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# Caddisflies (Trichoptera) of the Buffalo National River, Arkansas

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**Abstract.** We report 106 species of caddisflies (Trichoptera) representing 44 genera and 16 families that were collected across 50 sampling sites in the Buffalo River watershed. The species collected represent about 45% of the known Interior Highlands caddisfly fauna. The most speciose families collected were the Hydroptilidae (30), Leptoceridae (21), and Hydropsychidae (17). Two species found during this study, *Paduniella nearctica* and *Ochrotrichia contorta*, are listed as species of special concern in the state of Arkansas due to their relative rarity. Similarity analysis values among collection sites ranged from 9% to 77%. Seriation analysis of caddisfly genera and species showed that most are distributed throughout the entire Buffalo National River but some are restricted to either the upper or lower river or its tributaries. This represents the first comprehensive survey of caddisflies completed for the Buffalo National River.

**Key words.** Aquatic insects, diversity, Ozarks, streams.

## Introduction

The order Trichoptera (caddisflies) has approximately 45 families, 600 genera and over 13,000 described species worldwide (Holzenthal et al. 2007). On account of their broad ecological and taxonomic diversity, they are generally considered to be among the most important of all aquatic orders (Mackay and Wiggins 1979; Holzenthal et al. 2007). Accordingly, caddisflies are important in bioassessment surveys of streams and other water bodies (Barbour et al. 1999). Although caddisflies may be found in waterbodies of varying quality and condition, species-rich caddisfly assemblages generally indicate clean water. Identifying the species of caddisflies occurring in a stream can lead to the development of more precise tolerance values and a better understanding of stressors.

The flora and fauna of many streams and springs are at risk of destruction and extirpation due to anthropogenic activities, including climate change (e.g., Bowles et al. 2007; Karl et al. 2009; Kaushal et al. 2010; Woodward 2010; Betts et al. 2015). Therefore, conducting species level inventories of caddisflies and other aquatic insects occurring in these aquatic resources is of paramount importance. Additionally, routine monitoring of environmental changes and site-species retention can help identify conservation/

management needs before a species or resource is beyond saving. Despite this clear need for species-level inventories of caddisflies, they have been poorly documented on most National Park Service properties.

Buffalo National River (BUFF), located in north central Arkansas, is one of the two largest units of the National Park Service in the Ozark Plateaus. BUFF was established in 1972 to protect the corridor of the Buffalo River and its tributaries. The Buffalo River and its tributaries are located in an area of extensive karst topography, making the rivers vulnerable to contaminated groundwater recharge and interbasin transfer of groundwater from adjacent watersheds. However, the NPS jurisdictional boundary around the Buffalo River is generally a narrow corridor that encompasses only about 11% of the watershed, while over 50% of the watershed is in private ownership. This leaves much of the watershed unprotected from human activities such as timber management, landfills, grazing, livestock operations, urbanization, gravel mining, stream channelization, and removal of riparian vegetation. Although the Buffalo River and its tributaries are in generally good condition, multiple factors threaten their integrity (Bowles et al. 2017).

Prior to this study, a comprehensive inventory of caddisflies in the Buffalo National River had not been accomplished. The late Dr. Mike Mathis conducted an unpublished study of Trichoptera occurring in the upper Buffalo River and some tributaries (Boxley Valley), and Frazer et al. (1991) made one light trap collection on the Little Buffalo River, the largest tributary of the Buffalo River. This paper assesses and summarizes the results of caddisfly occurrences from throughout the Buffalo National River watershed, Arkansas.

## Materials and Methods

### Specimen collection and identification

Adults were collected using various methods including battery-powered black-light (UV) traps, mercury vapor (MV) traps, and sweep nets. Larvae were collected using benthic nets and hand-picking from the stream substrate. Adult caddisflies were removed from bulk samples, sorted and identified to species, labeled and stored in vials containing 80% ethanol. Adult terminalia were cleared at room temperature in a saturated solution of sodium hydroxide, rinsed in alcohol, and placed in microvials filled with glycerin and stored with the specimen (pins and vials). We also examined a collection of adult caddisflies collected by Travis Edwards, University of Arkansas. Additional species records were taken from routine monitoring data collected by the Heartland Inventory and Monitoring Network (HTLN). Larvae are reported here only when they could be identified to species. This paper also includes data from an unpublished report by Mathis (1990). Not all of his species identifications could be confirmed by us, but of his identifications are unexpected for the area. Other data were taken from previously published literature. Primary identification keys included Ross (1944) and Moulton and Stewart (1996), and all species determinations were by D.E. Bowles and M.L. Mathis. High level taxa names (suborders, infraorders, superfamilies) follow Moulton and Stewart (1996). Examples of identified species are deposited in the reference collection of the HTLN.

### Collection sites

We collected adult and larval caddisflies at multiple sites along the Buffalo River and its tributaries within the jurisdictional boundaries of the Buffalo National River, Arkansas (Fig. 1). Some sites that were closely located were combined into a single location. UTMs are zone 15S northings and eastings. The Buffalo River from its headwaters to its confluence with the White River is approximately 246 km in length. Along its course, it varies in size from a small, wadeable headwater stream with occasionally intermittent flows to a large, fifth order, river with long pools (~up to 1 km) and few riffles. Most of the tributaries we sampled were near their confluence with the river (<1 km) and primarily were first and second order streams. The exception was Little Buffalo River (sites 22–23), which is equivalent in size to the mainstem river at their confluence.

1. Newton Co., Buffalo National River, Buffalo River, Boxley Valley just below Upper Buffalo Wilderness Area boundary, UTM 3977369, 463445, v–x.1991, UV-light, M.L. Mathis; same, but 381 m elevation, 20.v.2016, UV-light, D.E. Bowles and F.D. Usrey.
2. Newton Co., Buffalo National River, LuAllen Spring run, Upper Boxley Valley, elevation 382 m, UTM 3977915, 463621, v.1991, UV-light, M. L. Mathis; same but, 20.v.2016, D.E. Bowles and F.D. Usrey.
3. Newton Co., Buffalo National River, Smith Creek, approximately 100 m upstream of Hwy 21 bridges, UTM 3978179.75, 464098.72, x.2009, benthic samples, HTLN staff.
4. Newton Co., Buffalo National River, Boxley Valley, Buffalo River, approximately 100 m above and below confluence with Moore Creek, UTM 3981659.3, 464088.5, ix–ii.2005–2010, 2012, 2014, 2016, benthic sample, D.E. Bowles, J.A. Hinsey, and J.T. Cribbs.
5. Newton Co., Buffalo National River, Mill Pond at Whiteley Creek, UTM 3982912, 463964, 20.v.2016, 385 m elevation, UV-light, D.E. Bowles and F.D. Usrey.
6. Newton Co., Buffalo National River, Whiteley Creek, Off AR-43N, UTM 3983188, 464015, T. Edwards, SLAM trap, v–ix.2012; same, but i.2007, benthic samples, D.E. Bowles, J.A. Hinsey and J.T. Cribbs.
7. Newton Co., Buffalo National River, Clark Creek at Eden Falls, Lost Valley Campground, UTM 39885971, 465096, vi.1991, UV-light, M. L. Mathis.
8. Newton Co., Buffalo National River, Main river channel; lower end of Boxley Valley, approximately 4.8 km upstream from Ponca bridge, UTM 3988313, 469847, v–x.1991, bi-weekly UV-light samples, M. L. Mathis.
9. Newton Co., Buffalo National River, Steel Creek, Off Steel Creek Road, UTM 3988263, 469851, v–vi.2012, SLAM trap, T. Edwards; same but Steel Creek Campground, Buffalo River at Steele Creek, D.E. Bowles and F.D. Usrey, 323 m, UV-light, 20.v.2016.
10. Newton Co., Buffalo National River, Sneeds Creek, near confluence with Buffalo River, UTM 3990497.25, 472172.12, ii.2009, benthic samples, HTLN staff.
11. Newton Co., Buffalo National River, Upper Huchingson Cave Spring, UTM 3993724, 479050, vii-viii.1991, UV-light, M.L. Mathis.
12. Newton Co., Buffalo National River, Lower Huchingson Spring at confluence with Cecil Creek near Erbie, UTM 3993710, 479058, bi-weekly vii–x.1991, UV-light, M.L. Mathis.
13. Newton Co., Buffalo National River, Cecil Creek near Erbie, low-water slab about 1.2 km above confluence with Buffalo River at Erbie, UTM 3993784, 479700, bi-weekly vi-x.1991, UV-light, M.L. Mathis; same but off Co Rd 19 (Erbie road), v–vi.2012, SLAM trap, T. Edwards; same but, x.2007, i.2014, benthic samples, HTLN staff.
14. Newton Co., Buffalo National River, Glade Creek, UTM 3992648.5, 481332.88, x.2009, benthic samples, HTLN staff.
15. Newton Co., Buffalo National River, Ozark Campground, Buffalo River, UTM 3991007, 485485, 11.x.2008, UV-light, D. E. Bowles.
16. Newton Co., Buffalo National River, Ozark House Spring at Park Service residence, Ozark Campground, UTM 3990145, 486465, ix.1991, UV-light, M.L. Mathis.
17. Newton Co., Buffalo National River, Mill Creek below Dogpatch; low-water bridge just above confluence with Buffalo River at Pruitt, UTM 3992167, 487657, vi-x.1991, UV-light samples at 2-week intervals, M.L. Mathis.
18. Newton Co., Buffalo National River, Mill Creek, Off Co Rd 472, UTM 3990800, 487802, v–ix.2012, SLAM trap, T. Edwards.
19. Newton Co., Buffalo National River, Mill Creek, approximately 50 m upstream of confluence with Buffalo River, UTM 3990501.25, 487979.09, ix.2007, 2013, 2015, x.2011, benthic samples, HTLN staff.
20. Newton Co., Buffalo National River, Vanishing Creek, UTM 3989463, 489406.03, ix.2010, benthic samples, HTLN staff.
21. Newton Co., Little Buffalo River, UTM 3980518, 479521 [approximate], 20.v.1983, UV-light, K. Frazier (Frazier et al. 1991).

22. Newton Co., Buffalo National River, Little Buffalo River, Off Co Rd 46, UTM 3988152, 488645, v–ix.2012, SLAM trap, T. Edwards.
23. Newton Co., Buffalo National River, Little Buffalo River, approximately 50 m upstream of confluence with Buffalo River, UTM 3987600, 490340.91, i.2007, 2013, benthic samples, HTLN staff.
24. Newton Co., Buffalo River, approximately 5.6 km downstream of Pruitt, UTM 3987599.9, 490340.9, ix–ii.2005-2010, 2012, 2014, 2016, benthic samples, HTLN staff.
25. Newton Co., Buffalo National River, Wells Creek, approximately 100 m upstream of confluence with Buffalo River, UTM 3986624, 490814.66, x.2009, benthic samples, HTLN staff.
26. Newton Co., Buffalo National River, Buffalo River@Hasty Access, UTM 3984631, 492683, 13-14.vii.2017, 21–22.ix.2017, UV-light, D.E. Bowles and C.R. Cheri.
27. Newton Co., Buffalo National River, Rock Creek, UTM 3984111, 492478.22, x.2009, benthic samples, HTLN staff.
28. Newton Co., Buffalo National River, Buffalo River@Carver Access, UTM 3982104, 496551, 13-14.vii.2017, 21–22.ix.2017, UV-light, D.E. Bowles and C.R. Cheri.
29. Newton Co., Buffalo National River, Lick Creek, UTM 3983426.5, 499899.69, x.2010, benthic samples, HTLN staff.
30. Newton Co., Buffalo River, approximately 4.5 km downstream of Carver Access bridge, UTM 3983483.7, 499985.25, ix–ii.2005–2010, 2012, 2014, 2016, benthic samples, benthic samples HTLN staff.
31. Newton Co., Buffalo National River, Mt. Hersey, Buffalo River@Davis Creek, UTM 3984942, 504197, 13-14.vii.2017, 21-22.ix.2017, UV-light, D.E. Bowles and C.R. Cheri; same, but approximately 100 m upstream of confluence with Buffalo River, ix.2013, 2015, x.2008, 2011, benthic samples, HTLN staff.
32. Newton Co., Buffalo National River, Mitch Hill Spring@Mill Branch, UTM 3985619, 504438, 13–14.vii.2017, 21-22.ix.2017, UV-light, D.E. Bowles and C.R. Cheri.
33. Newton Co., Buffalo National River, near Mt. Hershey Rd., Mill Branch, UTM 3985181, 504323, v–ix.2012, SLAM trap, T. Edwards.
34. Newton Co., Buffalo National River, Mill Branch, approximately 50 upstream of confluence with Buffalo River, UTM 3984978.25, 504310.34, x.2010, benthic samples, HTLN staff.
35. Searcy Co., Buffalo National River, Richland Creek, UTM 3975988, 509734.38, ix.2010, benthic samples, HTLN staff.
36. Searcy Co., Buffalo River, approximately 2 km upstream of Tyler Bend access, UTM 3981679.66, 520484.74, ix–ii.2005–2010, 2012, 2014, 2016, benthic samples, HTLN staff.
37. Searcy Co., Buffalo National River, Calf Creek, approximately 1.6 km upstream of confluence with Buffalo River, UTM 3981045.5, 520463.22, i.2012, x.2015, benthic samples, HTLN staff.
38. Searcy Co., Buffalo National River, Buffalo River@Tyler Bend, UTM 3982722, 520982, 13-14.vii.2017, 21-22.ix.2017, UV-light, D.E. Bowles and C.R. Cheri.
39. Searcy, Buffalo National River, Gilbert, Gilbert Spring, UTM 3982709, 525748, 13–14.vii.2017, 21–22.ix.2017, UV-light, D.E. Bowles and C. R. Cheri.
40. Searcy Co., Buffalo River, approximately 5 km downstream of Gilbert, UTM 3984878.6, 529619.95, ix–ii.2005–2010, 2012, 2014, 2016, benthic samples, HTLN staff.
41. Searcy Co., Buffalo National River, Water Creek, UTM 3989492.75, 53816.5, x.2009, i.2014, benthic samples, HTLN staff.
42. Marion Co., Buffalo National River, Hickory Creek, UTM 3992069.5, 540092.81, i.2007, benthic samples, HTLN staff.
43. Marion Co., Buffalo National River, Buffalo River@Toney Bend, UTM 3994901, 54351.3, 13–14.vii.2017, 21–22.ix.2017, MV-light, D.E. Bowles and C.R. Cheri.
44. Marion Co., Buffalo National River, Rush Creek@Rush Spring, UTM 3997992, 540224, 13-14.vii.2017, 21–22.ix.2017, UV-light, D.E. Bowles and C.R. Cheri.
45. Marion Co., Buffalo National River, Buffalo River at Clabber Creek, UTM 399799.5, 540895, 13-14.vii.2017, 21-22.ix.2017, UV-light, D.E. Bowles and C.R. Cheri; same but, ix.2010, 2015, x.2011, benthic samples, HTLN staff.

46. Marion Co., Buffalo River, approximately 7.5 km downstream of Rush Landing, UTM 3995359.4, 545997.97, ix–ii.2005–2010, 2012, 2014, 2016, benthic samples, HTLN staff.
47. Marion Co., Buffalo National River, Buffalo River, Lower Wilderness, river mile ~12, UTM 3993813, 548509, 5.vi.2006, UV-light, D.E. Bowles.
48. Marion Co., Buffalo National River, Middle Creek, approximately 100 m upstream of confluence with Buffalo River, UTM 3993556.5, 551428.31, i.2007, x.2011, 2015, benthic samples, HTLN staff.
49. Marion Co., Leatherwood Creek, approximately 100 m upstream of confluence with Buffalo River, UTM 3996258, 551307.69, i.2007, x.2011, 2015, benthic samples, HTLN staff.
50. Marion Co., Buffalo National River, Buffalo River, Lower Wilderness, river mile ~18, UTM 3998162, 550879, 6.vi.2006, UV-light, D.E. Bowles.

### Statistical analysis

Statistical analyses were conducted using PAST statistical software version 3.07 (Hammer et al. 2015). In order to obtain optimal results, statistical analyses were performed only for sites having 15 or more species that were sampled multiple times during spring through autumn. Because biological surveys cause can miss species that are present, but not detected, we estimated true, or potential, species richness for the Buffalo River watershed using Chao2 (Chao 1984, 1987), which was calculated using Hammer et al. (2015). The Chao2 estimator uses the number of rare species in samples to estimate the likelihood of undiscovered species that might have been found in the same area if more sampling had been conducted. For details on how this statistic is calculated and interpreted, see Chao (1984, 1987), Chao et al. (2017) and Harris and Armitage (2019)

Sørenson's similarity index was used to analyze similarity of taxonomic composition among the different collection sites (Southwood and Henderson 2000). We used this index because the numbers of adult caddisflies in samples were not quantified, and only species qualitative relative abundances are reported (e.g., rare, common). Similarity index scores among sites were subsequently analyzed by hierarchical cluster analysis (Ward 1963) with a Bray-Curtis distance following the recommendation of Magurran (2004).

Seriation analysis was used to visually estimate the distribution of genera along the river with the constrained gradient being the longitudinal order of the sampling sites from west to east, with the river increasing in discharge along that continuum (Bowles et al. 2017). Seriation reorders objects into a sequence along a one-dimensional continuum in order to distinguish patterns within the series with presences being concentrated along the diagonal (Liiv 2010). A Monte Carlo simulation based on seriation of 30 random matrices, with the same number of occurrences within each taxon, was compared to the original matrix to see if it is more informative than a random one. Mann-Kendall trend test ($\alpha$=0.05) was used to determine longitudinal trends in the watershed for numbers of families, genera and species (Hammer et al. 2015).

## Results

We report 106 species of caddisflies representing 44 genera and 16 families that were collected across all sampling sites. Numbers following each species correspond to the collection sites listed in the Methods and Figure 1. The Chao 2 estimate of species richness at the Buffalo National River was 114.91 (standard deviation 6.67) indicating there may be an additional 9 species in the watershed that were not collected during this survey. Flight periods for most species were broad and extended throughout much of the warmer season.

The most speciose families were the Hydroptilidae (30), Leptoceridae (21), and Hydropsychidae (17). Two species, *Psychomyia flavida* Hagen and *Helicopsyche borealis* (Hagen) are common throughout the entire river system and were collected throughout the spring, summer, and fall. The most widely distributed and commonly collected hydroptilids were *Hydroptila armata* Ross, *H. broweri* Blickle, *H. hamata* Morton, *H. perdita* Ross*, Ochrotrichia tarsalis* (Hagen), and *Orthotrichia aegerfasciella* (Chambers). Two male specimens of *Ochrotrichia* collected at Rush Spring appear to represent an undescribed species,

which will be treated in a separate publication. The most abundant *Cheumatopsyche* was *C. analis* (Banks) followed by *C. miniscula* (Banks), and *C. campyla* Ross. *Hydropsyche scalaris* Hagen was the most common representative of that genus, and *Polycentropus centralis* Banks was the most widespread and commonly collected species in the family Polycentropodidae. The most common and widely distributed leptocerid was *Oecetis avara* (Banks) followed by *O. inconspicua* (Walker), *Nectopsyche pavida* (Hagen), and *Ceraclea maculata* (Banks). Two species found during this study, *Paduniella nearctica* Flint and *Ochrotrichia contorta* Ross, are listed as species of special concern in the state of Arkansas due to their relative rarity (Arkansas Natural Hertitage Commission 2015).

## Species List

**Suborder Annulipalpia**

**Infraorder Curvipalpia**

**Superfamily Hydropsychoidea**

**Family Hydropsychidae**

*Cheumatopsyche analis* (Banks): 1, 6, 7, 8, 13, 15, 17, 18, 22, 28, 31, 32, 38, 44, 45. May-October. Widespread and common.

*C. aphanta* Ross: 1, 7, 8. June–July, September. This species was seldom collected from sites in the Buffalo River watershed, but it is common in other regional streams.

*C. campyla* Ross: 7, 11, 18, 22, 26, 28, 31, 32, 38, 43, 44, 45, 47. May–September. Widespread and common.

*C. minuscula* (Banks): 1, 7, 8, 13, 22, 26, 28, 31, 32, 38, 44, 45, 47, 50. May–September. Widespread and common.

*C. oxa* Ross: 1, 7, 8, 9, 17, 18, 22. May–September. Widespread and common.

*C. sordida* (Hagen): 2. May. Rare. Known only from a few specimens collected at this spring-run.

*Diplectrona modesta* Banks: 2, 7, 10, 11, 12. June, August. Known from a few males collected among these sites.

*Homoplectra doringa* (Milne): 10. Known from two larvae at this location.

*Hydropsyche alvata* Denning: 13. August. Rare; known from a few specimens at this site.

*H. arinale* Ross: 13, 15, 45. August, October

*H. betteni* Ross: 5, 7, 10, 13, 17, 32, 44, 45. May–June, August–September. Widespread and common.

*H. bidens* Ross: 1, 7, 8, 13. June, August. Uncommon; only at upper river sites.

*H. bronta* Ross: 1, 6, 7, 8, 13, 17, 44. June-September. This species is widespread in the watershed, but it is uncommon in samples.

*H. orris* Ross: 13. August. Rare; collected only from this single site, but it is common elsewhere in the Ozarks.

*H. scalaris* Hagen: 26, 28, 31, 32, 38, 43, 44, 45. September. Widespread in the watershed, but uncommon in samples.

*H. simulans* Ross: 1, 13. August. Rare; only from upper river sites.

*Potamyia flava* (Hagen): 1, 8, 13, 26, 28, 38, 43, 44, 45, 46. May, August–September. Widespread and common.

**Family Polycentropodidae**

*Cernotina calcea* Ross: 38, 45. July, September. Rare; known only from a few specimens collected at these sites.

*Cyrnellus fraternus* (Banks): 31, 45. July. Rare; known only from a few specimens collected at these sites.

*Neureclipsis crepuscularis* (Walker): 3, 4, 9, 10, 13, 14, 19, 25, 27, 29, 30, 31, 36, 38, 40, 45, 49. May. Widespread but uncommon in samples.

*Nyctiophylax affinis* (Banks): 1, 5, 6, 31, 32, 38, 44. May, July, September. Widely distributed but uncommon in samples. Widely distributed but uncommon in samples.
*Plectrocnemia cinerea* (Hagen): 2, 7, 17, 26, 28, 31, 38, 45. May–June, September.
*Polycentropus centralis* Banks: 1, 2, 5, 6, 7, 8, 9, 11, 13, 15, 22, 31, 32, 33, 38, 44, 45. May–June, August-October. Widespread and common.
*P. confusus* Hagen: 2, 6, 7, 31, 32, 45. May-June. Widely distributed but uncommon in samples.

**Family Psychomyiidae**

*Paduniella nearctica* Flint: 1, 13, 48. May, August–September. This rare species was collected only at three sites. This species is listed as a species of concern by the Arkansas Natural Heritage Commission (2015).
*Psychomyia flavida* Hagen: 1, 2, 4, 5, 6, 8, 9, 13, 15, 17, 18, 19, 22, 24, 25, 26, 28, 30, 31, 32, 33, 34, 35, 36, 37, 38, 40, 45. May-October. Widespread and common.

**Superfamily Philopotamoidea**

**Family Philopotamidae**

*Chimarra aterrima* Hagen: 6, 7, 9, 10, 13, 18, 22, 44. May–June, September. Widespread and common.
*C. feria* Ross: 6, 7, 13, 18, 22, 31, 32, 44. May–June, August–September. Widespread and common.
*C. obscura* (Walker): 1, 2, 5, 6, 7, 8, 9, 13, 15, 17, 18, 22, 26, 28, 31, 38, 43, 44, 45, 47, 50. May–October. Widespread and common.
*C. socia* Hagen: 1, 18, 22, 26, 28, 31, 38, 44, 45. June–July, September. Widespread and common.
*Wormaldia moesta* (Banks): 3, 6, 7, 11, 12, 14, 45. May–August. Widespread but relatively uncommon in samples.
*W. strota* Ross: 2, 5, 7, 9. May, June. Uncommon; known from a few specimens at each locality.

**Infraorder Spicipalpia**

**Superfamily Hydroptiloidea**

**Family Glossosomatidae**

*Agapetus illini* Ross: 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 18, 19, 20, 22, 23, 24, 25, 27, 29, 30, 31, 32, 33, 34, 35, 36, 37, 39, 40, 42, 44, 48, 49. May–July. Widespread and common.
*Protoptila lega* Ross: 1, 26, 28, 31, 32, 38, 45. September. Distributed primarily in the mid- to lower Buffalo River and uncommon in samples.

**Family Hydroptilidae**

*Dibusa angata* Ross: Searcy Co. (Moulton and Stewart 1996); 8, 9, 10, 12, 23, 30. May. Widely scattered but uncommon in collections.
*Hydroptila albicornis* Hagen: 44, 50. May. Rare; known only from two males at this site.
*H. armata* Ross: 1, 17, 26, 28, 31, 32, 38, 44, 45, 50. May, September. Widespread and common. Widely scattered and common.
*H. broweri* Blickle: Searcy Co. (Moulton and Stewart 1996); 6, 13, 17, 21, 28, 31, 32, 38, 44, 47. May, July–September. Widely scattered and common.
*H. consimilis* Morton: 2, 7, 11, 12, 13, 32, 38, 44. May–September. Widely scattered and common.
*H. grandiosa* Ross: 8, 13, 15, 17, 28, 31, 32, 38, 44, 45. August–October. Widely scattered and common.
*H. hamata* Morton: 1, 2, 8, 13, 15, 17, 26, 28, 31, 32, 38, 44, 45. April–May, July–October. Widely scattered and common.

*H. perdita* Ross: 1, 8, 9, 17, 22, 26, 28, 31, 32, 38, 44, 45, 47, 50. May-July, September–October. Widely scattered and common.
*H. sandersoni* Mathis & Bowles: 8, 13, 47. May–June, August–September. This Ozark endemic was widespread in the river, but it was uncommon in samples.
*H. virgata* Ross: 1, 8. May. June-August. Known only from a few specimens taken at these two locations.
*H. waubesiana* Betten: 45. July. This species is common in the region, but we found only a few specimens at this location.
*Neotrichia edalis* Ross: 31. July. June–August. Known only from a few specimens taken at this location.
*N. okopa* Ross: 1, 8. July–September June–August. Known only from a few specimens taken at these two locations.
*N. vibrans* Ross: 13, 15, 17. May, September–October. June-August. Known only from a few specimens taken at these locations.
*Ochrotrichia anisca* (Ross): 1, 2, 7, 8, 9. April–July. This species was restricted to upper river sites, where it was relatively abundant in samples.
*O. arva* Ross: 7, 11. June–August. Known only from a few specimens taken at these two locations.
*O. contorta* Ross: 2, 5, 9. April–May. This species is listed as a species of concern by the Arkansas Natural Heritage Commission (2015).
*O. eliaga* Ross: 2, 5, 7, 12, 13, 21. May–July. Found in upper and mid-river sites were it was fairly common.
*O. riesi* Ross: 7, 13. June, September. Restricted to upper river sites where it was uncommon in samples.
*O. tarsalis* (Hagen): 1, 8, 13, 15, 17, 18, 26, 31, 32, 38, 44, 45. June, August, September–October. Widely scattered and common.
*Ochrotrichia* n. sp.: 44. July. This undescribed species is rare and known only from two specimens collected at this site. The species will be described in a separate paper.
*Orthotrichia aegerfasciella* (Chambers): 1, 2, 5, 13, 17, 32, 38, 44, 45. May, July, September. Widely scattered and common.
*O. cristata* Morton: 44. July. Rare; found only at Rush Spring.
*Oxyethira coercens* Morton: This species was reported by (Moulton and Stewart 1996) from this Searcy Co., Buffalo River at Highway 65. We did not collect any specimens during this study.
*O. dualis* Morton: 5, 9. May–June. Restricted to upper river sites and it was uncommon in samples.
*O. forcipata* Mosely: 13. July–September. We collected a few examples at this location only.
*O. pallida* (Banks): 1, 8, 15, 17, 32, 38, 44, 47. May, July, September–October. Widely scattered and common.
*O. zeronia* Ross: 2, 31. May. Known from only a few specimens taken at these locations.
*Stactobiella delira* (Ross): 1, 2, 8, 24. May. Widely scattered but uncommon in collections.
*S. palmata* (Ross): 21. May. This species was reported by Frazer et al. (1991) from this site. We did not collect any specimens during this study.

**Superfamily Rhyacophiloidea**

**Family Rhyacophilidae**

*Rhyacophila banksi* Ross: 7, 12. June–July. Rare; known only from a few specimens at these sites.
*R. glaberrima* Ulmer: 12, 38. October. Rare; known only from a few specimens at these sites.
*R. kiamichi* Ross: 1, 2, 3, 5, 6, 7, 9, 20, 27, 37, 42, 45, 46, 48, 49. May–June. Common and widely scattered although not abundant in samples.

**Suborder Integripalpia**

**Infraorder Plenitentoria**

**Superfamily Limnephiloidea**

**Family Brachycentridae**

*Brachycentrus numerous* (Say): 13. December. This record is based on a single, late instar larva collected from this site.

**Family Lepidostomatidae**

*Lepidostoma griseum* (Banks): Newton Co. (Moulton and Stewart 1996); 13, 16. September–October. Rare; known only from a few specimens taken at these sites.
*L. libum* Ross: 2. October. Rare; known from a single male taken at this site.
*L. togatum* (Hagen): 3, 6, 19, 20, 24, 26, 30, 31, 32, 34, 48, 44, 45, 46. September. Widespread and common although not abundant in samples.

**Family Limnephilidae**

*Frenesia missa* (Milne): 2. May. Rare; based on a few larvae collected at this site.
*Ironoquia punctatissima* (Walker): 2, 4, 5, 12, 13, 16, 44. September–October. Uncommon and known from only a few specimens among these sites.
*Pycnopsyche guttifer* (Walker): 32, 39, 44. September. Uncommon; known only from three springs in the park where it occurs in moderately high densities.
*P. lepida* (Hagen): 13. September. Rare; known only from a few specimens at this site.
*P. rossi* Betten: 12, 13. September–October. Rare, known only from a small spring and headwater tributary and only from a few specimens.
*P. subfasciata* (Say): 10, 15, 16, 44, 45. September–October. Widely scattered and abundant at these sites.

**Family Thremmatidae**

*Neophylax concinnus* McLachlan: Newton Co. (Moulton and Stewart 1996); 2, 3, 4, 7, 10, 11, 19, 13, 19, 20, 25, 27. September. Widely scattered and common.

**Superfamily Phryganeoidea**

**Family Phryganeidae**

*Agrypnia vestita* (Walker): 1, 32. September. Rare; known only from a few specimens taken at these sites.
*Phryganea sayi* Milne: 1, 13. August–September. Rare; known only from a few specimens taken at these sites.
*Ptilostomis ocellifera* (Walker): 2, 12. May, July. Rare; known only from a few specimens taken at these sites.

**Infraorder Brevientoria**

**Superfamily Leptoceroidea**

**Family Leptoceridae**

*Ceraclea ancylus* (Vorhies): 1, 8, 9, 47, 50. May, July. Widely scattered, but uncommon in samples.
*C. cancellata* (Betten): 7, 9, 13, 31, 38, 47, 50. May–June. Widely scattered and common.
*C. maculata* (Banks): 1, 7, 8, 18, 26, 28, 31, 32, 38, 44, 45. Jun, August–September. Widely scattered and common.
*C. tarsipunctata* (Vorhies): 1, 7, 8, 47, 50. May–June, August. Widely scattered but relatively uncommon in samples.
*C. transversa* (Hagen): 1, 8, 13, 31, 43, 44, 47, 50. May, July–August. Widely scattered and common.

*Leptocerus americanus* (Banks): 47. May. We collected only a few examples of this species at this lower river site.
*Mystacides sepulchralis* (Walker): 15, 26, 31. September–October. Specimens were rare in samples taken from the mid-river sites.
*Nectopsyche candida* (Hagen): 13, 26, 44, 45. August–September. Widely scattered but uncommon in samples.
*N. exquisita* (Walker): 13, 31, 38, 43, 45, 47, 50. May, September. Widely scattered and common.
*N. pavida* (Hagen): 13, 17, 26, 28, 31, 32, 38, 44, 45, 47. May, August–September. Widely scattered and common.
*Oecetis avara* (Banks): 1, 8, 15, 26, 28, 31, 32, 38, 43, 44, 45, 47, 50. May, July–October. This was the most widespread and abundant leptocerid caddisfly collected during this study.
*O. cinerascens* (Hagen): 5. May. We collected this species only at the Mill Pond in Boxley Valley.
*O. ditissa* Ross: 1, 17, 31, 32, 44. July, September. Widespread but rare in samples.
*O. eddlestoni* Ross: 1, 13. August–September. This species is apparently restricted to the upper river where it is uncommon in samples.
*O. inconspicua* (Walker): 1, 2, 5, 8, 11, 13, 15, 16, 17, 26, 28, 31, 32, 38, 43, 44, 45. May, July–October. This species was widespread and common in samples.
*O. nocturna* Ross: 31, 43, 44, 45. September. This species occurred primarily in the lower river and it was uncommon in samples.
*O. persimilis* (Banks): 31, 38, 44, 45. September. This species was found in the mid- to lower river and it was uncommon in samples.
*Setodes oxapius* (Ross): 24, 26, 30, 36, 38, 40, 45, 46, 47, 50. May, September. This species was found commonly at the mid- to lower river locations.
*Triaenodes ignitus* (Walker): 9, 28, 31, 38, 44, 45. May, July, September. Widespread and common.
*T. injusta* (Hagen): 1, 5, 26, 31, 44, 45, 47, 50. May–June, September. Widely scattered and common.
*T. tardus* Milne: 13, 38, 44. July, September. Widespread in the river, but rare in samples.

### Family Molannidae

*Molanna blenda* Sibley: 7. June. Rare, known from a few specimens taken at this site.
*M. uniophila* Vorhies: Newton Co. (Moulton and Stewart 1996); 9. May. Rare, known only from two males collected near a small spring at these sites.

### Family Odontoceridae

*Marilia flexuosa* Ulmer: 30, 40, 43, 46, 47, 50. May–June. Widely scattered, but uncommon in samples.

### Superfamily Sericostomatoidea

### Family Helicopsychidae

*Helicopsyche borealis* (Hagen): 1, 2, 4, 5, 6, 8, 9, 10, 11, 12, 13, 17, 18, 19, 20, 22, 23, 24, 25, 26, 28, 29, 31, 32, 33, 34, 37, 38, 39, 40, 41, 44, 45, 46, 47, 48, 49. May–September. Widespread in the watershed and abundant in samples.

### Community Analysis

Similarity analysis values among collection sites ranged from 9% to 77% (mean = 42%, Table 1). Cluster analysis of the similarity data showed there were two primary clusters (Fig. 2). The first cluster consisted of collection sites located in the upper river. The second consisted of two subclusters of which the largest was primarily composed of sites from the mid-to-lower river. The smaller of the two clusters contained a mixture of upper-and-lower river sampling sites. Although the cluster analysis was consistent with the general grouping of sites along the river basin from upstream to downstream, the inclusion of

**Table 1.** Sørenson's similarity index values for Buffalo National River sites having 15 or more caddisfly species.

| Sampling Sites | 2 | 5 | 6 | 7 | 8 | 9 | 13 | 17 | 26 | 28 | 31 | 32 | 38 | 44 | 45 | 47 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.35 | 0.35 | 0.33 | 0.37 | 0.75 | 0.34 | 0.48 | 0.46 | 0.48 | 0.46 | 0.51 | 0.54 | 0.50 | 0.53 | 0.48 | 0.37 |
| 2 | | 0.55 | 0.37 | 0.42 | 0.35 | 0.43 | 0.31 | 0.32 | 0.26 | 0.27 | 0.32 | 0.34 | 0.31 | 0.24 | 0.32 | 0.09 |
| 5 | | | 0.44 | 0.30 | 0.26 | 0.50 | 0.31 | 0.32 | 0.25 | 0.21 | 0.29 | 0.34 | 0.26 | 0.33 | 0.32 | 0.16 |
| 6 | | | | 0.44 | 0.32 | 0.41 | 0.32 | 0.33 | 0.21 | 0.28 | 0.41 | 0.44 | 0.31 | 0.38 | 0.33 | 0.17 |
| 7 | | | | | 0.41 | 0.37 | 0.44 | 0.24 | 0.19 | 0.24 | 0.32 | 0.33 | 0.27 | 0.33 | 0.31 | 0.20 |
| 8 | | | | | | 0.42 | 0.45 | 0.48 | 0.42 | 0.48 | 0.44 | 0.47 | 0.46 | 0.47 | 0.41 | 0.41 |
| 9 | | | | | | | 0.27 | 0.25 | 0.19 | 0.25 | 0.31 | 0.20 | 0.29 | 0.23 | 0.27 | 0.26 |
| 13 | | | | | | | | 0.44 | 0.29 | 0.32 | 0.42 | 0.42 | 0.46 | 0.51 | 0.41 | 0.27 |
| 17 | | | | | | | | | 0.45 | 0.57 | 0.47 | 0.59 | 0.53 | 0.53 | 0.49 | 0.34 |
| 26 | | | | | | | | | | 0.77 | 0.65 | 0.57 | 0.68 | 0.55 | 0.70 | 0.47 |
| 28 | | | | | | | | | | | 0.67 | 0.63 | 0.74 | 0.56 | 0.66 | 0.44 |
| 31 | | | | | | | | | | | | 0.70 | 0.75 | 0.68 | 0.73 | 0.44 |
| 32 | | | | | | | | | | | | | 0.70 | 0.71 | 0.60 | 0.36 |
| 38 | | | | | | | | | | | | | | 0.68 | 0.76 | 0.46 |
| 44 | | | | | | | | | | | | | | | 0.65 | 0.38 |
| 45 | | | | | | | | | | | | | | | | 0.37 |

the lower river site (#47) in a cluster with upper river sites suggests this unresolved cluster may be a sampling artifact. It is possible that the physical diversity among sampling sites may have confounded the clustering, but that remains unknown. Among sampling sites included in this analysis, there were five tributaries (#6, 7, 9, 13, 17), five mainstem river locations (#1, 8, 26, 38, 47), three tributary/river confluences (#28, 31, 45), one tributary/spring confluence (#44), two springs (#2, 32), and one spring-fed pond/tributary confluence (#5). Although not fully resolved, the cluster analysis shows that those sites that are closer together in the watershed generally have similar caddisfly community structure.

Seriation analysis of caddisfly genera showed that most genera are distributed throughout the entire Buffalo National River, but some are restricted to either the upper or lower river (Fig. 3; Monte Carlo mean = 0.60, $Z = -2.07$, $p = 0.04$). A similar response was seen for a seriation analysis of species collected from throughout the river's length (Fig. 4; Monte Carlo mean=0.49, $Z = -2.93$, $P = 0.003$). In both treatments, gaps between upper and lower river distributions may be more likely an artifact of sampling rather than an actual absence. Mann-Kendall trend tests conducted for numbers of species, genera and families at collection sites showed no significant longitudinal trends (Figs. 5–7; $S = 28$, $Z = 1.12$, $p = 0.26$; $S = 17$, $Z = 0.69$, $p = 0.49$; $S = 12$, $Z = 0.45$, $P = 0.65$, respectively).

## Discussion

The most important findings of this study are that the Buffalo River and its tributaries support a rich assemblage of caddisfly species, with many species shared among sites distributed throughout the Buffalo National River. While many species were collected from throughout the river's length, others were collected in specific regions of the river (upper or lower), which is likely due to specific habitat conditions required for those species. Previously, 234 species of caddisflies have been reported from the broader Interior Highlands ecoregion (Moulton and Stewart 1996; Etnier 2010). The species collected from the Buffalo National River (n = 106) therefore represent about 45% of the known Interior Highlands caddisfly fauna. Our Chao2 estimate of about 115 species of caddisflies indicates we collected about 92%

of the species represented at the Buffalo National River. Based on the known distributions of caddisflies in northern Arkansas (Bowles and Mathis, Moulton and Stewart 1996) that estimate is likely correct.

Specific identifications of caddisflies, especially when associated with specific environmental data, allow for more refined estimates of tolerance to stressors, which will make a better assessment tool for managers (Bowles et al. 2016). This study is a step toward that goal. The increasing and on-going threat of anthropogenic disturbances in the Buffalo River Basin poses a potential threat to water quality and the biota of the river (Bowles et al. 2017). The results of this study provide further insight into the broad diversity and ecological functioning of the river, and they will assist resource managers in their decision-making processes.

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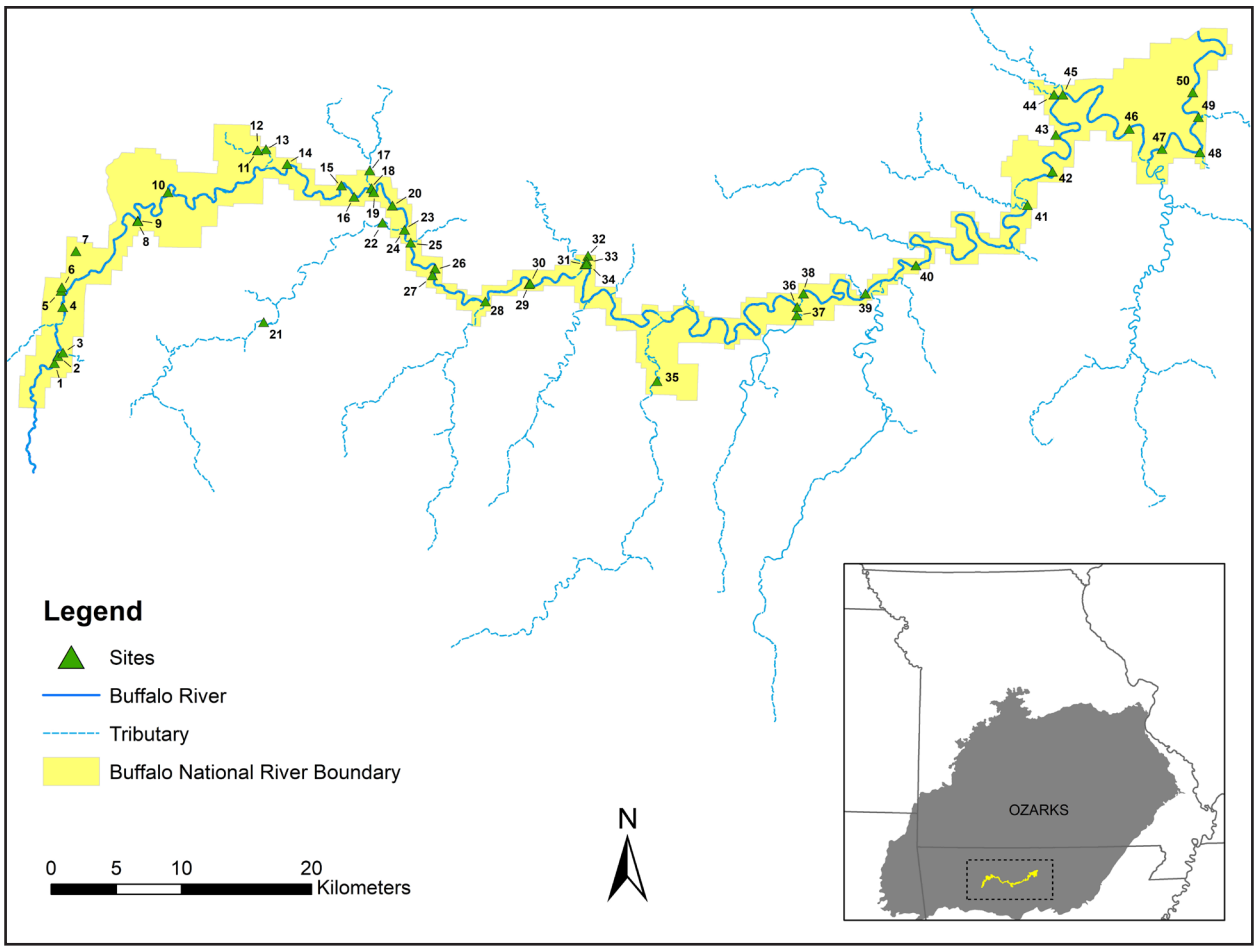



**Figure 1.** The Buffalo National River, Arkansas showing collection sites. Sites are described in the Methods.

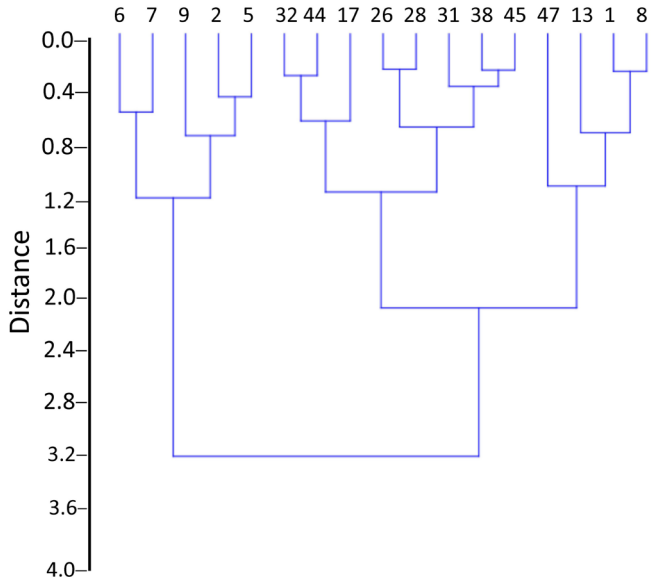



**Figure 2.** Dendrogram for hierarchical cluster analysis using Bray-Curtis distance measure for Sørenson's similarity index values among sites having 15 or more caddisfly species.


**Figure 3.** Seriation plot for caddisfly (Trichoptera) genera collected from the Buffalo National River, Arkansas. Monte Carlo mean = 0.60, Z = −2.07, p = 0.04. The longitudinal gradient of the Buffalo River runs from left to right for collection sites.

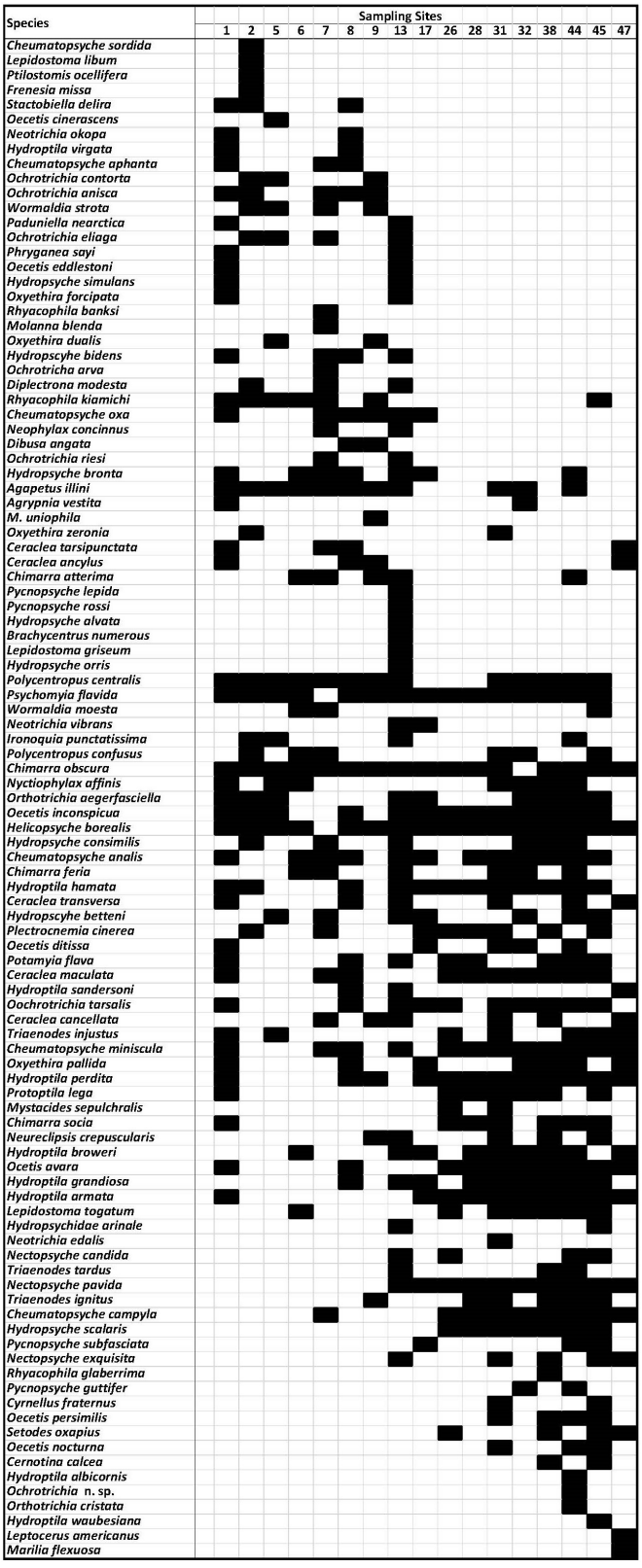
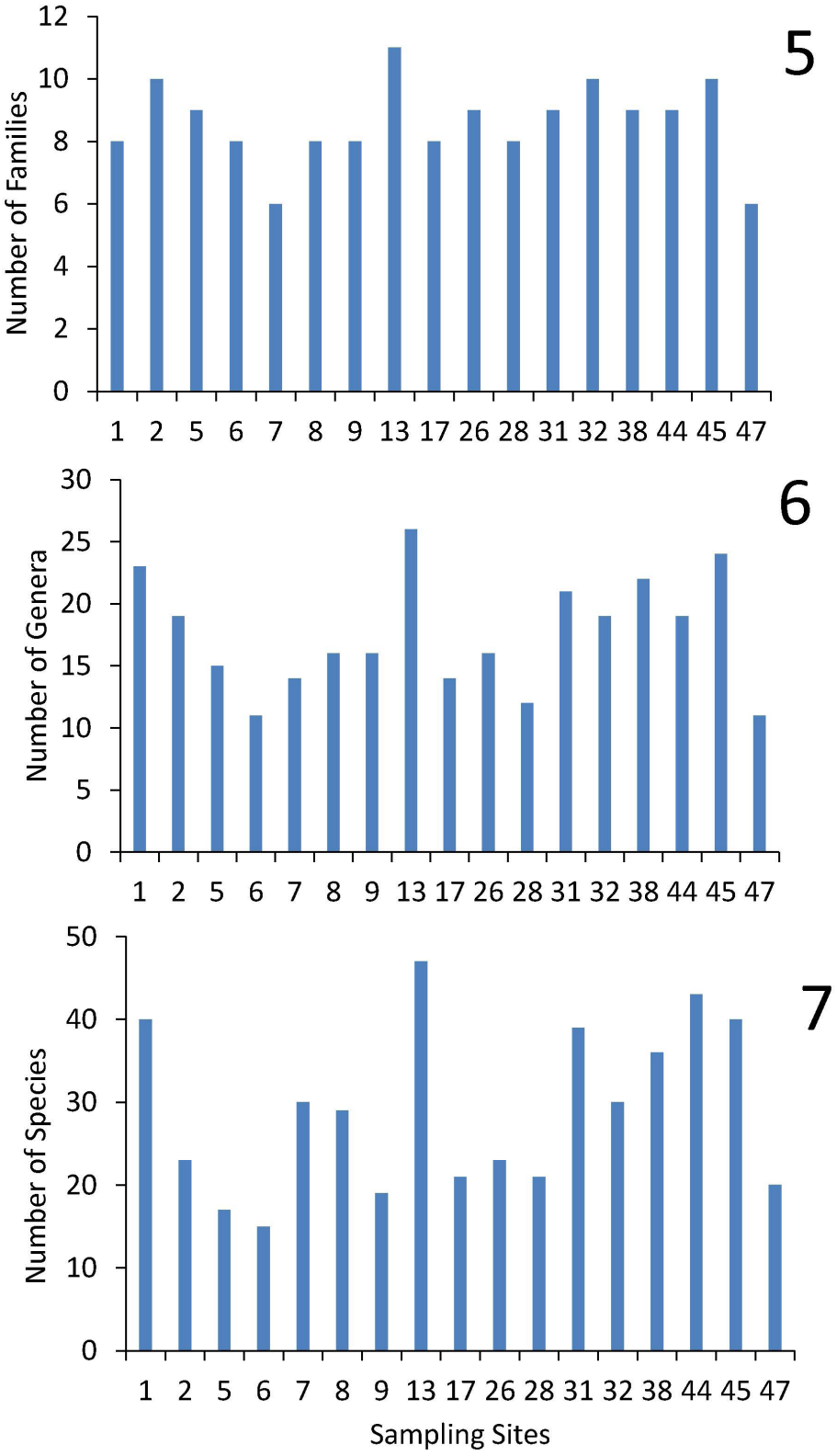



**Figure 4.** Seriation plot for caddisfly (Trichoptera) species collected from the Buffalo National River, Arkansas. Monte Carlo mean −0.49, Z = −2.93, P = 0.003. The longitudinal gradient of the Buffalo River runs from left to right for collection sites.




**Figures 5–7.** Diversity of caddisflies (Trichoptera) collected from the Buffalo National River, Arkansas. **5)** Families. **6)** Genera. **7)** Species.