

Species Diversity of Benthic Macroinvertebrates in Salt Creek, Oklahoma

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Forty-four taxa of benthic macroinvertebrates were collected from July 1986 to November 1987 in rock-filled baskets placed at five stations in Salt Creek, Osage County, Oklahoma. Number of taxa was lowest at the upstream stations, exhibited little change at the three middle stations and increased abruptly at the downstream station. No consistent spatial pattern in numbers of individuals was observed. Mean Shannon-Weiner diversity ($< d >$) ranged from 1.23 at the upstream station in May 1987 to 2.73 at the downstream station in September 1987. Diversity increased downstream during all seasons. Two mayflies, *Stenonema* and *Caenis*, and one caddisfly, *Hydropsyche*, were the most abundant genera collected.

INTRODUCTION

Benthic macroinvertebrates are important constituents in prairie streams influencing virtually every stream process that occurs. However, the number of recent studies of their distribution in central Oklahoma streams is limited. It is the objective of this paper to describe the seasonal and spatial diversity of benthic macroinvertebrates in Salt Creek, a prairie stream in northcentral Oklahoma.

STUDY AREA

Salt Creek is an 89-km stream located in the tallgrass prairie region of Osage County, Oklahoma. Its headwaters are at Grainola, Oklahoma near the Kansas-Oklahoma border. It flows southerly through the towns of Shidler and Fairfax, entering the Arkansas River 12 km south of Fairfax. The drainage basin covers 628 km² and is used extensively for grazing. The area receives 86 cm of precipitation per year with peaks in February, May, and October. The mean annual air temperature is 16.4 °C. A further description of the watershed is given by Bryant (1).

METHOD

A Hydrolab model 4000 was used to measure conductivity, dissolved oxygen, pH, and temperature at each station. Three random replicate measurements were made at 0.6 cm depth for each variable. Dissolved oxygen was measured at the time of sampling as well as at dawn and dusk. Carbonate and bicarbonate alkalinities were determined by titration (2) of three random replicates per station.

Five rock-filled baskets (3) for macroinvertebrate colonization were randomly placed in Salt Creek at each of the five stations. Contents of four of the baskets were analyzed and the fifth was a reserve. Each basket, constructed of 7.9-mm-mesh galvanized hardware cloth, was 20 cm long by 15 cm in diameter. Substrata, collected from the stream bed near the location where the baskets were to be placed, were scrubbed to remove all macroinvertebrates prior to placing in the baskets. After filling, the baskets were placed on the stream bed, attached to the shore, and allowed to remain for 6 weeks as suggested by Mason *et al.* (3, 4) for colonization. When collected, each basket was emptied into a bucket partially filled with water. The basket and each rock were scrubbed to remove macroinvertebrates and debris. These dislodged components were collected in a 63- μ m-mesh Nitex plankton net with an attached collecting bag. The contents of the collecting bags were preserved in the field with 10% formalin. In the laboratory, the samples were elutriated (5) and hand sorted, and the macroinvertebrates were enumerated and identified to the lowest possible taxon.

RESULTS AND DISCUSSION

Mean depth and mean water velocity increased downstream. Mean depth ranged from 12.5 to 24.5 cm at Station 1 and from 31.0 to 41.1 cm at Station 5. Mean water velocity ranged from 1.3 to 1.5 and 11.1 to 17.0 m/s at Stations 1 and 5, respectively. Temperature ranged from 4.4 °C in December, 1986, to 29.8 °C in July 1986.

Conductivity generally increased downstream and was higher in March and May than during other sampling times. The variation between dawn and dusk measurements of dissolved oxygen ranged from 3.2 mg/L at Station 3 in July 1986 to 13.6 mg/L at Station 1 in December 1986. Most dissolved oxygen values exceeded 5.0 mg/L, even at dawn.

Forty-four taxa of benthic macroinvertebrates were collected in Salt Creek (Table 1). Mean number of taxa of the four replicates at each station ranged from nine at Station 1 in September 1986 to 25 at Station 5 in July and September 1987 (Table 2). Generally, the number of taxa was lowest at Station 1, exhibited little change from Stations 2 to 4, and was considerably higher at Station 5. The number of taxa was higher at all stations in July and September 1987 than at other sampling times.

The total number of taxa collected from Salt Creek was less than that collected in other annual studies of Oklahoma streams (Table 3). Numbers varied from 42 in Skeleton Creek, which received both domestic and oil refinery effluents, to 122 in Otter Creek, which received oil field brines. Although rock baskets were used in Salt Creek, the rocks were natural substrates and should have produced a variety of invertebrate comparable to that in the other streams. However, invertebrates that prefer fine substrates such as silts and sands, or macrophytic habitats, may not have colonized the baskets used to sample Salt Creek. Invertebrates in these microhabitats may have been sampled in the studies that used Ekman or Surber samplers or kick nets.

Mean numbers of individuals of the four samples at each station varied from 64 in November 1987 to 301 in July 1987. Both extremes occurred at Station 2 (Table 2). No consistent longitudinal pattern was noted such as was observed for species richness. However, greater numbers were collected at Station 2 in summer and at Station 5 during the rest of the year. Lower numbers were generally collected in fall and winter at all stations. Since organisms were collected in rock baskets, estimates of density per substrate area were not possible; this precluded comparison with other studies.

Mean Shannon-Weiner diversity ($\langle d \rangle$) of the four replicates at each station ranged from 1.23 at Station 1 in May 1987 to 2.73 at Station 5 in September 1987 (Table 2). Diversity increased downstream as the Station 1 in May 1987 to 2.73 at Station 5 in September 1987 (Table 2). Diversity increased downstream as the macroinvertebrate assemblage changed from a grazer-dominated system to a grazer-collector-co-dominated system. Additionally, the relative proportions of shredder and predator macroinvertebrates increased downstream. The variations in diversity among stations was less than 0.67 in December 1986 and in March and November 1987 and exceeded 1.10 at the other sampling times. Mean annual diversity increased 0.35 between Stations 1 and 2 and between Stations 4 and 5. Values of diversity were low in March 1987 and higher in September and November 1987. Mean diversity over all stations did not vary significantly during the 1986 collections but decreased 0.36 from December 1986 to March 1987.

The ranges of species diversity were greater in Oklahoma streams than in Salt Creek (Table 3). Otter, Skeleton, and Black Bear creeks reported known inputs of pollution. However, extensive inputs did not exist in Greasy and Red Rock creeks. Although artificial substrates were used to sample in the latter two creeks, their diversity was considerably higher than in Salt Creek. The downstream decrease in diversity observed in Salt Creek was also observed in Greasy and Skeleton creeks; however, the increase in Skeleton Creek reflected an input of domestic and oil refinery influents in the headwaters which became diluted downstream. Longitudinal trends were related in Otter and Black Bear creeks to inputs of oil field brines. No longitudinal trend was observed in Red Rock Creek.

Two mayflies, *Stenonema tripunctatum* and *Caenis* sp., dominated almost every collection in Salt Creek, comprising 35 % and 23% of the invertebrates, respectively. They were abundant at every station and during all seasons. One other taxon, the caddisfly *Hydropsyche* sp. (10%), was abundant throughout the year although it was not collected at Station 1. Species of the orders Odonata, Megaloptera, Trichoptera, and Coleoptera were collected throughout the year, but were less common at upstream stations than farther downstream. Plecopterans were collected only at Station 5. The majority of the organisms in these taxa are shredders or predators. Biomass of shredders was directly related to the amount of coarse particulate

TABLE 1. Benthic macroinvertebrates collected in Salt Creek from July 1986 to Nov 1987

Taxa	
EPHEMEROPTERA	DIPTERA
<i>Caenis</i> sp.	Ceratopogonidae
<i>Hexagenia</i> sp.	<i>Chrysops</i> sp.
<i>Isonychia</i> sp.	<i>Nemotelus</i> sp.
<i>Siphonurus</i> sp.	<i>Simulium</i> sp.
<i>Stenonema tripunctatum</i>	Chironomidae
PLECOPTERA	<i>Ablabesmyia</i> sp.
<i>Acroneuria</i> sp.	<i>Chironomus</i> sp.
<i>Hydroperla crosbyii</i>	<i>Cricotopus</i> sp.
<i>Taeniopteryx</i> sp.	<i>Dicrotendipes</i> sp.
MEGALOPTERA	<i>Endochironomus</i> sp.
<i>Corydalis cornutus</i>	<i>Glyptotendipes</i> sp.
<i>Sialis</i> sp.	<i>Pentaneura</i> sp.
TRICHOPTERA	<i>Polypedilum convictum</i>
<i>Chimarra</i> sp.	<i>P. fallax</i>
<i>Helicopsyche</i> sp.	<i>P. illinoense</i>
<i>Hydropsyche</i> sp.	<i>Pseudochironomus</i> sp.
<i>Micrasema</i> sp.	<i>Strictochironomus</i> sp.
LEPIDOPTERA	<i>Thienemannimyia</i> sp.
<i>Crambus</i> sp.	ODONATA
COLEOPTERA	<i>Engallama</i> sp.
<i>Berosus</i> sp.	<i>Telebasis</i> sp.
<i>Gyretes</i> sp.	OTHER
<i>Hexacylloepus</i> sp.	Lumbricidae
<i>Microcylloepus</i> sp.	<i>Physella</i> sp.
<i>Phanocerus</i> sp.	Ancylidae
<i>Stenelmis markeii</i>	<i>Hyaella azteca</i>

TABLE 2. Mean number of taxa (s), individuals (n), and species diversity (<d>) of benthic macroinvertebrates in Salt Creek, OK.

Date	Vari- able	Station					
		1	2	3	4	5	x
Jul 86	s	13	18	15	15	21	116
	n	125	285	137	131	224	180
	<d>	1.38	1.70	1.99	2.01	2.53	1.92
Sep 86	s	9	17	15	*	21	15
	n	82	85	87	*	120	94
	<d>	1.47	2.04	1.57	*	2.58	1.92
Dec 86	s	10	12	13	12	18	13
	n	71	66	69	84	102	78
	<d>	1.60	1.70	1.99	2.06	2.26	1.92
Mar 87	s	12	15	16	17	19	16
	n	103	128	141	165	191	146
	<d>	1.30	1.51	1.49	1.63	1.89	1.56
May 87	s	14	16	18	20	22	18
	n	171	140	123	138	145	143
	<d>	1.23	1.69	1.81	1.93	2.35	1.80
Jul 87	s	14	19	16	19	25	18
	n	136	301	168	138	231	195
	<d>	1.50	1.68	1.99	2.05	2.59	1.96
Sep 87	s	11	18	17	22	25	19
	n	87	92	98	97	139	103
	<d>	1.58	2.15	2.09	2.33	2.73	2.18
Nov 87	s	10	14	14	12	20	14
	n	75	64	65	74	105	77
	<d>	1.61	1.98	2.10	2.19	2.13	2.00
Mean	s	12	16	16	17	22	
	n	106	145	111	118	157	
	<d>	1.46	1.81	1.88	2.03	2.38	

organic matter available which increased downstream as the riparian vegetation system changed from grassland to woodland. Predator macroinvertebrates were dominated by *Sialis* sp. upstream. Downstream, several co-dominant predators of the orders Odonata, Megaloptera, Coleoptera, and Plecoptera were present. The increase in the diversity of predators present may have been associated with increased available prey diversity and increased habitat diversity. At the downstream stations, several species of the family Chironomidae were also generally more common, including *Pentaneura* sp., *Thienemannimyia* sp. and three species in the genus *Polypedilum*. In contrast, *Ablabesmyia* sp., *Cricotopus* sp., *Endochironomus* *Glyptotendipes* sp., *Pseudochironomus* sp., and *Strictochironomus* were more common upstream.

The mayfly *Caenis* sp. was the most common organism collected in Otter Creek, Oklahoma. The mayfly *Stenonema* sp. was the most common collected in Salt Creek but was rarely collected in Otter Creek (11). Six species of the order Trichoptera were collected in Otter Creek, but *Hydropsyche* was not reported. All three of these mayfly taxa were listed as exceeding 25 individuals/m² in Black Bear Creek (7). The Otter and Black Bear creeks collections were taken with Ekman and Surber samplers. In a study of macroinvertebrates using Hester-Dendy

TABLE 3. Numbers of taxa and diversity of benthic macroinvertebrates collected in annual studies of Oklahoma streams.

Stream	Taxa	Diversity	Sampler	So ^a
Skeleton	42	0.83-3.44	Ekman/Surber	(6)
Black Bear	74	1.98-3.38	Ekman/Surber	(7)
Otter	122	0.59-3.84	Ekman/Surber	(8)
Greasy	62	1.18-3.78	Hester Dendy	(9)
Red Rock	64	0.42-3.78	Hester Dendy	(9)
Kiamichi	68	NM ^b	Ekman/net	(10)
Gates	45	NM ^b	Ekman/net	(10)
Salt	47	1.23-2.73	Rock baskets	--

^aSo = Source

^bNM = Not measured

samplers, *Caenis* and *Stenonema* were often abundant in Greasy Creek, while *Stenonema* was common in Red Rock Creek (9). *Hydropsyche* was present in both creeks.

Salt Creek supports large numbers of benthic macroinvertebrates. However, numbers of species and diversity are generally less than in other Oklahoma streams not receiving significant inputs of pollution.

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