The Aquatic Macroinvertebrate Fauna of an Ozark and a Deltaic Stream

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ABSTRACT

An Ozark and a deltaic stream in northeastern Arkansas were studied to compare physicochemical and aquatic macroinvertebrate parameters and to determine whether the number and kind of organisms increase downstream. Janes Creek, the Ozark-type stream, is clear, spring-fed and alkaline with a steep gradient and high flow velocity; dissolved oxygen values are not limiting. Big Creek, the deltaic stream, is turbid, low in alkalinity and has a slight gradient and low stream velocity. These streams comprise distinct habitats created by differences in substrate, watershed and land use.

A total of 122 taxa were collected in both streams, 62 of which were identified to species. Of the total taxa, 100 were found in Janes Creek and 55 were found in Big Creek. Only 33 taxa were common to both streams. Species diversity indices for Janes and Big Creek stations ranged from 3.272 to 4.454 and 1.822 to 2.905, respectively. Snails which fed on algal film of submerged rocks in pools were characteristic of Janes Creek, whereas oligochaetes which fed on organic detritus were characteristic of Big Creek. Mean numerical standing crop of Big Creek was almost three times that of Janes Creek (726 organisms vs. 265 organisms/m^2). Longitudinal zonation was characterized in each stream by an increase in numbers and kinds of aquatic macroinvertebrates downstream. Diversity index values did not completely support this observation, however.

INTRODUCTION

Few studies have been made of the aquatic macroinvertebrates of streams in the Ozark Plateau region of Arkansas (Aggus and Warren, 1965; McGary and Harp, 1972; Robison and Harp, 1971; Sublette, 1956; Van Kirk, 1962) and none have been published concerning its deltaic streams.

The purposes of this study were to describe and contrast the physicochemical and aquatic macroinvertebrate characteristics of an Ozark and a deltaic stream, and to determine whether the number and diversity of aquatic macroinvertebrates increase downstream. An increased number of species downstream would correlate with greater variety of available riches and moderating environmental conditions (Kendeigh, 1961).

The lotic habitats of northeastern Arkansas are basically of two types. Streams of the Ozark Plateau are typically clear, spring-fed and alkaline, and have a relatively steep gradient. Streams of the St. Francis basin are turbid, low in alkalinity and have low flow velocity.

Janes Creek typifies the Ozark stream habitat. It arises in the northwesternmost corner of Randolph County, meanders for 39 km near the western border, and reaches its confluence with Spring River at the Randolph-Lawrence county line in the Salem Plateau section of the Ozark Plateau province. Limestone and dolomite are dominant rock types, and allow widespread development of large springs in the Salem Plateau (Croneis, 1930; Thornbury, 1965). Climax vegetation in the watershed is oak-hickory. Forest and pasture land result in controlled runoff from the watershed. Aquatic vascular plants present in the stream were water willow, *Justicia americana* (L.) Vahl, and yellow water lily, *Nuphar luteum* var. *ozarkanum* (L.) Sibthorp and Smith. Loose gravel, mostly chert, characterizes the bottom.

Big Creek is comparable to Janes Creek in size and is representative of the deltaic streams of the St. Francis Basin. It arises on Crowley's Ridge in south central Green County, enters Craighead County after 10 km, and is channeled for most of its remaining length, finally becoming Bayou DeView Ditch 8 km east of Cash, Craighead County, Arkansas. Major soils of the watershed are of the Falaya-Collins association. These are deep, rather poorly drained, moderately permeable soils washed from loess (SCS, 1962). Climax vegetation is oak-hickory, but cultivated fields dominate. Big Creek is a drainage ditch, periodically dredged for flood control. Its substrate is mud, silt and hard clays. The high, steep stream banks result in frequently heavy runoff and increased silt deposition.

Two stations were established on each stream. On Janes Creek station I was at an elevation of 110 m in S36, T20N, R3E. Station II, 4 km downstream, was at an elevation of 101 m at the stream's junction with Arkansas State Highway 90 in S7, T19N, R2E. Station I (S35, T15N, R3E) of Big Creek was at an elevation of 87 m, and station II (SE ¼ S10, T14N, R3E) was 4 km downstream at U.S. Highway 63, at an elevation of 84 m.

MATERIALS AND METHODS

Data were collected monthly from both pool and riffle areas of each station from 12 July to 18 October 1969. Physicochemical parameters were measured at streamside. Dissolved O, was measured by the sodium azide modification of the basic Winkler method (APHA, 1960). Carbon dioxide and methyl orange alkalinity were measured by standard limnological methods (Welch, 1948). Hydrogen ion concentration (pH) was measured with a colorimetric pH meter. Light penetration was determined by Secchi disk. Current was measured by timing a floating object over a known distance. Temperature was measured with a standard centigrade thermometer. A total of 128 aquatic macroinvertebrate samples were taken, 96 quantitative and 32 qualitative. On each sampling date samples were collected along a transect of each pool by use of a

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36 in² (0.023 m²) Ekman dredge, each sample consisting of one dredge haul. These were washed through a benthic screen having 11.8 sq/linear cm (pore area 0.174 mm²). In each riffle area, triplicate bottom samples were procured with a 1 ft² (0.09 m²) Surber sampler. Qualitative samples were collected in pool and riffle at both stations by use of a dip net of fine mesh. Preservation of quantitative and qualitative samples was by 10% formalin and 70% ethanol, respectively.

Species diversity indices were calculated for pool and riffle communities at each station by the equation of Wilhm and Dorris (1966). Pool and riffle data were combined to determine species diversity indices for each station.

RESULTS

Janes Creek was found to be a clear, well-oxygenated, spring-fed alkaline stream with a relatively steep gradient (2.3 m/km) and high flow velocity (Table I). The aquatic macroinvertebrate fauna was diverse, 100 taxa being identified (Table II). Snails, mayflies and dipterans dominated in that order. Diversity index values for stations ranged from 3.272 to 4.454 (Table III). Riffles of both stations supported a more diverse aquatic macroinvertebrate community than pools, 63 vs. 42 taxa. This observation is corroborated by the fact that all eight riffle diversity indices were greater than their companion pool diversity indices (Table III). The number of organisms and the number of taxa collected increased downstream. A mean number of 205 and 321 organisms/m² constituting 44 and 69 taxa were collected from stations I and II, respectively. Diversity indices reflected this trend as three of the four values were greater at station II (Table III).

Big Creek was found to be turbid and low in alkalinity; it had a lower dissolved oxygen content and a slight gradient (0.7 m/km) with low stream velocity (Table I). It supported an aquatic macroinvertebrate population whose mean numerical standing crop was nearly three times that of Janes Creek, 726 vs. 265 organisms/m². However, the population was less diverse, with 55 taxa and a range of diversity indices from 1.822 to 2.905 (Table II, IV). Moreover, the difference in kinds of organisms was dramatic (Table V). Molluscs were scarce in Big Creek. Plecoptera, which more than any other aquatic insect characterizes clear, running water, was absent in Big Creek. Swimming mayflies such as *Baetis* and *Ameletus*, characteristic of Janes Creek, were replaced in Big Creek by burrowing *Hexagenia* and sprawling *Caenis*. Although the numbers of dipteran taxa in the two streams were comparable, Big Creek contained more species of detrital feeding chironomids, and *Atherix* was absent.

Big Creek supported more taxa in riffle than pool areas, 28 vs. 26. Riffle diversity indices were greater in 7 of 8 instances (Table IV). Though 35 taxa with a mean number of 1106 organisms/m² were identified at station II, in comparison with 328 organisms/m² and 27 taxa at station I, diversity indices did not indicate a clear increase in diversity at station II.

Table I. Physicochemical Characteristics, Expressed as Mean Values, Stations I and II, Janes and Big Creeks, 12 July-18 October 1969

	Janes Creek				Big Creek			
	Sta. I		Sta. II		Sta. I		Sta. II	
Item	P[1]	R	P	R	P	R	P	R
Dissolved 0, (ppm)	5.8	6.9	7.8	8.1	6.2	7.0	5.4	5.6
CO_2 (ppm)	5.0	6.2	2.4	2.2	9.0	9.6	7.0	6.4
Methyl orange alk. (ppm)	247	249	250	251	70	84	69	70
pH	8.0	7.8	7.9	8.1	6.9	7.2	7.2	7.2
Current (cm/sec)	---	60	---	80	---	40	---	40
Light penetration (cm)	75[2]	---	90[2]	---	26	---	17	---

[1] P = pool, R = riffle.
[2] Reading taken on pool bottom.

DISCUSSION

The aquatic macroinvertebrate fauna in Janes Creek was more diverse than those reported by other investigators of Ozark streams. This is because of sample size (Robison and Harp, 1971; Sublette, 1956), identification of organisms to species where possible rather than use of high levels of classification (Blanz et al., 1969; Brown et al., 1967); and pool area sampling (Blanz et al., 1969; Sublette, 1956).

Gastropods are characteristic of such streams as Janes Creek because the high alkaline salts content facilitates shell formation (Kendeigh, 1961). In addition, the clear water allows photosynthesis to occur at all depths; one result is abundant aufwuchs, an important food for gastropods. In contrast, the scarcity of molluscs in Big Creek was not caused by lower alkalinity (Hutchinson, 1957), but by the combination of unsuitable substrate and reduced photosynthesis which greatly reduced available aufwuchs in this stream.

The greater standing crop of aquatic macroinvertebrates in Big Creek probably resulted from two factors. Enrichment from surrounding fields would provide food suitable for detrital

Table II. Aquatic Macroinvertebrate Taxa, Stations I and II, Janes and Big Creeks, 12 July-18 October 1969

	Janes Creek				Big Creek			
	Sta. I		Sta. II		Sta. I		Sta. II	
Taxa	P[1]	R	P	R	P	R	P	R
TURBELLARIA								
Planariidae	X	_	X	X	_	X	X	X
OLIGOCHAETA	X	_	X	_	X	_	X	_
HIRUDINEA								
Placobdella	_	_	X	_	_	_	X	_

Taxa	Janes Creek Sta. I P[1]	Janes Creek Sta. I R	Janes Creek Sta. II P	Janes Creek Sta. II R	Big Creek Sta. I P	Big Creek Sta. I R	Big Creek Sta. II P	Big Creek Sta. II R
GASTROPODA								
Ancylidae	X	X						
Fossaria parva (Lea)							X	
Goniobasis ovoidae (Lea)	X	X	X	X	X			
Pleurocera acuta (Rafinesque)	X	X	X	X				
PELECYPODA								
Carunculina glans (Lea)			X	X				
Elliptio dilatatus (Rafinesque)				X				
Lampsilis reeviana (Lea)				X				
Lasmigona costata (Rafinesque)				X				
Villosa occidentalis (Conrad)				X				
Musculium transversum (Say)								X
Pisidium compressum (Prime)				X				
Pisidium dubium (Say)				X				
Sphaerium striatinum (Lamarck)				X				
CRUSTACEA								
Asellus brevicaudus (Forbes)			X	X		X		
Gammarus fasciatus (Say)	X			X				
Hyalella azteca (Saussure)	X		X		X			
Orconectes virilis (Hagen)		X		X				
HYDRACARINA		X	X					
COLLEMBOLA								
Sminthurides				X				
PLECOPTERA								
Acroneuria				X				
Isoperla				X				
Leuctra		X		X				
Neoperla clymene (Newman)		X						
EPHEMEROPTERA								
Stenonema ares Burks, Stannard, Smith	X	X	X	X		X	X	X
S. gildersleevei (Traver)			X	X		X	X	X
S. nepotellum (McDunnough)		X		X				
S. tripunctatum (Banks)								X
Ephemera guttulata Pictet				X				
Hexagenia limbata (Serville)	X		X	X	X	X	X	
H. rigida (McDunnough)					X		X	
Potamanthus	X	X	X					
Baetis frondalis (McDunnough)		X		X		X		X
B. herodes (Burks)						X		X
B. intercalaris (McDunnough)		X		X		X		X
B. levitans (McDunnough)		X				X		X
Caenis	X	X	X	X	X	X	X	
Choroterpes			X					
Ephemerella deficiens (Morgan)		X		X				
E. frisoni (McDunnough)		X		X				
Isonychia		X		X				
Paraleptophlebia praepedita (Eaton)	X		X					
ODONATA								
Anomalagrion hastatum Say			X					
Argia				X				X
Hetaerina	X		X					
Ischnura	X							
Dromogomphus spinosus (Selys)	X		X					

Taxa	Janes Creek Sta. I P[1]	Janes Creek Sta. I R	Janes Creek Sta. II P	Janes Creek Sta. II R	Big Creek Sta. I P	Big Creek Sta. I R	Big Creek Sta. II P	Big Creek Sta. II R
Lanthus albistylus (Hagen)			X					
Macromia	X		X		X		X	
Perithemis lydia (Drury)	X		X					
P. tenera (Say)							X	
Tetragoneuria cynosura (Say)					X		X	
HEMIPTERA								
Corixidae	X							
Hydrometra	X		X					
Microvelia americana (Uhler)	X		X					
Rhagovelia knighti Drake & Harris		X	X			X		X
Gerris dissortis Drake & Harris	X		X		X		X	
Rheumatobates trulliger Bergroth					X		X	
MEGALOPTERA								
Corydalis cornutus (L.)		X		X				X
Sialis	X	X						
TRICHOPTERA								
Helicopsyche borealis (Hagen)	X	X	X	X				
Hydroptila				X		X		
Cheumatopsyche		X		X		X		X
Hydropsyche incommoda (Hagen)		X		X		X		X
Macronemum								X
Chimarra		X		X		X		X
Neophylax				X				
Polycentropus	X	X		X		X		X
TRICHOPTERA[2]								
Athripsodes transversus (Hagen)							X	X
Leptocella	X	X						
Mystacides sepulchralis (Walker)	X	X						
Oecetis inconspicua (Walker)	X	X						
Triaenodes marginata (Sibley)	X	X						
Cheumatopsyche analis (Hagen)							X	X
Cheumatopsyche aphanta (Ross)	X	X						
Cheumatopsyche burksi (Ross)							X	X
Cheumatopsyche oxa (Ross)	X	X						
Cheumatopsyche	X	X					X	X
Chimarra aterrima Hagen	X	X						
Chimarra feria (Ross)	X	X						
Chimarra obscura (Hagen)	X	X						
Chimarra	X	X						
LEPIDOPTERA								
Elophila	X	X		X				
COLEOPTERA								
Berosus (A)[3]								X
Helophorus (A)		X						
Dryops (A)			X					
Lutrochus (A)				X				
Macronychus glabratus (Say) (A)				X				
Microcylloepus pusillus (LeConte) (A)		X						
Optioservus ampliatus (Fall) (A)		X						
Optioservus		X						
Stenelmis crenata (Say) (A)				X				
Stenelmis		X						X
Ectopria	X	X	X					
Psephenus herricki (DeKay)	X	X	X					

Taxa	Janes Creek Sta. I P[1]	Janes Creek Sta. I R	Janes Creek Sta. II P	Janes Creek Sta. II R	Big Creek Sta. I P	Big Creek Sta. I R	Big Creek Sta. II P	Big Creek Sta. II R
DIPTERA								
Atherix		X		X				
Palpomyia			X			X	X	
Chaoborus punctipennis (Say)					X		X	
Ablabesmyia			X				X	
Pentaneura							X	X
Procladius							X	
Tanypus							X	
Chironomus (*Cryptochironomus*) = (*Harnischia*)						X		
Chironomus (*Cryptochironomus*)			X				X	
Chironomus (*Dicrotendipes*)			X					
Chironomus (*Tribelos*)			X					
Micropsectra			X					
Tanytarsus			X			X		
Empididae				X		X		
Simulium		X		X		X		X
Tabanus		X		X		X		

[1] P = pool, R = riffle.

[2] Adults collected by black light at station I, Janes Creek, 6 September 1969, and station II, Big Creek, 23 September 1969.

[3] (A) = adults.

Table III. Species Diversity Indices, Janes Creek, 12 July-18 October 1969

	Station I			Station II		
	Pool	Riffle	Combined	Pool	Riffle	Combined
July	1.981	3.114	3.528	2.051	3.094	3.447
Aug.	2.935	2.980	3.272	3.200	3.371	4.057
Sept.	3.370	3.428	3.892	3.462	4.114	4.454
Oct.	3.049	3.450	3.784	3.028	3.032	3.856

Table IV. Species Diversity Indices, Big Creek, 12 July-18 October 1969

	Station I			Station II		
	Pool	Riffle	Combined	Pool	Riffle	Combined
July	1.610	1.404	1.822	1.807	1.991	2.615
Aug.	1.119	1.444	1.917	0.628	1.425	2.051
Sept.	1.310	2.462	2.833	1.640	2.356	2.549
Oct.	1.411	2.412	2.905	1.729	2.600	2.794

feeders. Oligochaetes constituted 71% of the total pool fauna by number and, with Trichoptera and Diptera, accounted for 90% of the total aquatic macroinvertebrate community.

There was a decrease in diversity of microhabitats in Big Creek. Rooted aquatic plants were absent, and the dual pressures of dredging and siltation have provided a uniform habitat suitable for a relatively limited number of aquatic macroinvertebrate taxa. The degree of environmental stress is reflected in the diversity index values (Table IV). Values between 1 and 3 indicate moderate pollution, whereas values above 3 indicate clean water areas (Wilhm and Dorris, 1968). Those species present in Big Creek may take advantage of decreased competition and predation to establish a community relatively higher in number per unit area.

The greater diversity of organisms in riffle areas of both streams, particularly Janes Creek, may be due to the greater variety of niches (Kendeigh, 1961). Increased diversity downstream, seen in Janes Creek, is a well documented

phenomenon (Robison and Harp, 1971; Sublette, 1956; Van Kirk, 1962) and may be correlated with a greater variety of available niches and moderating environmental conditions (Kendeigh, 1961). This phenomenon was not obvious in Big Creek, probably because of channelization and therefore greater uniformity of habitats present.

Table V. Comparison of Number of Taxa Present in Major Aquatic Macroinvertebrate Groups, Janes and Big Creeks, 12 July-18 October 1969

Group	Number	
	Janes Creek	Big Creek
Mollusca	11	2
Plecoptera	4	0
Ephemeroptera	17	12
Trichoptera	12	7
Coleoptera	11	2
Diptera	11	12

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