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Effect of City Effluent on the Diversity of Aquatic macroinvertabrates of Sugar Creek, Clay County, Arkansas

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disturbance to the cave system. Searches were discontinued from March 15 through September 15 in caves known to contain gray bats, and at other times when endangered bats were seen.

Of the 14 caves reported by Willis and Brown (Amer. Midl. Natur., 114:311-317, 1985) to contain cavefish, fish were sighted in eight (Table 1). These were Logan Cave, Cave Springs Cave, and Civil War Cave in Arkansas; Ben Lassiter Cave, Turnback Creek Cave, and Kellhaufer's Cave in Missouri; and Twin Cave and Jail Cave in Oklahoma. However, two of the caves could not be adequately surveyed. Sarcoxie Cave and Kellhaufer's Cave, Jasper County, Missouri, were flooded by heavy rains. The owners of Kellhaufer's Cave reported seeing four fish in the cave June 30, 1986. Failure to sight fish in Fantastic Caverns in three visits is significant because a large area can be searched during each visit.

Three new Ozark cavefish populations were found in Benton County, Arkansas. A single fish was observed in Rootville Cave January 17, 1986. Henry James and Scott Ditto, amateur cavers, excavated a narrow passageway into a small cave near Gentry, Arkansas. Our visits to the cave on January 29, 1987 confirmed their reports of an *A. rosae* population. An unintentional excavation of a water-filled cave on the east bank of Beaver Reservoir by Arkansas Game and Fish Commission personnel revealed the third additional location for Ozark cavefish in Arkansas.

During the 1983 survey (Willis and Brown, Amer. Midl. Natur., 114:311-317, 1985), Mule Hole Sink, Benton Co., Arkansas, contained a small pool at the bottom which contained cavefish. During the present study the pool did not exist. Mule Hole Sink is probably connected to Cave Springs Cave which is 2 kilometers to the south, and has easier access. Wilson's Cave in Jasper County, Missouri, consists of only a small pool in the twilight zone that is accessible to humans. During this study the pool contained several bluegill *(Lepomis macrochirus)* and a large snapping turtle *(Chelydra serpentina)*. Presence of these predators probably is related to lack of sightings of cavefish at this location.

The larger number of fish seen in Logan Cave in 1986 (Table 1) was probably due to use of facemasks and snorkels in the larger pools. Many of the fish could not have been seen from the surface because of their position beneath undercut areas of the cave walls. Apparently, greater numbers of fish can be seen in the caves between December and March compared with other times of the year.

Many of the caves continue to be abused by frequent visits by cavers, as evidenced by debris left in the caves, writing on the walls, etc. Strict limitation of this traffic must be achieved to ensure continued survival of this interesting species.

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THE EFFECT OF CITY EFFLUENT ON THE DIVERSITY OF AQUATIC MACROINVERTEBRATES OF SUGAR CREEK, CLAY COUNTY, ARKANSAS

Sugar Creek is a small stream that originates on Crowley's Ridge in Clay County, Arkansas. It flows through Piggott and receives surface runoff from the community. South of Piggott, it has been channelized and drains into Big Slough Ditch, within the St. Francis River watershed. The purpose of the study was to determine what effect, if any, the surface runoff from Piggott had on the aquatic macroinvertebrate community of Sugar Creek.

Only three previous studies have been published with respect to biota of streams on Crowley's Ridge. Cather and Harp (1975) compared the aquatic macroinvertebrates of an Ozark stream to those of a deltaic stream that originates on Crowley's Ridge in Greene County, approximately 60 km southeast of this study area. Beadles (1970) noted effluent effects on fishes of Lost Creek, and Fulmer and Harp (1977) surveyed the fishes of streams occurring on the Ridge, three of which are in Clay County.

Sugar Creek is a second order stream within the study area. The main channel has a mean width of approximately 12 m and a maximum depth of 3 m at flood stage. The stream has a substrate of sand, gravel, silt and organic mud and the banks are steep and often eroded. Vegetation along the banks includes oak, willow, elm, hickory, sycamore, sweet gum, hackberry and tulip poplar. The soil type in the northern part of the study area is Collins silt loam. This loam is moderately well drained and found on upland drainageways and level areas next to Crowley's Ridge. Falaya silt loam was found south of Piggott along the creek. This loam is poorly drained and found on the flood plains of upland drainageways and level areas near the Ridge. Both soil types are primarily a mixture of brown silt loam and mottled brown silt loam. Both are low in organic matter and strongly acid. They are often geographically associated (Soil Conservation Service, 1978).

For collection purposes, two stations were established on Sugar Creek. Station I was located at the northern edge of the city limits in the SE¼ S3, T20N, R8E. Station II was located downstream, at the southern city limits, in the SW¼ S11, T20N, R8E. Collections were made for a timed period of 45 minutes from each station every two weeks from 31 August-9 November 1985. Collections were made with a fine mesh aquatic "D" net. An attempt was made to sample all microhabitats. Specimens were preserved in 70% ethanol. After identification, all specimens were catalogued and housed in the Aquatic Macroinvertebrate Collection of the Arkansas State University Museum of Zoology (ASUMZ).

Simpson Diversity, Simpson Dominance, Shannon-Wiener Diversity, H'max and Evenness values were calculated using the AQUATIC ECOLOGY-PC disc of Oakleaf Systems, Decorah, IA. Simpson's Index of Diversity corresponds to the number of randomly selected pairs of individuals that must be drawn from a community in order to have an even chance of obtaining a pair with both individuals of the same species. It therefore expresses the dominance of or concentration of abundance into the one or two commonest species of the community (Poole, 1974). Conversely, the Shannon-Wiener Diversity Index expresses the relative eveness of the abundances of all the species. Further, it is relatively independent of sample size (Poole, 1974). H'max is a calculated theoretical maximum diversity (Wilhm and Dorris, 1968). The base 2 logarithm was selected for calculating diversity indices, as it is the most commonly utilized log (Cox, 1985).

A total of 927 specimens of aquatic macroinvertebrates was collected (Table 1). Station I showed the greatest species richness with 44 taxa, 24 of which were found only at Station I. Station II had 24 taxa, with four taxa found only at that station. Stations I and II had 20 taxa in common. Of the 44 taxa collected, 42 were generalists, or species found in many different habitats. Two exceptions to this were *Hydrometra hungerfordi*, a rarely collected species that prefers clean water streams (Harp, 1985), and *Calopteryx maculata*, which is characteristically found in small shaded streams in forested areas (Walker, 1953). These two species were collected at Station I.

Table 1. Total Number of Aquatic Macroinvertebrates Collected at Sugar Creek, 31 Aug - 9 Nov 1985.

Taxa	Station I	Station II
Branchiobdellidae	5	
Physa	141	188
Musculium		1
Simocephalus	13	
Caecidotea	96	60
Synurella bifurca (Hay)	3	
Palaemonetes kadiakensis Rathbun		7
Cambarinae	28	26
Isotomurus palustris (Muller)	2	
Bourletiella spinata (MacG.)	1	
Callibaetis	10	6
Caenis	1	6
Hesperocorixa nitida (Fieber)	1	
Sigara alternata (Say)	1	
Trichocorixa kansa	7	
Gelastocoris oculatus oculatus (Fabricius)	1	9
Gerris remigis Say	10	1
Limnoporus canaliculatus (Say)	16	16
Neogerris hesione (Kirkaldy)	3	1
Rheumatobates	3	1
Trepobates	1	
Hydrometra hungerfordi Torre-Bueno	1	
H. martini Kirkaldy	6	
Mesovelia mulsanti White	1	
Notonecta undulata Say	8	20
Microvelia americana (Uhler)	31	19
M. hinei Drake	16	
Calopteryx maculata (Beauvois)	3	
Ischnura	6	24
Nasiaeschna pentacantha Rambur	1	1
Libellula	3	11
Acilius fraternus fraternus (Harris)	1	
Coptotomus venustus (Say)	2	1
Hydroporus	2	
Laccophilus fasciatus rufus Melsheimer	14	4
Thermonectus ornaticollis Aube	1	
Gyrinus	1	
Cyphon	3	
Peltodytes dunavani Young	1	
P. sexmaculatus Roberts		1
Enochrus sayi Gundersen	1	
E. pygmaeus nebulosus (Say)		1
Tropisternus lateralis nimbatus (Say)	20	15
Chironomus	10	4
Anopheles punctipennis (Say)	6	4
Culex restuans Theobald	8	
Chrysops	1	
Eristalis	10	
Total Organisms	500	427
Total Taxa	44	24

Table 2. Shannon - Wiener Diversity values for Sugar Creek, 1985.

Date	Station I	Station II
31 Aug	2.309	2.966
14 Sep	3.299	2.166
28 Sep	3.375	2.777
12 Oct	3.737	2.342
26 Oct	2.903	2.903
9 Nov	2.824	2.797

Table 3. Nested (Combined) Values for Sugar Creek, 1985.

Parameter	Station I	Station II
Simpson Diversity Index	.870	.772
Simpson Dominance	.130	.228
Shannon - Wiener Diversity Index	3.893	3.026
H'max	5.458	4.584
Evenness	.713	.660

Diversity index values fluctuated, with respect to a given station in time, and also between stations. For example, Shannon-Wiener Diversity values at Station I gradually increased from 31 Aug-12 Oct, then declined. At Station II, these values alternately rose and fell. Further, these values were greater at Station I on three occasions, similar at both stations twice, but greater at Station II once (Table 2). Nevertheless, when the data for all six sampling dates are combined, or nested, all measures of diversity show the community diversity to be greater at Station I (Table 3).

Greater community diversity (stability) at Station I appears to be the result of two basic conditions — a greater number of microhabitats and less pollution. Station I had isolated shallow pools lined with vegetation and often covered with filamentous algae. In areas, creek banks were gently sloping and grass-covered. Grass clippings had been dumped into the creek. Upstream from the study area, tin cans and other solid waste had been dumped along the bank of the creek, and a small amount of asphalt had been dumped into a spring that flowed into the creek. At Station II the creek banks were steeper, more heavily eroded, and had less vegetation. The stream had a small volume flow, except when heavy rains increased runoff. Pools of water up to 0.5 m in depth alternated with riffle areas between rains. Observed sources of pollution included erosion and residue from the burning of creek-bank vegetation, oils and gases from surface runoff from roadways, chemicals from a cleaning establishment, aluminum cans, concrete slabs and other solid waste dumped along the banks and some rotten apples dumped into the creek.

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NEW COUNTY RECORDS OF ARKANSAS VASCULAR FLORA FROM THE UNIVERSITY OF CENTRAL ARKANSAS HERBARIUM

A search of specimens in the Vascular Plant Herbarium of the University of Central Arkansas was conducted from 1983 to the present to compile records not documented by Smith (1978) in his ***Atlas and Annotated List of the Vascular Plants of Arkansas*** nor in his five supplements (Smith, 1986). As a result, 916 new county records were located. They represent 650 species in 112 families located in 46 counties throughout Arkansas. Most records, however, are from Faulkner County or the central part of the state. Of special note is one specimen, ***Lathyrus aphaca*** L. from Pulaski County. This is an Asian species which Smith (pers. communication) says may represent a waif and may not persist. This yellow flowered legume was collected from a field near a house in Little Rock where it was growing profusely on May 16, 1971.

These species/county occurrence records add to the plant distribution of a geographical area and are important steps toward the publication of a manual of vascular plants, a work that is yet to be completed for Arkansas. This listing of records can be found in the Arkansas Native Plant Society Occasional Papers No. 7.

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WOODY PLANTS OF SOUTH ARKANSAS: COMPUTER AIDED INSTRUCTION IN DENDROLOGY

The objective of this paper is to introduce a program for Apple II computers designed to supplement existing instruction in the identification of woody plants and their corresponding common and scientific names. At many universities dendrology is a sophomore level course introducing majors to the identification, classification, and nomenclature of woody plants of the forest. Laboratory field exercises reinforce concepts presented during lecture and introduce advanced concepts from upper level courses. In this manner, dendrology establishes a foundation through formal and informal instruction leading to the successful completion of the dendrology course and subsequent upper level courses. For example, at the University of Arkansas at Monticello, each weekly trip introduces students to one of Arkansas' many varied habitats and approximately 15 forest species of woody plants. These species are described botanically, related to the unique characteristics of the site, and presented as a member of a dynamic and complex forest community valued for its products and intangible amenities. After a few weeks of study, students have (1) acquired an appreciation of forest species as members of the broader plant community, (2) participated in the consumptive and nonconsumptive uses of the forest, and (3) observed patterns in phenotypic variation explained by concepts from synecology, autecology, and genetics which are applied to forest management during courses in silviculture, tree improvement, and forest recreation. For these reasons dendrology initiates the foundation for advanced study in forest resources management and is the base on which professional careers are built. The ability to recognize and identify the forest resource is fundamental to appreciation, advanced study, and professional development in forestry.

Laboratory exercises in dendrology are designed to encompass as many different habitats, forest communities, and species as possible. Sometimes sites selected for field study require traveling 40 or more miles from campus. Students needing additional out-of-class review with limited available time for study or lacking personal transportation may encounter difficulty returning to a laboratory site. Consequently, an inexpensive and effec-