	8	8	8	11	14	14	21	39	45	0	0	0	30	65	90
Fall	26	51	60	21	41	46	11	15	15	2	2	2	3	3	4	19	37	43	0	0	0	26	63	76
Total	35	74	115	34	70	99	27	52	72	22	33	37	23	37	41	30	64	84	12	13	16	36	86	139

* F= family, G= genus, S= species.

Larval richness was highest during the spring, whereas adult richness was highest in the summer. During no season did the collection of only one life stage yield the total EPT generic or species richness available at the time.

Taxonomic Notes

Serratella sordida McDunnough is reported from Missouri for the first time.

Pseudocentroptiloides or Procloeon sp.: Two adult male specimens collected in Prairie State Park key to *Pseudocentroptiloides* using Edmunds and Waltz (1996). However, Wiersema and McCafferty (1998) cautioned that *Procloeon viridoculare* (Berner) possesses characters which would cause it to key to *Pseudocentroptiloides* using the key in Edmunds and Waltz (1996). Additional specimens, specifically larvae, are needed to distinguish these taxa.

Eurylophella temporalis (McDunnough): Reports of this species in Missouri were considered doubtful by Sarver and Kondratieff (1997). Some specimens of *Eurylophella* collected herein key to *E. temporalis* using Funk and Sweeney (1994), who reported this species from Illinois. This genus has many morphologically cryptic species (Funk and Sweeney, 1994) and is in need of special attention in the Interior Highlands (R. Sarver, pers. comm.).

Tricorythodes sp.: Larvae of the genus *Tricorythodes* presently cannot be identified to species. Although three other species of *Tricorythodes* are known from surrounding states, only *Tricorythodes cobbi* Alba-Tercedor and Flannagan has been reported from Missouri. Thus, the majority of the *Tricorythodes* sp. are possibly *T. cobbi*.

Amphinemura sp.: The larvae of *Amphinemura* sp. presently cannot be identified to species. However, based on adults, by far the most common species in Missouri is *Amphinemura delosa* (Ricker). Thus, the majority of the *Amphinemura* sp. larvae are probably *A. delosa*.

Triaenodes perna Ross is reported from Missouri for the first time.

Helicopsyche sp.: Three species of *Helicopsyche* are known from the Interior Highlands: *H. borealis* (Hagen), *H. limnella* Ross, and *H. piroa* Ross. A key to the larvae of *Helicopsyche* was provided in Moulton and Stewart (1996), however the key is mostly based on color and is highly subjective. Therefore, all *Helicopsyche* larvae are reported herein as *Helicopsyche* sp., the majority of which are probably *H. borealis*.

Frenesia missa (Milne): This species was not collected in the stream at Coakley Hollow, but larvae were hand picked from the fen adjacent to the stream. Moulton and Stewart (1996) reported that this species is found only in spring seeps. Therefore, it is unlikely that *F. missa* will be included in surveys that target only lentic or lotic habitats.

Ironoquia sp.: Moulton and Stewart (1996) collected only *Ironoquia punctatissima* (Walker) from the Interior Highlands. However, the congener *I. kaskaskia* (Ross) has been reported from southwestern Illinois, and might eventually be found in Missouri. The larvae collected during this research are most likely *I. punctatissima*.

Mesohabitat Associations and Seasonality

EPHEMEROPTERA. Mayfly richness was significantly different among dates ($F = 9.778$, $P < 0.001$) and mesohabitats ($F = 12.417$, $P < 0.001$), and the interaction term was not significant ($F = 1.667$, $P = 0.088$). Post-hoc pairwise comparisons

Table 5. Differences in richness* among (A) seasons and (B) mesohabitats of Ephemeroptera, Plecoptera, and Trichoptera separately.

A.	Ephemeroptera		Plecoptera		Trichoptera	
	Season	Richness	Season	Richness	Season	Richness
	Spring	4.07 a	Spring	1.72 a	Fall	2.43 a
	Fall	3.90 b	Fall	0.47 b	Spring	2.35 b
	Summer	3.19 b	Summer	0.44 b	Summer	1.71 c

B.	Ephemeroptera		Plecoptera		Trichoptera	
	Mesohabitat	Richness	Mesohabitat	Richness	Mesohabitat	Richness
	Riffle	4.97 a	Riffle	1.80 a	Riffle	3.40 a
	Run	4.11 b	Leafpack	1.29 bc	Bank	2.11 b
	Bank	3.48 bc	Run	0.83 bcd	Run	2.10 b
	Leafpack	3.25 bc	Bank	0.61 cd	Leafpack	1.77 bc
	No Flow Org	2.55 cd	Pool	0.58 bcd	Pool	0.88 cd
	Pool	1.96 cd	No Flow Org	0.31 cd	No Flow Org	0.86 cd

* Like letters denote means which are not significantly different (post-hoc comparisons) ($\alpha = 0.05$).

between seasons (Table 5) showed that mayfly richness was significantly different between spring and summer ($P < 0.001$) and between spring and fall ($P < 0.001$), but not between summer and fall ($P = 0.091$). Post-hoc pairwise comparisons between mesohabitats (Table 5) showed that mayfly richness of riffles was significantly higher than that of all other mesohabitats ($P < 0.001$ for each comparison). Additionally, mayfly richness of runs was significantly higher than that of pools ($P = 0.006$) and no flow organic ($P = 0.014$). No other pairwise comparison between mesohabitats was significant.

PLECOPTERA. Stonefly richness was significantly different among dates ($F = 42.331$, $P < 0.001$) and mesohabitats ($F = 14.968$, $P < 0.001$), and the interaction term was not significant ($F = 0.771$, $P = 0.656$). Post-hoc pairwise comparisons between seasons (Table 5) showed that stonefly richness was significantly different between spring and summer ($P < 0.001$) and between spring and fall ($P < 0.001$), but not between summer and fall ($P = 0.882$). Post-hoc pairwise comparisons between mesohabitats (Table 5) showed that stonefly richness of riffles was significantly higher than that of all other mesohabitats (run, $P < 0.001$; leafpack, $P = 0.008$; pool, $P = 0.001$; no flow organic, $P < 0.001$; bank, $P < 0.001$). Additionally, stonefly richness of leafpacks was significantly higher than that of no flow organic ($P = 0.020$) and bank ($P = 0.023$). No other pairwise comparison between mesohabitats was significant.

TRICHOPTERA. Caddisfly richness was significantly different among dates ($F = 6.797$, $P = 0.001$) and mesohabitats ($F = 13.168$, $P < 0.001$), and the interaction term was not significant ($F = 0.448$, $P = 0.921$). Post-hoc pairwise comparisons between seasons (Table 5) showed that caddisfly richness was significantly different between spring and summer ($P < 0.001$), between spring and fall ($P < 0.001$), and between summer and fall ($P = 0.020$). Post-hoc pairwise comparisons between mesohabitats (Table 5) showed that caddisfly richness of riffles was significantly higher than that of all other mesohabitats ($P < 0.001$ for each comparison). Caddisfly richness of runs was significantly higher than that of pools ($P = 0.027$) and

no flow organic ($P = 0.008$). Additionally, caddisfly richness of banks was significantly higher than that of pools ($P = 0.037$) and no flow organic ($P = 0.011$). No other pairwise comparison between mesohabitats was significant.

Discussion

Spring was the season in which richness was highest for Ephemeroptera and Plecoptera, however Trichoptera had the highest richness in the fall. Summer and fall richness was not significantly different for Ephemeroptera and Plecoptera, but Trichoptera showed significantly higher richness in the spring with summer richness significantly lower than all other seasons. Approximately 58% of the larval specimens (~20,000) were from the spring sampling period. Specimens from summer and fall were considerably smaller and less developed than those from spring. For each order, summer showed the lowest richness. This is to be expected, as the life histories of many EPT and other aquatic macroinvertebrates have evolved to exploit the high nutrient availability in the spring and fall seasons and avoid the relatively nutrient poor summer season (Vannote *et al.*, 1980; Cummins *et al.*, 1989; Wallace and Anderson, 1996). Therefore, stream biomonitoring programs might be best served by sampling early in the year.

Richness for each order was highest in the riffle, and the second richest mesohabitats were run, leafpack, and bank, which were generally not significantly different from one another. For each order, species richness was lowest in pool and no flow organic, which were generally not significantly different from each other. Substrate types may influence species distributions, however velocity and complex hydraulic characters also may be important (Sites and Willig, 1991; Lloyd and Sites, 2000). The high velocity and turbulence of a riffle increases aeration and provides an area where filterers are able to exploit the current and gather food with minimum energy expenditure (Cummins and Merritt, 1996). Additionally, the shallow water in riffles and runs, and increased diversity of microhabitats of the bank and leafpack, help to protect EPT from predation by fish (Schlosser, 1987).

Many water quality metrics are based wholly or partially on the EPT fauna (Barbour *et al.*, 1999). Future studies that reveal significantly fewer taxa would indicate a perturbation of some kind. State park, stream, mesohabitat, season, and life stage information are given here not only to aid in future management decisions, but also to aid in the recollection of a particular taxon, for monitoring rare species, and targeting particular mesohabitats to promote/protect increased richness.

The study of the Ephemeroptera, Plecoptera, and Trichoptera fauna of the state parks of Missouri surveyed is by no means complete. We expect that additional species will be discovered at each state park, and many records left as undetermined genera may be determined at the species level in the future. This study represents an important foundation for future work, especially concerning the use of EPT fauna for biomonitoring.

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