Species Composition of Aquatic Macroinvertebrates and Environmental Conditions in Cucumber Creek

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An annual survey of the macroinvertebrates of Cucumber Creek in the Ouachita Mountains of southeastern Oklahoma was conducted. Seasonal invertebrate collections and water samples were taken from upstream and downstream sites. The invertebrates were sampled quantitatively by using a Surber net and qualitatively by hand examination of microhabitats at each site. Samples were dominated by insects and yielded 78 macroinvertebrate taxa. Water temperature, dissolved oxygen concentration, pH, and specific conductance fell within ranges expected in Oklahoma and usually capable of supporting a diverse biota. Species diversity was generally high and pollution-intolerant taxa were present throughout the study period, indicating high water quality in the stream.

INTRODUCTION

Freshwater macroinvertebrates are often studied during stream investigations. Frequently these studies are conducted to determine species composition of a stream or its drainage basin. Several such investigations have taken place in Oklahoma (*1-14*); there have been few studies of aquatic macroinvertebrates from Ouachita Mountain streams and none in Cucumber Creek.

Benthic macroinvertebrates serve as indicators of water quality in streams (*15-19*). Characteristics of macrobenthic organisms that make them especially useful for water quality studies include: 1) long life cycles, which may reflect conditions for an extended period of time, 2) low motility, 3) various ranges of tolerance to varying environmental conditions, and 4) occupancy of central positions in aquatic food chains (*20*).

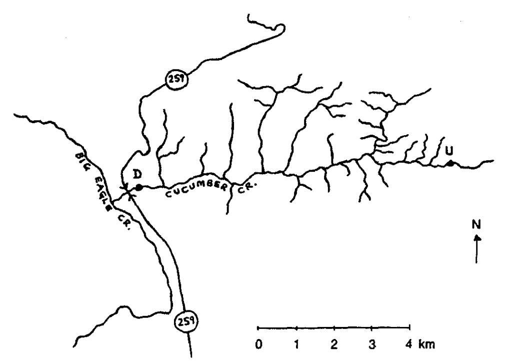

Figure 1. Cucumber Creek sampling sites; U=upstream site; D=downstream site.

Species diversity indices have been used to analyze community structure of benthic macroinvertebrates. Shannon's diversity index (*21*) is possibly the most widely accepted, as it reflects the eveness of taxa distribution, is dimensionless, and is relatively independent of sample size (*17*). Other studies have shown the usefulness of Shannon's diversity index (*18*, *19*, *22*). Sorenson's index of similarity (*23*) has been used to compare faunal similarity between sampling sites (*14*, *19*).

The objectives of this investigation were to: 1) determine the taxonomic composition and relative abundance, and seasonal trends of macroinvertebrates, and 2) provide baseline water quality data.

METHODS

Cucumber Creek is located in southern LeFlore County of southeast Oklahoma and its watershed lies entirely within the Ouachita Mountains ecoregion (*24*). An annual study of macroinvertebrates in Cucumber Creek was conducted. Two sampling sites (Fig. 1) were visited in July, October, January, and April. The downstream site was located approximately 0.5 km from the confluence of the creek with Big Eagle Creek while the upstream site was approximately 14 km upstream and near the headwaters. The upstream site was less than 0.3 m deep, less than 2 m wide, and heavily shaded, while the downstream site was less than 1.0 m deep, approximately 20 m wide, and generally exposed except along banks where trees occurred. The substrate was primarily cobble at both sites. Four quantitative samples were collected at each site during each collection with a Surber net. Qualitative collections were also made by examining rocks, wood debris, leaf debris, and other microhabitats by hand in the stream for 40 min. at each sampling site. This is an effective sampling method in combination with traditional sampling equipment (*14*, *25*), especially in streams such as these which contain a diversity of microhabitats.

All invertebrate collections were preserved in the field and taken to the laboratory for sorting, identification, and enumeration. Statistical analysis, including a modification of Shannon's diversity index (*17*, *26*) and community similarity (*23*) was applied.

Physicochemical conditions prevailing at each station were also monitored during each collection period. These parameters included water temperature (Celsius thermometer), dissolved oxygen concentration (Winkler method), pH (Hanna pocket pH meter), and specific conductance (Hach conductivity meter).

RESULTS AND DISCUSSION

Physicochemical conditions generally indicated high water quality in Cucumber Creek (Table 1). These values were within ranges expected in this region of Oklahoma (*27*) and indicate conditions capable of supporting a diverse biota (*28*). A total of 78 macroinvertebrate taxa were collected from the upstream and downstream stations in Cucumber Creek (Table 2).

TABLE 1. Physicochemical data from upstream (U) and downstream (D) stations in Cucumber Creek, July 1993 – April 1994.

	July		Oct.		Jan.		April	
	U	D	U	D	U	D	U	D
t,[a] °C	23	27	15	17	6	4	15	14
Cd[b]	39	19	60	40	15	12	34	25
DO[c]	1.9	1.6	6.5	6.4	8.0	8.1	6.1	6.9
pH[d]	6.9	7.5	7.4	6.7	7.3	7.2	7.3	8.1

a Water temperature, °C. b Conductivity, μS/cm.
c Dissolved oxygen, mg/l. d Acidity

July: Physicochemical conditions, particularly dissolved oxygen concentration, were at their most critical limits during the July collecting period. During this time, the upstream site was a series of isolated pools and the downstream site had low flow with much of the stream bottom exposed. The number of taxa at the upstream site was reduced, probably owing to the stressful conditions (low dissolved oxygen concentrations and lack of flowing water). The downstream site maintained a greater number of species despite the low D.O. concentrations, since water continued to flow. Chironomid larvae were the dominant macroinvertebrates at both sites.

October: Stream flow increased considerably following heavy rainfall in the watershed during early October. This was the only sampling period when the number of taxa collected at the upstream site exceeded that at the downstream site. Perhaps species which had sought the hyporheic zone as a refuge during the "pool stage" had returned to the stream bed surface as flow resumed at the upstream site (*29*). The low number of species at the downstream site may have resulted from the recent flooding of much of the stream bed and current re-colonization of that formerly exposed substrate. In addition, emergence of adults may partly explain the reduced numbers at the downstream site, but emergence was not measured.

January: The number of species present increased through the autumn and seemed to have stabilized by January. The increase in taxa at the downstream site may have been due to colonization from upstream and/or by the hatching of eggs previously deposited there (*31*). Immature mayflies, stoneflies, and chironomids were the dominant macroinvertebrates during this period.

April: The warming of the stream water and the lengthening of the daylight period resulted in an increase in productivity and benthic algal growth, particularly at the downstream site. This additional nutrient resource could support the larger benthic population present in the stream at that time. As in the previous collection, immature mayflies, stoneflies, and chironomids dominated the benthic macroinvertebrate community.

The similarity analysis revealed significant differences in macroinvertebrate community composition existed between the upstream and downstream sites. These values were relatively low, ranging from 0.34 to 0.60 (Table 2). These differences were predicted by the river continuum concept (*30*) as the upstream site was a first-order stream near the headwaters and the downstream site was a third-order stream. Therefore, the environmental conditions at each site differed considerably, resulting in the differences in species composition.

Arthropods, especially aquatic insects, dominated the macroinvertebrate assemblage (Table 2). The most common of these, which occurred at both sites during every collection, included an unidentified crayfish, nymphs of the mayfly *Stenonema*, larvae of the water penny beetle *Psephenus herricki*, and larvae of the chironomid *Microtendipes pedellus* group. Other frequently encountered taxa included the mayfly nymph *Leptophlebia*, the stonefly nymph *Zealeuctra*, and the chironomid larvae *Orthocladius* and *Phaenopsectra*.

CONCLUSIONS

Overall, the water quality of Cucumber Creek is suitable to support a diverse assemblage of macroinvertebrates. This is illustrated by the high species diversity, the presence of many pollution-intolerant macroinvertebrates, and the fact that aquatic insects were much more prevalent than oligochaetes. Perhaps the most stressful environmental factor influencing this stream is the reduced flow following periods of little precipitation.

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TABLE 2. Numbers of macroinvertebrates collected from Cucumber Creek at the upstream/downstream stations, July 1993 - April 1994.

Taxa	July	October	January	April	Total
Platyhelminthes					
Dugesia sp.	0/0	0/0	0/0	0/0[a]	0/0[a]
Oligochaeta					
Dero sp.	0/0	0/0	0/0	0/1	0/1
Limnodrilus sp.	6/2	0/0	1/1	9/1	16/4
Nais sp.	0/0	4/0	0/0	0/0	4/0
Gastropoda					
Ferrissia sp.	0/0	0/0	0/0	0/0[a]	0/0[a]
Pelecypoda					
Sphaerium sp.	1/0	0/0	0/0	1/0	2/0
Isopoda					
Lirceus hoppinae	0/0	6[a]/0	3[a]/0	2[a]/0	11[a]/0
Amphipoda					
Hyalella azteca	1/0	0/0	0/0	0/0	1/0
Decapoda	2[a]/0[a]	2[a]/0[a]	1/3	3[a]/2[a]	8[a]/5[a]
Hydrocarina	0/0	0/0	0/1	0/0	0/1
Ephemeroptera					
Ameletus sp.	0/0	0/0	0/0	0[a]/0	0[a]/0
Baetis sp.	0/0[a]	0/0	4[a]/5[a]	3[a]/5[a]	7[a]/10[a]
Leptophlebia sp.	0/0	3/0	10/4	5/9[a]	18/13[a]
Pseudocleon sp.	0/0	0/0[a]	0/0	0/0	0/0[a]
Stenocron sp.	0/0[a]	2/5	0/0	0/0	2/5[a]
Stenonema sp.	0[a]/0	13/12	27[a]/38	16[a]/30[a]	46[a]/80[a]
Odonata					
Argia sp.	0/0	0/0	0/1	0/0	0/1
Lanthus albistylus	4/3	0/0	0/0	0/0	4/3
Stylogomphus sp.	0/0	0/0	1/0	0/0	1/0
Plecoptera					
Acroneuria sp.	0/1	0/0	4/1	0/0	4/2
Isoperla sp.	0/0	0/0	0/0	0[a]/3[a]	0[a]/3[a]
Neoperla sp.	1[a]/11	0/2	0/1[a]	0[a]/2	1[a]/16[a]
Strophopteryx sp.	0/0	0/0	0[a]/0	0/0	0[a]/0
Zealeuctra sp.	0/0	5/0	15[a]/5	59/1	79[a]/6
Hemiptera					
Gerris sp.	0[a]/0	0/0	0/0	0[a]/0	0[a]/0
Trepobates sp.	0/0[a]	0/0	0/0	0/0	0/0[a]
Megaloptera					
Corydalus cornutum	0/0	2/0	0/0	0/0	2/0
Sialis sp.	2/0	0/0	2/0	1/0	5/0
Trichoptera					
Agapetus sp.	0/0	0/0	3[a]/4[a]	3[a]/1[a]	6[a]/5
Cheumatopsyche sp.	0/0	0/0	0/2[a]	0/1	0/3[a]
Helicopsyche sp.	0/5[a]	0/0	0/[a]	0/1[a]	0/6[a]
Hydropsyche sp.	0/0	1/0	0/0	0/0	1/0
Lepidostoma sp.	0/0	0/0	0[a]/2[a]	0/0	0[a]/2[a]
Limnephilus sp.	0[a]/1	0/0	0/0	0/0	0[a]/1
Nectopsyche sp.	0[a]/1[a]	0/0	0/0	0/0	0[a]/1[a]
Polycentropus sp.	0/6	0/1	0/0	0/1	0/8
Pycnopsyche sp.	0/0	0/0	7[a]/2	7/0	14[a]/2
Coleoptera					
Dineutus sp.	0/0[a]	0/0	0/0	0/0	0/0[a]
Psephenus herricki	35[a]/28[a]	11[a]/1[a]	10/2[a]	22[a]/9[a]	78[a]/40[a]
Stenelmis sp.	0/13	0/0	0/0	0/0	0/13
Diptera					
Ablabesmyia mallochi	0/1	0/0	0/0	0/0	0/1
Ablabesmyia philosphagus	0/0	0/0	2/0	12/0	14/0

Taxa	July	October	January	April	Total
Bezzia sp.	0/1	0/0	0/0	5/0	5/1
Cladotanytarsus sp.	0/0	0/0	0/0	0/2	0/2
Cricotopus bicinctus gr.	0/0	0/0	0/0	15/12	15/12
Cryptotendipes sp.	0/1	0/0	0/0	0/0	0/1
Dicrotendipes neomodestus	0/0	0/1	0/0	0/0	0/1
Dixella sp.	0[a]/0	0/0	0/0	0/0	0[a]/0
Eukiefferiella sp.	0/0	0/0	0/0	0/1	0/1
Helopelopia sp.	0/8	0/0	0/0	0/0	0/8
Hexatoma sp.	0/2	0/1	0/0	7/3	7/6
Larsia sp.	3/0	1/0	0/0	2/0	6/0
Leptotarsus sp.	0/0	0/0	0[a]/0[a]	0/0	0[a]/0[a]
Micropsectra sp.	4/1	0/0	0/1	0/0	4/2
Microtendipes pedellus gr.	52/12[a]	1/5	18/8	6/3	77/28[a]
Natarsia sp.	0/0	0/0	0/0	2/1	2/1
Omisus sp.	0/0	1/0	0/0	0/0	1/0
Orthocladiinae sp. A	0/0	1/0	0/0	0/0	1/0
Orthocladius sp.	0/6	0/0	1/2	0/20	1/28
Parachaetocladius sp.	0/1	0/2	0/0	0/0	0/3
Paramerina sp.	0/0	1/0	3/0	0/0	4/0
Parametriocnemus sp.	0/0	0/0	1/0	1/0	2/0
Paratanytarsus sp.	0/1	0/0	0/0	0/0	0/1
Phaenopsectra sp.	2/11	0/0	1/0	6/0	9/11
Polypedilum aviceps gr.	0/0	0/0	0/0	0/1	0/1
Polypedilum convictum gr.	0/4	0/0	1/0	0/0	1/4
Polypedilum halterale gr.	0/0	7/0	0/0	0/0	7/0
Psectrocladius sp.	0/0	0/0	0/2	0/0	0/2
Pseudorthocladius sp.	0/0	0/0	0/16	0/0	0/16
Rheotanytarsus sp.	0/2	0/0	0/0	0/0	0/2
Simulium sp.	0/0	0/0	0/0	0[a]/0	0[a]/0
Stenochironomus sp.	0/0	1/0	0/0	0/0	1/0
Tanytarsus sp.	0/1	0/0	0/0	2/0	2/1
Tabanidae sp. A	0/3	0/0	0/0	0/0	0/3
Thienemanniella sp.	0/2	0/0	0/0	0/0	0/2
Tipulidae sp. A	0/0	0/0	3/0	0/0	3/0
Tipulidae sp. B	0/0	0/0	0/2	0/2	0/4
Tribelos jucundum	0/0	1/0	0/0	0/0	1/0
Number of individuals	150/172	57/31	118/99	189/115	514/417
Number of taxa	13/26	18/9	21/24	22/24	41/51
Species diversity	2.51	3.52	3.60	3.57	---
Similarity[b]	0.42	0.34	0.60	0.54	---

[a] taxa also collected in non-quantitative samples and not included in statistical analysis.
[b] all taxa collected, both quantitative and non-quantitative, were included in analysis.