A DISTRIBUTION STUDY OF THE BENTHIC FAUNA OF A LIMITED SECTION OF AUGUSTA CREEK, KALAMAZOO COUNTY, MICHIGAN

By

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ABSTRACT

A DISTRIBUTION STUDY OF THE BENTHIC FAUNA
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During the period of August, 1961 to June, 1962 a distribution study was conducted on Augusta Creek, Kalamazoo County to determine a correlation between types and numbers of benthic fauna, bottom composition, and seasonal changes. Also, a comparison was made between the results of this study and those obtained ten years previously by Fetterolf (1951) to indicate the possible effect of a fish kill which occurred during August, 1960.

The section of Augusta Creek studied was that portion flowing through the W. K. Kellogg Forest. This part of the stream has been the object of a prolonged improvement study begun in 1934.

Samples were collected using the Surber square foot bottom sampler and the Ekman dredge. The Ekman dredge was employed to sample the soft bottom, slow current areas where the Surber sampler was ineffective.

The samples were concentrated by sieving and preserved in pint jars for later sorting and identification. A sectioning procedure was initiated into the sorting process which proved to be greatly time saving.

The organisms were identified to genus and species when possible. They have been recorded in the tables at a

higher level of classification for convenience in making comparisons with other literature.

There were a total of 26,171 bottom animals collected. Of this total 57% were obtained during January, February, and March. The Diptera were the most numerous comprising 67.2% of the total. The station contributing the most bottom organisms was Station III (fine gravel) with 27.2% of the total.

The results indicate no major changes have occurred since Fetterolf's (1951) report. It appears, however, there has been a shift in the dominant group of organisms from the Mollusca to the Chironomidae. This shift has been accompanied by a change in the most productive type of bottom. In Fetterolf's (1951) studies, the sand bottom habitat produced the largest number of animals, and in 1961-1962 the fine gravel habitat yielded the greatest population density.

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INTRODUCTION

Michigan's rivers and streams are used for industrial purposes, sewage disposal, and recreation. Many biologists have studied the effects of these uses on aquatic fauna. Conversely, other biologists have studied the contribution of aquatic fauna in the over-all value of these lotic waters. One such study has been the productivity and distribution of benthic fauna as potential fish food.

The object of this study was to survey the aquatic bottom animals of Augusta Creek to find a correlation between benthic fauna, bottom type, and seasonal changes. It was also of interest to determine the number of bottom animals as the stream recovered from a serious fish kill which occurred one year prior to this study.

LITERATURE REVIEW

The study of stream bottom biology was somewhat of a neglected science until about 50 years ago. Since then bottom fauna data has been reported in ever-increasing amounts. Early investigators had to meet the challenge of inventing devices suitable for taking qualitative and quantitative stream bottom samples. Techniques also had to be devised for sorting these samples and reporting the results. Procedural methods are still not standardized.

Most stream fauna distribution studies have dealt with the total number and kinds of animals present (Cummins, 1962). Some investigators have, however, dealt with a particular group of organisms (Scott, 1958; Cummins, 1964). Some life history studies have contained data on micro-distribution of a particular group (Corbet, 1957).

Much work has been done on the physical limiting factors of benthic fauna distribution. "Substrate, current velocity, and food materials have been shown to be of primary importance, although the way in which these interrelated parameters determine distribution remains to be completely delineated," (Cummins, 1962). Needham and Usinger (1956) found no correlation between population density and bottom types, but striking correlations were observed with depth and speed of curremt. Wene and Wickliff (1940) found in a stream bottom modification study that aquatic insects showed preference for particular bottom types, the medium rubble in a riffle being the most productive. Pennak and Van Gerpen (1947) found variations in benthic populations depending on bottom types; the rubble habitat being the most productive. Armitage (1958) found on the Firehole River, Wyoming, the rubble bottom had an average of 2.48 times more weight of organisms than on bedrock. He postulated that alkalinity might be the chief factor determining the level of standing crop in a stream, but this level can be highly modified by the action of temperature and current and by the physical composition of the stream bottom.

The methods vary by which different authors have indicated the abundance of benthic fauna in their particular studies. Pennak and Van Gerpen (1947) used number and grams per square meter. Wene and Wickliff (1940) used number per square yard. Armitage (1958) expressed his results in average number per square foot and average weight in milligrams per square foot. Waters (1961) reported his findings as volume of organisms per hour.

The investigator setting out to conduct a stream bottom survey must decide upon an appropriate sampler. Some of the instruments that have been used are the Surber (1936) square foot bottom sampler, the Hess (1941) circular sampler, the Ekman (1911) dredge, the Petersen (1911) dredge, and the Ide (1940) cage-type trap for collecting emerging adults. The use of a net designed to collect drift organisms was introduced by Waters (1962, 1961). Welch (1948) described the use and limitations of many types of samplers. Guyer and Hutson (1955) described the use of funnel and tent-type traps for emerging adults.

There is also the question of how many samples should be taken. Needham and Usinger (1956) found in sampling a single riffle with a Surber sampler that 194 samples were required to give acceptable figures for total wet weight of organisms and 73 samples were needed to give significant figures for total numbers at the 95% confidence level. Leonard (1939) found that samples from a similar area varied in species composition from 20 to 40 percent. He concluded, "One sample of the sort described may be depended upon to yield a reasonably accurate index of the amount of food organisms produced per unit area of uniform bottom, but cannot be expected to provide a comprehensive picture of the relative numbers of individual species throughout the larger areas from which the sample is collected."

There are a number of variables which affect the standing crop of a stream's benthos. Waters (1962) found an incredible drift of organisms during the night. The drift rate increased one hour after sunset, continued through the night, decreasing again at daybreak. The amount of drift was much lower in the winter than in summer. Maciolek and Needham (1951) found the greatest number of bottom fauna during February and the least during August. Needham (1934) found the greatest seasonal abundance for weight and numbers in May and a lesser peak in November. Mechanical disturbances, such as children playing, was shown by Waters (1962) to affect the downstream drift of bottom animals. Samples taken in a California stream before and after a flood showed a drastic reduction in the standing crop following the flood (Needham and Needham, 1963).

Surber (1930, 1936) and Needham and Needham (1963) have described suitable methods of concentrating and sorting samples. The selection of a proper mesh sieve has been discussed by Jonasson (1955). Anderson (1959) has reviewed some flotation techniques which make use of solutions of high density (sugar, calcium chloride) which float benthic organisms to the surface. Lauff (1961) described a device which agitates the sample with compressed air. The suspended organisms are then decanted off.

DESCRIPTION OF SAMPLING AREA

Augusta Creek originates in Gilkey Lake in Barry County, and empties into the Kalamazoo River in Kalamazoo County. Investigations on it began in 1934 (Morofsky, Tack, and Lammien, 1949) with a stream alteration study designed to improve conditions for trout productivity. Over one hundred current altering devices were installed in order to increase the current velocity and remove silt overlaying the gravel bottom. A carefully controlled trout stocking and harvest census was carried out. A trout stocking program is still in operation in the W. K. Kellogg Forest under the direction of Mr. Walter Lemmien, Resident Supervisor.

Bottom samples were taken from that part of Augusta Creek which flows through the W. K. Kellogg Forest, Ross Township, T.1S, R.9W, Sections 21, 22, and 27, Kalamazoo County. The section of stream under consideration was approximately 1.8 miles long.

Samples were collected from seven stations as follows:

STATION I - Large stone (Figure 1)

The bottom consisted of gravel on top of which were stones ranging up to 15 inches in diameter. There were also several large boulders in this area. The average depth* was nine inches, and the average width was 15 feet. The current velocity was 0.6 feet/second. The sampling station was well shaded by large trees, but had scanty brush cover

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* Measurements of stream depth, width, and velocity were taken at low water level.

at stream edge, since this was a picnic area.

STATION II - Coarse gravel (Figure 2)

The bottom was gravel covered with stones ranging in size up to 5 inches in diameter. The maximum depth was 20 inches and the average width 12 feet. The current velocity was 0.3 feet/second. The stream had abundant brush cover at this station.

STATION III - Fine gravel (Figure 2 and 3)

The bottom consisted of a mixture of fine gravel and stones up to 2 inches in diameter. The maximum depth was 11 inches and the width averaged 17 feet. The current velocity was 1.3 feet/second. The water here was fairly well shaded by brush and small trees.

STATION IV - Riffles (Figure 4)

This station was located just downstream from a stone current-diverter. The bottom was gravel with scattered stones up to 12 inches in diameter. The maximum depth was 19 inches and the average width 16 feet. The current velocity was 1.7 feet/second. The water was well shaded by trees and brush.

STATION V - Sand (Figure 5)

This area was situated just downstream from a pool and was a deposition area. The bottom was fine gravel covered with sand and silt. The maximum depth was 15 inches and the average width 12 feet. The current velocity was 0.8 feet/second. The water here was largely exposed to the sun. Some shade was provided by a low brush cover along the banks.

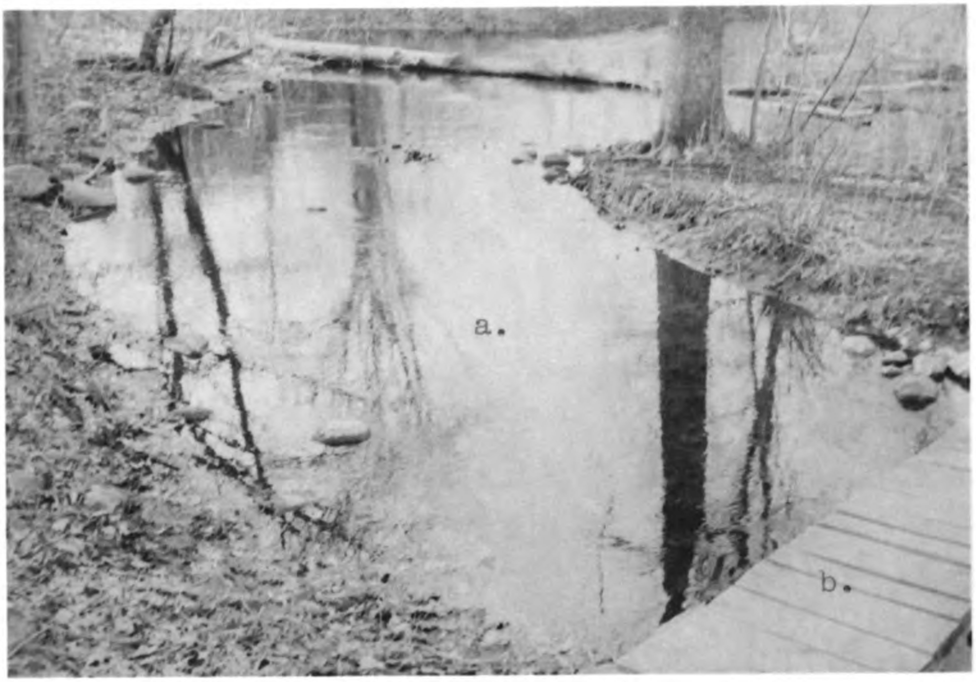

Figure 1

STATION I- Large stone. (a) Sampling area. (b) Foot bridge. Area to left of stream is highly frequented picnic site.

Figure 2

STATION II- Coarse gravel. (a) Sampling area.
(b) Fallen tree which acts as natural dam.
(c) STATION III

Figure 3

STATION III- Fine Gravel. (a) Sampling area.

Figure 4

STATION IV- Riffles. (a) Sampling area.
(b) Part of stone current diverter.

STATION VI AND STATION VII - Silt and muck (Figure 6) These two collecting sites were adjacent to each other and differed only in their bottom types. There was a stone diverter upstream from them and a low stone dam just downstream. The bottom consisted of gravel where the current was swift and gravel covered by silt and muck where the current was slower.

The silt area was located where the current velocity was slow enough to allow the fine silt particles to settle out. The bottom here consisted of a mixture of silt and organic matter.

The muck area was located adjacent to and downstream from the diverter and the bottom consisted of deep organic debris mixed with silt.

The maximum depth in this part of the stream was 21 inches. The water's depth from where the silt was taken was about 15 inches. The depth of water where the muck was located was about 5-10 inches. The average width was 21 feet. The current velocity ranged from 1 foot/second in midstream to zero behind the diverter.

Figure 5

STATION V- Sand. (a) Sampling area.
(b) Pool.

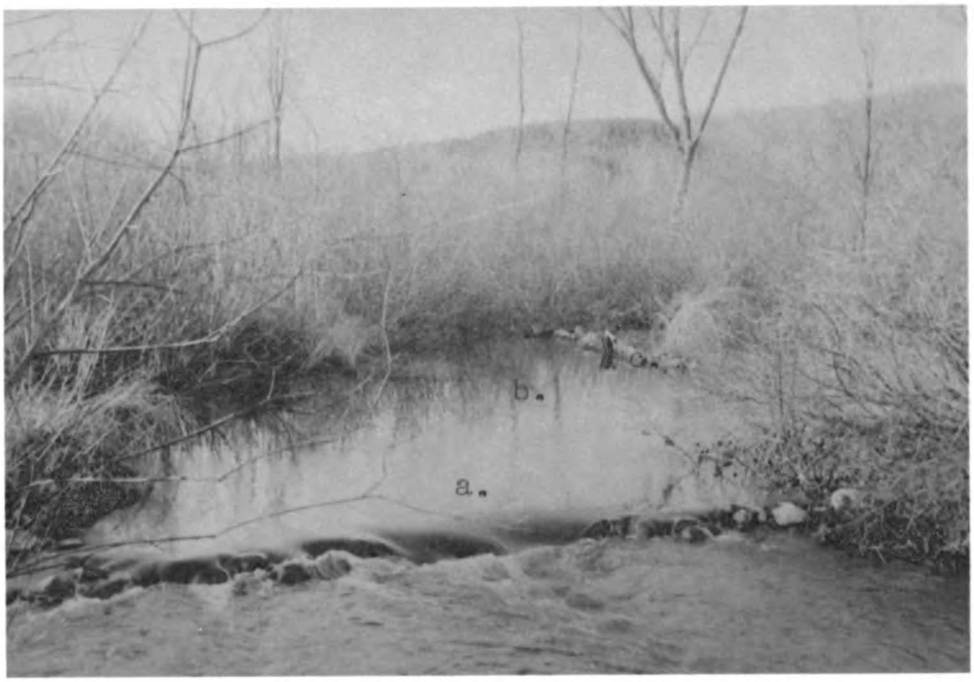

Figure 6

STATIONS VI - Silt; and VII - Muck. (a) Silt bottom. (b) Muck bottom. (c) Log current diverter.

SAMPLING AND SORTING TECHNIQUES

A modification of the Surber sampler, as shown in Figure 7, was used by earlier investigators to sample Augusta Creek. The device was constructed of copper wire screen (part a, Figure 7) and galvanized metal. The galvanized metal sides are held parallel to the current. The copper screen front allows water to flow through the apparatus, but excludes drift organisms from upstream. Bottom materials are dislodged and swept into a removable screen (part c, Figure 7). The bottom material is later removed from this retaining screen and placed into a container for future sorting. This device was heavy and cumbersome to use.

The Surber (1936) square foot bottom sampler (Figure 8) was employed in this study because of its relative efficiency (Leonard, 1939) and its ease in handling. Ease in handling is not so critical during the summer months, but it is of prime importance while taking samples during the winter period.

The use of a Surber sampler is limited to areas where there is an appreciable current. Stations VI and VII with silt and muck and little or no current were sampled by an Ekman dredge (Figure 8).

When using the Surber sampler it was placed firmly on the bottom. If there were gaps under the square foot frame they were filled in using small stones from outside the square foot area. While holding the sampler securely to the bottom the material within the frame was thoroughly agitated. This was done violently enough to dislodge any animals clinging to the bottom or to stone, etc., so they would be swept into the net by the current. Care was taken to include matter in the corners of the frame.

The contents of the net were next transferred to a galvanized pail (Figure 8), and the net rinsed and inspected for any clinging organisms.

The next step was concentration of the sample by sieving. This step was standardized as much as possible. The size of the mesh of the screen can appreciably alter the number of organisms recovered (Jonasson, 1955). A number 40 mesh soil sieve was used for every Surber sampler sorting (Figure 8). Some biologists use a number 28 mesh (Needham and Needham, 1963), but I found that some Chironomidae and Elmidae larvae passed through even the smaller number 40 mesh screen. The material in the pail was swirled vigorously with the hand and immediately decanted through the sieve. The contents of the sieve were rinsed by sloshing it up and down in the water. Care had to be taken not to submerge the upper rim of the sieve while carrying out this rinsing process. By rotating the sieve, while holding it in the water, the contents were congregated to one side. It was then emptied into a wide-mouthed pint jar with preservative. This process was repeated several times or until it appeared there were no more organisms being retained on the screen. The bulk

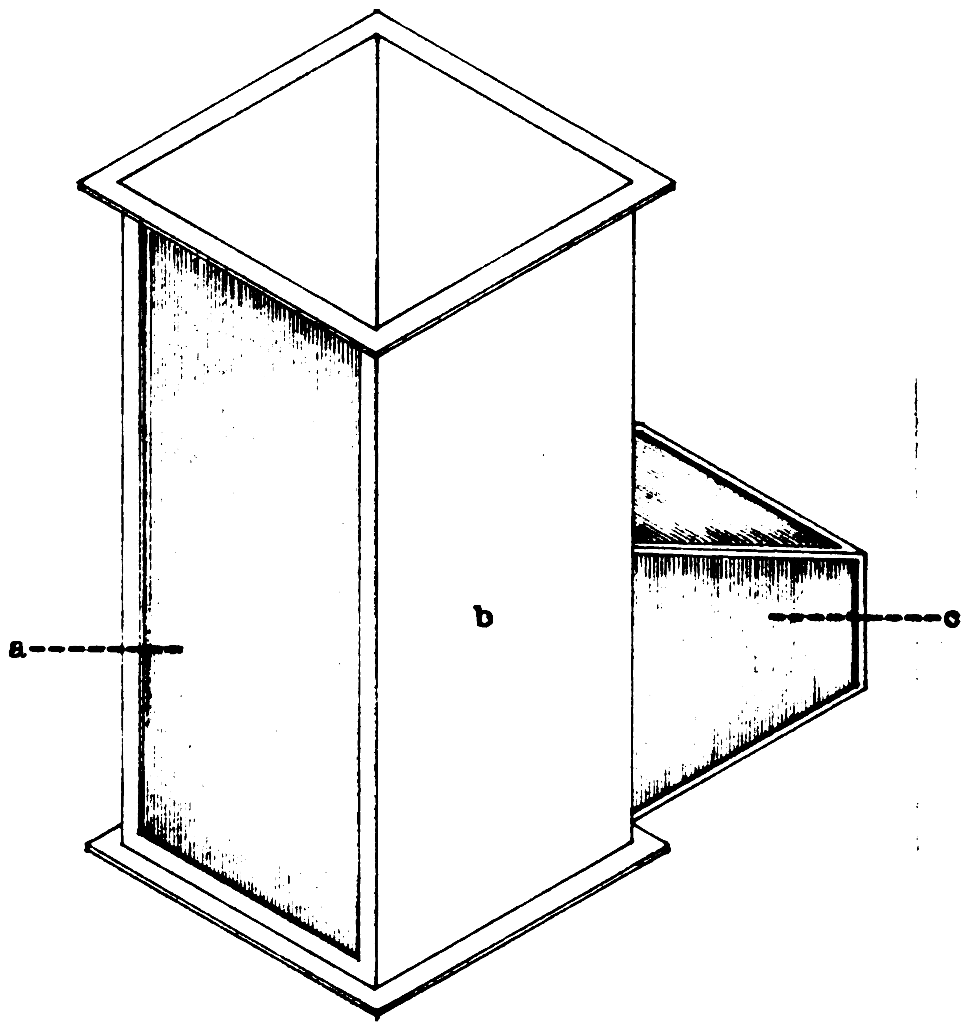

Figure 7

Modified Surber sampler. (a) Copper wire screen front. (b) Galvanized metal side. (c) Detachable retaining screen.

material which was left in the pail was then quickly sorted in a white enamel pan (Figure 8) to recover any Trichoptera cases, snails, clams, etc. which were too dense to decant off. It was evident that most of the heavier organisms were decanted with the lighter matter.

The jar was then labeled, usually a little more preservative added, and stored until it could be sorted in the laboratory.

In using the Ekman dredge the sampler was first "cocked" and then placed upon the area from which a sample was desired. This process was done by hand without a rope. Due to the light consistency of the silt and muck the sampler would have sunk had it been released. It was placed in the bottom to a depth of about two or three inches and then tripped. The sampler was then placed in a galvanized pail about one-fourth full of water. This was done immediately after the sampler was brought above the water otherwise escaping water carried many organisms with it.

The collected material was left in the pail and taken to the Kellogg Biological Station at Gull Lake. Spilling was prevented during the winter by allowing a thin layer of ice to form on the surface of the water before transporting it by automobile. Upon arriving at the laboratory the samples were placed in a screen-bottomed wooden box. The screen size was 80 mesh. The sample was then rinsed with a garden hose which washed

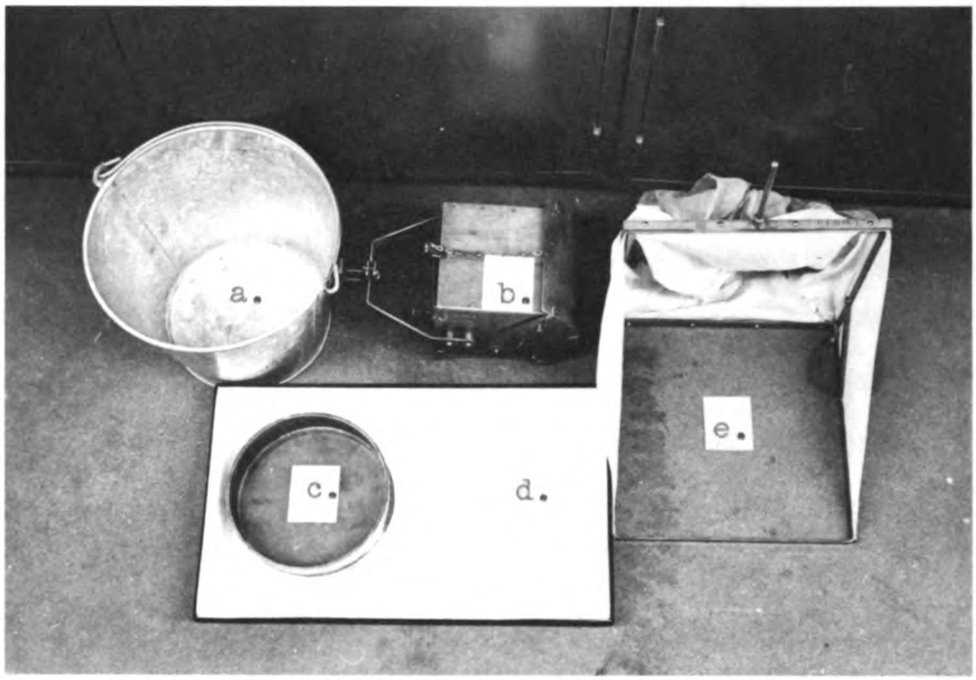

Figure 8

Collecting and sorting equipment. (a) Galvanized pail. (b) Ekman dredge. (c) #40 mesh soil sieve. (d) White enamel pan. (e) Surber square foot bottom sampler with the net folded.

away all the fine inorganic matter. The material was then transferred to a wide-mouthed pint jar with preservative and labeled for future sorting.

When the material was to be sorted it was emptied into a glass fingerbowl. Small amounts of this material (about a teaspoon full) were put into a Syracuse watch glass and examined with a dissecting microscope. The animals were identified to genus and species when possible, counted, and preserved in glass vials.

This sorting technique was extremely time consuming and a modification of it was put into use. A circle with a diameter equal to that of the bottom half of a glass petri dish was marked off on a white peice of cardboard. This circle was then subdivided into eight equal "pie slices." Material was then taken from the finger bowl and placed into the petri dish. It was then stirred to accomplish random distribution of any organisms present. The petri dish was then placed over this subdivided circle. The material from one of these "pie slices" was then transferred to a Syracuse watch glass, examined, sorted, identified, and preserved. The number of animals picked from the Syracuse watch glass was multiplied by eight. If the sample was taken with an Ekman dredge it was also multiplied by four since this sampler takes only ¼ square foot of bottom sample. Larger animals such as crayfish, etc. were sorted directly and were not multiplied by eight. Much time was saved by using this sorting procedure.

By using a dissecting microscope to observe the sample, many Chironomidae, Tipulidae, and Elmidae larvae one millimeter in length or less were recovered. These animals would have been missed had the sample been sorted in the field.

A floating magnifying glass with self-contained fluorescent bulbs was found to be extremely helpful in finding the larger animals.

The preservative used was a mixture of 10 parts - 95% ethanol; 10 parts - water; 1 part - formaldehyde. The formaldehyde concentration was low enough so that it was not irritating to the eyes and nose while observing the sample at close range. Its presence, however, prevented spoilage of the sample when large amounts of organic matter were included.

RESULTS

Tables V-XII show by month and station the kinds and number of bottom organisms collected from Augusta Creek. It will be noted there are three months not listed between the period of August, 1961 and June, 1962. Samples were not collected during the months of October and November 1961 and April 1962. The October and November samples were not taken due to an incapacitating illness. An unusual occurence rendered the taking of the April sample impossible. Upon entering the stream, it was discovered the bottom was completely covered with a green "scum." An attempt was made to secure a sample with the Surber sampler, but the dislodged algae floated into and plugged the sampler's net. This caused the remaining material to flow around the net opening and downstream. The algae were a mixture of filamentous blue-green (Oscillatoria sp.) and a number of genera of diatoms. The diatoms seemed to be entangled in the fibers of the Oscillatoria sp. By May the growth of these algae had subsided sufficiently to allow samples to be taken. Also, the STATION IV (Riffle) sample for June, 1962 was accidentally destroyed and is therefore not listed.

The organisms taken during the eight months totaled 26,171. Table IV shows the monthly distribution of this total. The number of bottom animals steadily increased from August to February when the stream reached its peak in productivity. Of the total organisms taken, 67% were collected during the months of January, February, and March.

Table XIII shows the distribution of benthic fauna by station for each month. Table III shows the distribution of total organisms with respect to bottom type. Most of the animals were collected from the first four stations. The largest number of organisms were taken from a fine gravel bottom (STATION III).

Table II shows the distribution of the total number of organisms by taxonomic groups. The Diptera contributed 67.89% to the total animals collected and of the Diptera 54.75% were Chironomidae.

Table I contains a taxonomic list of the aquatic insects collected both in bottom samplings and random samplings during 1961-1962. Some of the insects listed were taken in random samples but not in bottom samples.

Table XIV-XV shows Fetterolf's (1951) results from his summer samplings of 1951. Tables XVI-XVII show the percent distribution of bottom organisms in relation to bottom composition and distribution of total organisms by taxonomic groups according to Fetterolf's findings. These samplings were done with a modified Surber sampler (Figure 7).

Table I

Qualitative list of insects collected
from Augusta Creek during 1961-1962

PODURIDAE	Podura
PTERONARCIDAE	Pteronarcys
NEMOURIDAE	Taeniopteryx
EPHEMERIDAE	Ephemera, Hexagenia
BAETIDAE	Caenis, Isonychia, Tricorythodes
HEPTAGENIIDAE	Stenonema
GOMPHIDAE	Ophiogomphus, Gomphus
AESCHNIDAE*	
LIBELLULIDAE*	
AGRIONIDAE*	Agrion*
SIALIDAE	Sialis
CORYDALIDAE	Chauloides
RHYACOPHILIDAE	Glossosoma
HYDROPSYCHIDAE	Hydropsyche
LIMNEPHILIDAE	Neophylax, Pycnopsyche
LEPTOCERIDAE	Mystacides, Oecetis
HELICOPSYCHIDAE	Helicopsyche
PSYCHOMYIIDAE*	Psychomyia*
ELMIDAE	Optioservus
PSEPHENIDAE	Ectopria
TIPULIDAE	Tipula, Antocha
DIXIDAE*	Dixa*
SIMULIIDAE	Simulium
CHIRONOMIDAE	
RHAGIONIDAE	Atherix

* Collected by dip net only.

Table II

Percent distribution of total organisms collected

GROUP	PERCENT
PODURIDAE	0.02%
PTERONARCIDAE	0.004
NEMOURIDAE	0.45
EPHEMERIDAE	0.60
BAETIDAE	2.21
HEPTAGENIIDAE	0.41
GOMPHIDAE	0.40
CORYDALIDAE	0.004
SIALIDAE	0.02
RHYACOPHILIDAE	0.16
HYDROPSYCHIDAE	1.16
HELICOPSYCHIDAE	0.03
LIMNEPHILIDAE	0.12
ELMIDAE	4.16
PSEPHENIDAE	0.38
TIPULIDAE	12.13
SIMULIIDAE	0.26
CHIRONOMIDAE	54.75
RHAGIONIDAE	0.75
OLIGOCHAETA	18.77
AMPHIPODA	0.11
DECAPODA	0.16
MOLLUSCA	2.27
NEMATODA	0.34
HYDRACARINA	0.35

Table III

Distribution of total organisms according to bottom composition

STATION	TYPE	PERCENT
I	Large stone	10.9%
II	Coarse gravel	21.0
III	Fine gravel	27.2
IV	Riffle	19.8
V	Sand	3.7
VI	Silt	7.1
VII	Muck	10.3

Table IV

Monthly distribution of total organisms collected

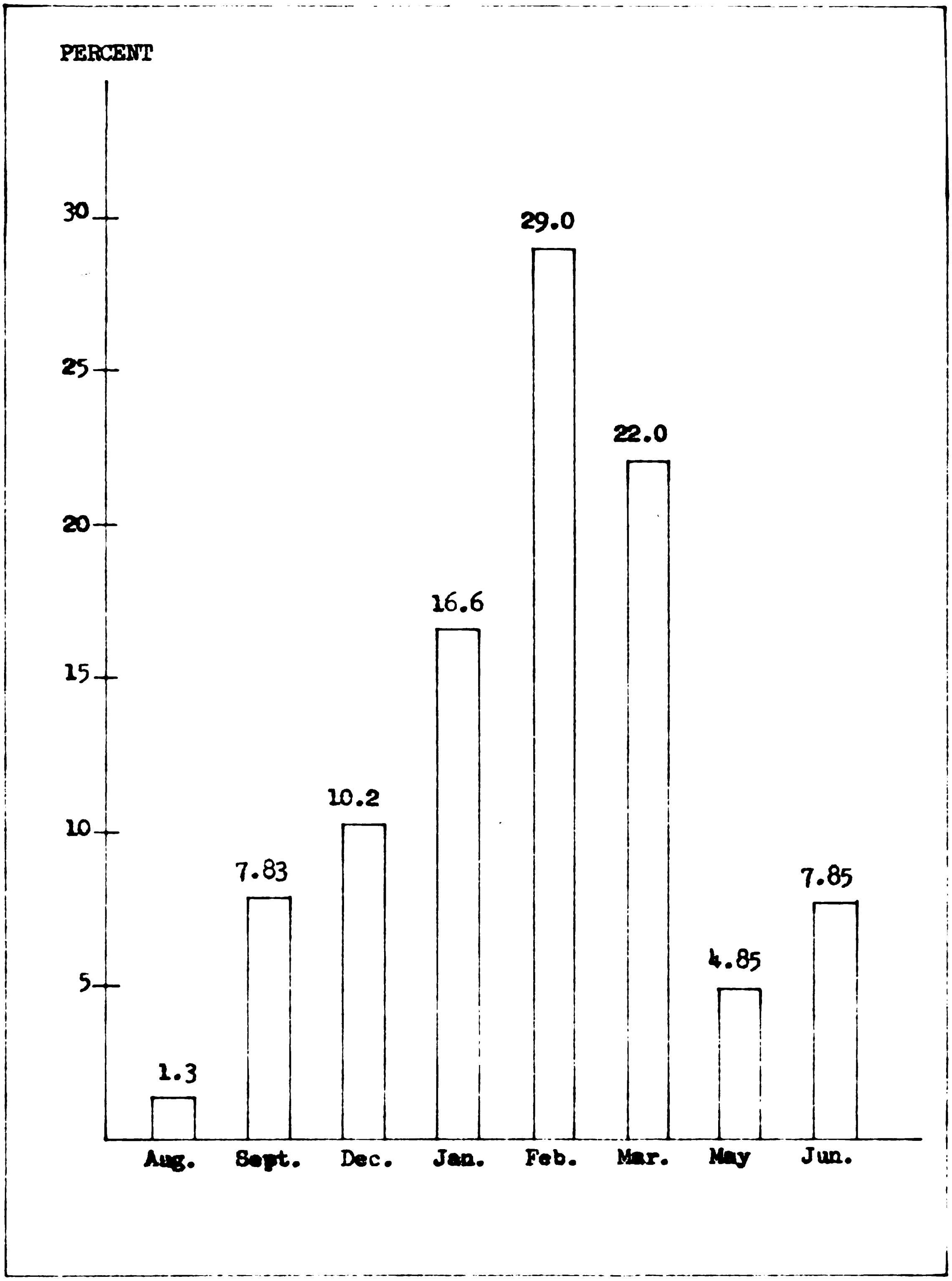

Table V

August 25, 1961

STATION----------	I	II	III	IV	V	VI	VII	
BOTTOM TYPE-------	Large stone	Coarse gravel	Fine gravel	Riffle	Sand	Silt	Muck	
TYPE OF ORGANISM	NUMBER PER SQUARE FOOT							TOTAL
PODURIDAE				1				1
EPHEMERIDAE	2	2		1	1		5	11
BAETIDAE	3	5	2	5	4			19
HEPTAGENIIDAE	3		1					4
GOMPHIDAE					3	7	1	11
SIALIDAE							3	3
HYDROPSYCHIDAE		1	1	3				5
LIMNEPHILIDAE			1					1
HELICOPSYCHIDAE					2			2
ELMIDAE	1		3	35				39
PSEPHENIDAE		1	1		1			3
TIPULIDAE			1	2				3
CHIRONOMIDAE	4	15	12		28	1	15	75
OLIGOCHAETA						2	47	49
AMPHIPODA	2	3		1				6
DECAPODA	2	1		8			1	12
MOLLUSCA	3	4	14	11	54	1	3	90
NEMATODA	2		2					4
HYDRACARINA			4					4
TOTAL	22	32	42	67	92	11	75	341

Table VI

September 28, 1961

STATION-----------	I	II	III	IV	V	VI	VII	
BOTTOM TYPE-------	Large stone	Coarse gravel	Fine gravel	Riffle	Sand	Silt	Muck	
TYPE OF ORGANISM			NUMBER PER SQUARE FOOT					TOTAL
EPHEMERIDAE	1	19	2	3	4	16		45
BAETIDAE	9	40	12	67	4			132
HEPTAGENIIDAE	6			1				7
GOMPHIDAE	1		1			20	20	42
HYDROPSYCHIDAE	10	2		15				27
HELICOPSYCHIDAE			1	3				4
ELMIDAE		5	36	29	8			78
PSEPHENIDAE		8	1	1				10
TIPULIDAE	33	2	20	139		4		198
SIMULIIDAE			1					1
CHIRONOMIDAE	15	22	657	109	44	60	60	967
RHAGIONIDAE		1	4	4				9
OLIGOCHAETA		166	85		44	12	144	451
AMPHIPODA	2	1						3
DECAPODA	3			2				5
MOLLUSCA	3		7	18	16	8		52
NEMATODA			7					7
HYDRACARINA	1	5	2		4			12
TOTAL	84	266	839	393	120	124	224	2050

Table VII

December 1, 1961

STATION-----------	I	II	III	IV	V	VI	VII	
BOTTOM TYPE-------	Large stone	Coarse gravel	Fine gravel	Riffle	Sand	Silt	Muck	
TYPE OF ORGANISM	NUMBER PER SQUARE FOOT							TOTAL
NEMOURIDAE	2	2	3					7
EPHEMERIDAE	2	2						4
BAETIDAE	1	6		2				9
HEPTAGENIIDAE	4		1	1				6
GOMPHIDAE						8		8
SIALIDAE				1				1
RHYACOPHILIDAE			2	6				8
HYDROPSYCHIDAE	1	1	6	21				29
LIMNEPHILIDAE	3	2	4			4		13
HELICOPSYCHIDAE					1			1
ELMIDAE	3	7	70	131	3	4		218
PSEPHENIDAE	1	1	4	3				9
TIPULIDAE	12	31	86	166	4		8	307
CHIRONOMIDAE	162	278	385	243	59	28		1155
RHAGIONIDAE	1	10	44	4				59
OLIGOCHAETA	138	38	10	11	81	480	4	762
AMPHIPODA	2							2
DECAPODA	1		2					3
MOLLUSCA	2	3	3	6	25	8		47
NEMATODA		2		1	3			6
HYDRACARINA			4	23				27
TOTAL	335	383	624	619	176	532	12	2681

Table VIII

January 24, 1962

STATION	I	II	III	IV	V	VI	VII	
BOTTOM TYPE	Large stone	Coarse gravel	Fine gravel	Riffle	Sand	Silt	Muck	
TYPE OF BOTTOM	NUMBER PER SQUARE FOOT							TOTAL
NEMOURIDAE	11	8	17	10		28		74
EPHEMERIDAE		4		1				5
BAETIDAE	1							1
HEPTAGENIIDAE	9	3		20		8		40
GOMPHIDAE	1							1
CORYDALIDAE	1							1
RHYACOPHILIDAE		2	4	2				8
HYDROPSYCHIDAE		3	11	35		8		57
LIMNEPHILIDAE	2	1	3	1				7
ELMIDAE	13	13	87	66	1			180
PSEPHENIDAE	1	13	9	2				25
TIPULIDAE	53	115	282	281	1	20		752
SIMULIIDAE	39		1	2				42
CHIRONOMIDAE	120	562	1273	581	3	216	12	2767
RHAGIONIDAE	1	3	41	5				50
OLIGOCHAETA	24	50	20	8	1	4	108	215
AMPHIPODA				1				1
DECAPODA	2			3				5
MOLLUSCA	3	6	37	8	22		12	88
NEMATODA	2		12	2				16
HYDRACARINA	1		7	9				17
TOTAL	284	783	1804	1037	28	284	132	4352

Table IX

February 25, 1962

STATION	I	II	III	IV	V	VI	VII	
BOTTOM TYPE	Large stone	Coarse gravel	Fine gravel	Riffle	Sand	Silt	Muck	
TYPE OF ORGANISM	NUMBER PER SQUARE FOOT							TOTAL
PODURIDAE			2	2				4
NEMOURIDAE	16		10					26
EPHEMERIDAE	48	10						58
BAETIDAE		24				4		28
HEPTAGENIIDAE	16		1	23				40
GOMPHIDAE			1					1
RHYACOPHILIDAE			2	10				12
HYDROPSYCHIDAE		2	4	80		8		94
LIMNEPHILIDAE		1	2	2				5
HELICOPSYCHIDAE				1				1
ELMIDAE	24	19	32	216	1			292
PSEPHENIDAE		1	5	3				9
TIPULIDAE	24	80	333	580	2	4		1023
CHIRONOMIDAE	888	960	2140	1136	8	4	16	5152
RHAGIONIDAE	16		24	4				44
OLIGOCHAETA	56	72	35		1		524	688
DECAPODA	1			5				6
MOLLUSCA	1	34	35	8	20	4		102
NEMATODA			11	7				18
HYDRACARINA	8	8		1				17
TOTAL	1098	1211	2637	2078	32	24	540	7620

Table X

March 20, 1962

STATION	I	II	III	IV	V	VI	VII	
BOTTOM TYPE	Large stone	Coarse gravel	Fine gravel	Riffle	Sand	Silt	Muck	
TYPE OF ORGANISM	NUMBER PER SQUARE FOOT							TOTAL
NEMOURIDAE		8	1	1				10
EPHEMERIDAE	1		5					6
BAETIDAE	2							2
HEPTAGENIIDAE	1							1
GOMPHIDAE						8		8
RHYACOPHILIDAE		10	1					11
HYDROPSYCHIDAE	1	10	2	4				17
LIMNEPHILIDAE		2		1				3
ELMIDAE	5	36	11	16	1		4	73
PSEPHENIDAE		1						1
TIPULIDAE	32	512	14	160	4		4	726
SIMULIIDAE	1	3	2		4			10
CHIRONOMIDAE	484	1352	504	512	45	256	56	3209
RHAGIONIDAE	1	4			1			6
OLIGOCHAETA	52	6	20		168	192	1184	1622
DECAPODA	2							2
MOLLUSCA	8	8	1	10	33	2		62
NEMATODA	3	8	12		1			24
HYDRACARINA		1	1	1				3
TOTAL	595	1961	574	705	257	458	1248	5796

Table XI

May 16, 1962

STATION------------	I	II	III	IV	V	VI	VII	
BOTTOM TYPE--------	Large stone	Coarse gravel	Fine gravel	Riffle	Sand	Silt	Muck	
TYPE OF ORGANISMS			NUMBER PER SQUARE FOOT					TOTAL
PTERONARCIDAE		1						1
EPHEMERIDAE	5		2					7
BAETIDAE	17	17	25	81				140
HEPTAGENIIDAE	8							8
GOMPHIDAE	1	1	1		4	8		15
RHYACOPHILIDAE		3						3
HYDROPSYCHIDAE		1						1
LIMNEPHILIDAE				1				1
HELICOPSYCHIDAE				2				2
ELMIDAE	1	15	6	36	4			62
PSEPHENIDAE				9				9
TIPULIDAE	2	48	32	36				118
SIMULIIDAE		5	2	3	4			14
CHIRONOMIDAE	168	168	192	83	32	16		659
RHAGIONIDAE	6	2	4	16				28
OLIGOCHAETA	115	10	5				4	134
MOLLUSCA	2	9	5		12	20		48
NEMATODA		1	2	8		4		15
HYDRACARINA		2	1					3
TOTAL	325	283	277	275	56	48	4	1268

Table XII

June 25, 1962

STATION------------	I	II	III	IV	V	VI	VII	
BOTTOM TYPE--------	Large stone	Coarse gravel	Fine gravel	Riffle	Sand	Silt	Muck	
TYPE OF ORGANISM			NUMBER PER SQUARE FOOT					TOTAL
EPHEMERIDAE	8						12	20
BAETIDAE	24	184	40					248
GOMPHIDAE		2			5	4	8	19
HYDROPSYCHIDAE		73						73
LIMNEPHILIDAE		1						1
ELMIDAE		118			8	12	8	146
PSEPHENIDAE		25	8					33
TIPULIDAE		40	8					48
CHIRONOMIDAE	8	104	104		16	36	76	344
OLIGOCHAETA	24	8	136		152	320	352	992
AMPHIPODA	16							16
DECAPODA	7	2			1			10
MOLLUSCA	12	24	32		32		4	104
HYDRACARINA		8						8
TOTAL	99	589	328		214	372	460	2062

Table XIII

Monthly distribution of organisms per station

August

STATION	BOTTOM TYPE	PERCENT	RANK
I	Large stone	5.9%	6
II	Coarse gravel	9.4	5
III	Fine gravel	12.3	4
IV	Riffle	19.6	3
V	Sand	27.2	1
VI	Silt	3.2	7
VII	Muck	21.9	2

September

STATION	BOTTOM TYPE	PERCENT	RANK
I	Large stone	4.1	7
II	Coarse gravel	13.0	3
III	Fine gravel	41.0	1
IV	Riffle	19.2	2
V	Sand	5.9	6
VI	Silt	6.1	5
VII	Muck	10.9	4

December

STATION	BOTTOM TYPE	PERCENT	RANK
I	Large stone	12.5	5
II	Coarse gravel	14.3	4
III	Fine gravel	23.2	1
IV	Riffle	23.0	2
V	Sand	6.6	6
VI	Silt	19.8	3
VII	Muck	0.5	7

January

STATION	BOTTOM TYPE	PERCENT	RANK
I	Large stone	6.6	4
II	Coarse gravel	18.0	3
III	Fine gravel	41.5	1
IV	Riffle	23.8	2
V	Sand	0.6	7
VI	Silt	6.5	5
VII	Muck	3.0	6

Table XIII (Continued)

February

I	Large stone	14.4	4
II	Coarse gravel	15.9	3
III	Fine gravel	34.6	1
IV	Riffle	27.3	2
V	Sand	0.4	6
VI	Silt	0.3	7
VII	Muck	7.1	5

March

I	Large stone	10.2	3
II	Coarse gravel	34.0	1
III	Fine gravel	9.9	5
IV	Riffle	12.2	4
V	Sand	4.5	7
VI	Silt	7.9	6
VII	Muck	21.6	2

May

I	Large stone	25.6	1
II	Coarse gravel	22.3	2
III	Fine gravel	21.8	3
IV	Riffle	21.6	4
V	Sand	4.4	5
VI	Silt	3.8	6
VII	Muck	0.3	7

June

I	Large stone	4.8	6
II	Coarse gravel	28.6	1
III	Fine gravel	15.9	4
IV	Riffle	(Sample destroyed)	
V	Sand	10.4	5
VI	Silt	18.0	3
VII	Muck	22.3	2

Table XIV

(Data from Fetterolf, 1951)

June 28, 1951

STATION*	II	III	V	VI	VII	
BOTTOM TYPE	Coarse gravel	Fine gravel	Sand	Silt	Muck	
TYPE OF ORGANISM	NUMBER PER SQUARE FOOT					TOTAL
EPHEMERIDAE	15	1	1		22	39
ODONATA		1		1		2
TRICHOPTERA	7	4	12	3	8	34
COLEOPTERA	4	3		3	4	14
TIPULIDAE	9					9
CHIRONOMIDAE	210	50	52	74	31	417
EMPIDAE	1					1
RHAGIONIDAE	1					1
OLIGOCHAETA				78	11	89
AMPHIPODA	3	3			5	11
DECAPODA	1					1
MOLLUSCA	121	161	426	1	37	746
NEMATODA	1	1				2
HYDRACARINA	22	6	2	32	22	84
TOTAL	395	230	493	192	140	1450

* These stations used by Fetterolf are identical to the ones used by this author while studying Augusta Creek.

Table XV

(Data from Fetterolf, 1951)

August 29, 1951

STATION*	II	III	V	VI	VII	
BOTTOM TYPE	Coarse gravel	Fine gravel	Sand	Silt	Muck	
TYPE OF ORGANISM	NUMBER PER SQUARE FOOT					TOTAL
EPHEMERIDAE	7	1		2	1	11
ODONATA					3	3
NEUROPTERA				1		1
TRICHOPTERA	18	8	17		31	74
COLEOPTERA	8	8			2	18
TIPULIDAE	8	2				10
CHIRONOMIDAE	109	40	11	26	22	208
EMPIDAE	12					12
RHAGIONIDAE	3	2	2			7
OLIGOCHAETA		1		44	59	104
AMPHIPODA	8					8
DECAPODA					1	1
MOLLUSCA	53	290	250		68	661
NEMATODA	1	1	1		1	4
HYDRACARINA	11	8	2	7	2	30
TOTAL	238	361	283	80	190	1152

* See foot-note, page 39.

Table XVI

Percent distribution of total organisms collected during the summer, 1951 (Data from Fetterolf, 1951)

GROUP	PERCENT
EPHEMERIDAE	1.92%
ODONATA	0.19
NEUROPTERA	0.04
TRICHOPTERA	4.15
COLEOPTERA	1.23
TIPULIDAE	0.73
CHIRONOMIDAE	24.02
EMPIDAE	0,50
RHAGIONIDAE	0.31
OLIGOCHAETA	7.42
AMPHIPODA	0.73
DECAPODA	0.08
MOLLUSCA	54.07
NEMATODA	0.23
HYDRACARINA	4.38

Table XVII

Distribution of total organisms according to bottom composition during the summer, 1951
(Data from Fetterolf, 1951)

STATION	TYPE	PERCENT
II	Coarse gravel	24.33%
III	Fine gravel	22.71
V	Sand	29.82
VI	Silt	10.45
VII	Muck	12.68

DISCUSSION

The seven sampling stations included large stone, coarse gravel, fine gravel, sand, silt, and muck. Homogeneous habitats, however, do not exist. As Armitage (1958) pointed out, a riffle is a series of intergrading communities. It was not the object of this study to determine the total number of species and quantities of organisms in a particular area of stream; but, rather to acquire knowledge of the relative number of bottom organisms for a fairly uniform type of bottom.

Table I shows a qualitative list of aquatic insects taken in both the quantitative sampling and in random samples taken with dip net in the same vicinity. Some species collected by dip net did not occur in the bottom samples. The quantitative samples were taken in mid-stream, where there was greatest current velocity, and the random dip net samples were taken both at mid-stream and near the stream bank. As Needham and Usinger (1956) showed, bottom fauna show a definite preference for various depths and current velocities. They pointed out some animals prefer slow, shallow water, while others select fast, deep water.

Of the seven sampling stations three of the produced the greatest number of organisms. These three were Station II (Coarse gravel), Station III (Fine gravel), and Station IV (Riffle). Station III (Table III) produced the most animals of any collecting site contributing 27.2% of the total 26,171 organisms taken. Armitage (1958) reviewed some of the literature concerning the most important limiting factors determining the quantity of bottom fauna. Some of these were water depth, volume, velocity, temperature, alkalinity, bottom composition, etc. Probably prime importance should not be placed on any of these factors, for the sum of these will determine the suitability of a particular habitat for a particular species. It would be rare to find two habitats in two streams where all of these conditions were equal or, indeed, two habitats in the same stream which were identical. But, one riffle has similarities to other riffles and dissimilarities with respect to composition of bottom materials to silt, muck, etc. Certain fauna inhabit most gravel bottoms which would not be present in comparable numbers on sand, silt, or muck bottoms. It is apparent from Table II that Ephemeroptera, Coleoptera, Trichoptera, and Diptera were the most abundant insects collected, the Diptera representing 67.89% of the total. They showed a preference for those stations with gravel substrata (Table III). Needham and Needham (1963) claim the riffles to be the "larders" of streams while pools are usually poor in numbers. Pennak and Van Gerpen (1947) found the greatest wet weights of organisms on rubble and the least on sand bottoms. Of the total organisms which they collected Ephemeroptera and Diptera made up 91.6% of the total.

The number of bottom animals in Augusta Creek began increasing in September and reached a peak in February, and then decreased steadily toward summer with a slight increase of June over March (Table IX). Maciolek and Needham (1951) found a similar peak in February with a low in August. Needham (1934) found a peak in May and a lesser one in November. This phenomenon follows the life cycle pattern of the aquatic insects present. During the summer the larvae and naiads had become adults. Since, with few exceptions, insects do not emerge in winter the greatest numbers present were larvae and naiads. With the entire quantity of eggs hatching and the immatures undergoing growth the amounts of fauna in both weight and number were at their peak in about mid-winter. There is an interesting possibility for an explanation of the sudden drop in numbers in May and then a slight increase in June. Waters (1962) showed that mechanical disturbances to the stream bottom had a definite effect on the benthos. Needham and Needham (1963) pointed out that floods drastically reduce the numbers present. The drop in number in Augusta Creek in May was caused by a combination of these factors. The trout fishing season opened on April 27.

The wading of fishermen undoubtedly caused a tremendous disturbance to the bottom. Also, during the latter part of April and May the stream was high, often overflowing its banks. In June the water level began receding, and the fishing pressure slackened off. This allowed the bottom fauna to begin re-establishing itself. The overall decrease in the number of bottom organisms from February to June was probably due to adult emergence. I observed an emergence of stoneflies (Taeniopteryx sp.) on February 25, 1962. The adult insects were walking about on the snow. I also observed midges (Chironomidae) flying about in late winter and early spring.

Table XIII shows that over 20% of the total number of bottom organisms collected for each month of August, March, and June were from a muck bottom (Station VIII). The non-insect groups were the contributing factor to these relatively high percentages, especially the Oligochaeta. In the overall survey Chironomidae and Tipulidae were the most abundant.

Since Augusta Creek is an experimental trout stream, it was of interest to determine the availability of natural food. It was known that aquatic insects were an important constituent in the diet of brook, rainbow, and brown trout (Morofsky, 1940). In brook trout, Needham (1930) found that insects formed 94.92% of the aquatic diet. He also found insects belonging to the orders Diptera, Ephemeroptera, and Trichoptera composed about 66% of all the foods taken by brook trout. It was evident these orders of insects were abundant enough in Augusta Creek to support a substantial trout population.

Fetterolf (Tables XIV-XVII) sampled Augusta Creek during June and August of 1951. His analyses showed a high percentage of Chironomidae and a good representation of Mollusca, Ephemeroptera, and Trichoptera. Fetterolf's findings indicated a similarity to my studies of 1961-1962, however during his 1951 sampling the non-insect groups were dominated by Mollusca and in 1961-1962 these were replaced by the Oligochaeta. No significant changes in the insect fauna are apparent after this ten year span.

It should be pointed out that both Fetterolf (1951) and myself counted all snail "shells" with no discrimination between living and dead ones. This makes the high percentage of Molluscs in both these studies misleading. If this group is omitted, Fetterolf's data shows the gravel bottom to be the most productive rather than the sand. Also, the Chironomidae are the most abundant organisms, and the Oligochaeta the most abundant non-insect group.

In August, 1960, there was a serious fish kill in Augusta Creek extending from a point 0.2 mile below the 43rd street bridge, Sec. 10, Ross Township, Kalamazoo

Co. to a point about 5.5 miles downstream (Fetterolf, 1960). The poison was believed to have been rotenone of unknown origin. There was some interest to know to what extent the bottom fauna were affected by this poison. It is shown in this paper that Arthropoda were at least as abundant one year following the kill as they were ten years previously. According to Smith's (1939-1940) findings, there was a good possibility the insect inhabitants of Augusta Creek were not greatly affected by the rotenone. Walter Lemmien, Resident Supervisor of W. K. Kellogg Forest, said trout were planted in Augusta Creek in the spring following the August 1960 fish kill. Evidence indicated the natural food present was sufficient to support trout and the creel census for the fishing season that year was average.

SUMMARY

1. A distribution study was conducted on Augusta Creek, Kalamazoo County from August 1961 to June 1962 to determine a correlation between types and numbers of benthic fauna, bottom composition, and seasonal changes. Also, a comparison was made between the results of this study and those obtained ten years previously by Fetterolf (1951) to indicate the possible effect of a fish kill which occurred during August, 1960.

2. The section of Augusta Creek studied was that portion flowing through the W.K. Kellogg Forest. This part of the stream has been the object of a prolonged improvement study begun in 1934.

3. Samples were collected using the Surber square foot bottom sampler and the Ekman dredge. The Ekman dredge was employed to sample the soft bottom, slow current areas where the Surber sampler was ineffective.

4. The samples were concentrated by sieving and preserved in pint jars for later sorting and identification. A sectioning procedure was initiated into the sorting process which proved to be greatly time saving.

5. The organisms were identified to genus and species when possible. They have been recorded in the tables at the family level (insects) or higher (Mollusca, Oligochaeta, etc.). This level of classification has often been used in the literature concerning stream

bottom studies.

6. There were a total of 26,171 bottom animals collected. Of this total 67% were collected during January, February, and March. The group of animals most numerous were the Diptera representing 67.89% of the total. The station contributing the most bottom organisms was Station III (Fine gravel) with 27.2% of the total.

7. The results indicate no major changes have occurred since Fetterolf's studies in 1951. It appears, however, there has been a shift in the dominant group of organisms from the Mollusca to the Chironomidae. This shift has also been accompanied with a change in the most productive bottom type; the sand being replaced by the fine gravel bottom in importance.

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