FOR ADMINISTRATIVE USE

WATER POLLUTION SURVEILLANCE SYSTEM
APPLICATION AND DEVELOPMENT REPORT
#17

The Use of Limestone-Filled Samplers for Collecting Macroinvertebrates From Large Streams

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Many suggestions have been made in developing samplers which can be used for collecting macroinvertebrates in large rivers. The efforts and contributions of Dr. E. B. Henson and Mr. L. B. Tebo, Jr., who formerly worked in the Aquatic Biology unit, are acknowledged.

Summary

1. Two limestone-filled, artificial substrate samplers for the collection of macroinvertebrates in large streams are described, and summary data from three sampling locations given.
2. The samplers facilitate the collection of stoneflies, caddisflies, mayflies, midges, coelenterates, and bryozoans which are often difficult to obtain with dredges in large streams.
3. The cubical and cylindrical substrate samplers collect a large number and variety of macroinvertebrates. Some organisms, however, such as worms, clams, and certain midges, normally found in bottom sediments, are collected in relatively few numbers.
4. There was no discernable difference in the number and variety of organisms collected by the cubical sampler and the cylindrical sampler.
5. The number of organisms collected in a sampler varied considerably with the time of year.
6. Variations in macroinvertebrate populations that inhabit the samplers are useful in indicating trends in water quality.

Recommendation

The cylindrical substrate sampler is a low-cost, easily obtainable, and durable sampler. It collects macroinvertebrates with equal or greater effectiveness than any other known substrate sampler. It is recommended that this sampler be used as the standard type for Water Pollution Surveillance System studies.

Introduction

A number of artificial substrate samplers have been built by investigators to facilitate or improve sampling. Scott (1958) developed a "brush box" consisting of a cube of 1/4 inch mesh hardware cloth which was filled with sticks, stones, and other stable substrates. Hester and Dendy (1962) constructed a "multiple-plate sampler" with eight, 3 in. square, 1/8 in. tempered hardboard plates separated by seven, smaller 1 in. square, 1/8 in. hardboard. Cauthron (1961) used a sampler in which weathered sticks and Spanish moss were enclosed with ordinary window screen. Henson (1965) described the cubical sampler in use by the Water Pollution Surveillance System which consists of an 8 in. angle iron, cubical framework lined with 1/2 in. hardware cloth.

Benthic sampling of large streams is difficult due, in part, to the variety of natural substrates encountered. Representative bottom sampling is difficult even within a limited area because of shifting substrates, stream flow, and a host of other physical factors. Dredges or similar devices which cut or scrape the bottom are used extensively by aquatic biologists. This method usually produces a poor variety of macroinvertebrates and quite often a relatively small number of individuals. It is distressing to spend many hours sorting through sand and debris to find only a few worms, midges, and mollusks.

In the Water Pollution Surveillance System there was a need to develop a method for collecting macroinvertebrates in large streams that was simple and effective. Also, a sampler that could be serviced by persons with different backgrounds of training and experience was desirable.

For these reasons, the "Cubical" and "Cylindrical" artificial substrate samplers were devised for the collection of macroinvertebrates. Data on the populations collected during the summer and fall of 1965 were compared from three locations.

Description of the Cubical and Cylindrical Substrate Samplers

Cubical substrate sampler

The cubical sampler (Figs. 1 and 3) consists of 1/8 X 1 X 1 in. angle iron welded into a cubical frame with sides approximately 8 in. square. It is lined with 1/2 in. mesh, 19-gauge hardware cloth, and one side is removable. The cube is filled with 0.25 cu. ft. of 1 to 2 in. crushed limestone. The loaded sampler weighs approximately 35 lb. It has been suspended by 1/8 in. wire cable from stationary structures. Cost per unit is from $9 to $12 including labor and 10 ft. of cable. Rusting of the hardware cloth is sometimes a problem and has required replacement in as little as 3 months when the sampler is used in corrosive water.

Cylindrical substrate sampler

The cylindrical sampler (Figs 2 and 3) is a spot-welded, chrome-plated Bar-B-Q[1] basket manufactured by the Hewitt Manufacturing Company, National City, California, and is available at less than $2.00 each if bought in quantities. The cylindrical basket is formed of 2-mm steel wire, braced by four, 4-mm steel rods. It is corrosion resistant and strong. The sampler contains 0.2 cu. ft. of limestone and weighs 20 lb. The sampler opens its entire length for easy placement or removal of the rocks.

[1]Mention of commercial sources or products does not constitute endorsement by the Water Pollution Control Administration.

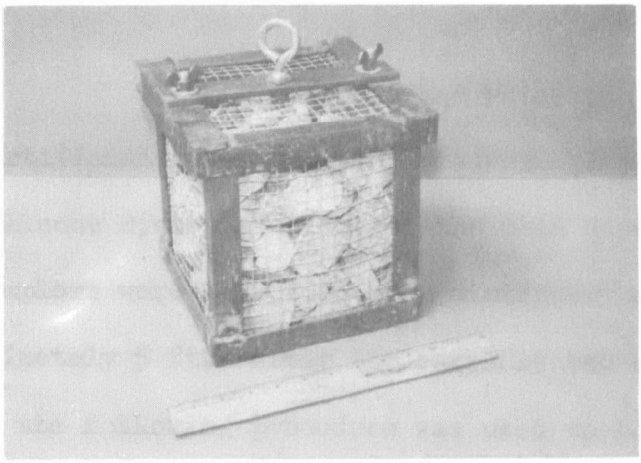


Fig. 1. Cubical substrate sampler, closed.

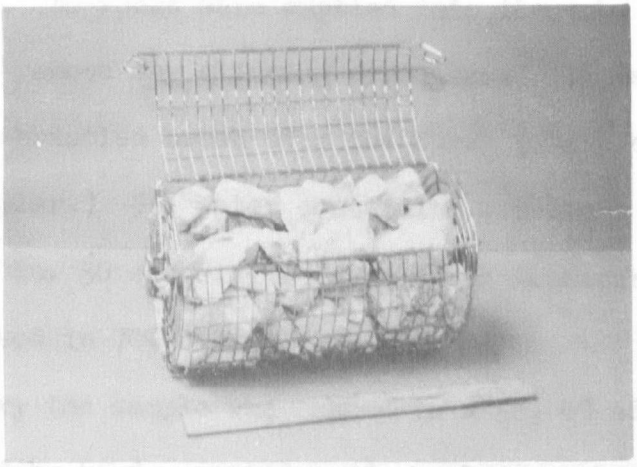


Fig. 2. Cylindrical substrate sampler, open.

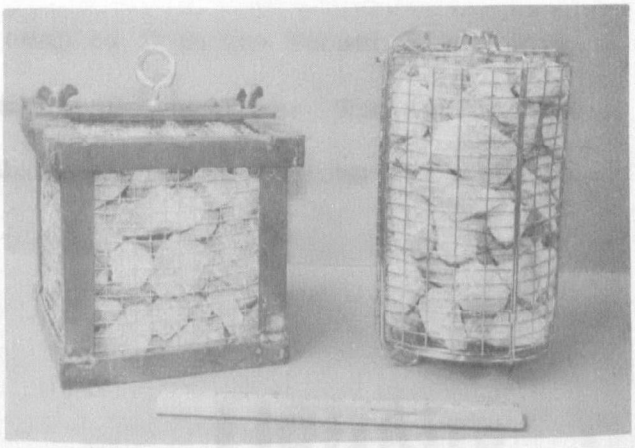


Fig. 3. Cubical and cylindrical samplers.

Methods and Materials

Artificial substrate samplers were placed at Water Pollution Surveillance System stations on the Ohio River and the Wabash River. The samplers were suspended from stationary structures to a depth of approximately 5 ft. After the samplers had been in the water for 6 weeks, the following procedure was used to collect the organisms.

1. Sampler was removed and placed in a tub containing a small amount of water. 2. The rocks were emptied into the tub. 3. Sampler was rinsed in tub to remove any clinging organisms. 4. Each rock was brushed with a stiff-bristled brush over the tub. (The clean rocks were replaced in sampler.) 5. Water containing organisms and debris was poured through a No. 30 sieve. 6. Sample was transferred from the sieve and preserved in 70% ethanol.

In the laboratory the sample was washed in a No. 40 sieve. The organisms were sorted by hand, counted, and, excluding the Oligochaeta, identified to genus or species. The results were expressed as numbers per sampler. Aliquots of some samples from the Wabash River were counted because of the large number of organisms. The appropriate factor was applied to express the number of organisms per sampler.

Discussion

The artificial substrate sampler is a useful tool for obtaining data on population trends as an indication of water quality and for determining cyclic population fluctuations. Like dredges and trawls the artificial substrate samplers are selective for certain benthic organisms. Although many of the organisms found on the samplers rarely are found on the stream bottom, they are often the most valuable for the evaluation of water quality.

Placement of the cubical and cylindrical samplers within the euphotic zone creates a shallow stream environment that attracts a larger variety of macroinvertebrates than when placed at greater depths. Sediments deposited in the samplers and currents are important physical factors, among others, affecting the organisms inhabiting the samplers. Installations on stationary structures do not permit compensation for river-level fluctuations. A preferable method for future studies is to suspend samplers from barges or other floating objects.

Seasonal differences in collections

The artificial substrate samplers were placed for collection of organisms as early as May and as late as December. Though the sampling periods are not exactly comparable, some general observations on the effectiveness of attracting organisms during summer and fall can be made from a comparison of Tables I, II, and III.

The largest collections at the Ohio River locations were obtained from June through September with the maximum number of organisms occurring in July and August. The number collected at Cincinnati (Table I) from October 6 to November 16 decreased markedly based on earlier collections, but the variety was not appreciably less. At Louisville (Table II) during the period September 28 to November 12 fewer total organisms were collected than earlier periods. The number of species present was less than in the May to August period and about the same as in the August to September samples.

The Wabash River samples collected September 29 and November 17 contained the greatest number and variety of organisms with the maximum number occurring in the September to November period (Table III). Although there were fewer numbers for the period November 17 to December 20, the number of species was not appreciably reduced.

The Tendipedid (midge) collections in the Ohio River were greatest during June, July, and August. In the Wabash River large numbers were collected as late as October and November.

A fairly large number of the Trichopteran larva, Cyrnellus fraternus, Banks, (Flint, 1964) were collected from the Ohio River from June to early October; a fewer number were collected during May and after September. Additional observations of seasonal variations of groups

or species are needed to clearly establish the periods of greatest abundance.

Comparison of organisms collected at Louisville and Cincinnati on the Ohio River

Some species were collected regularly in both the cubical and cylindrical samplers during 1965 at Louisville and Cincinnati (Table IV): the Tendipedid larvae of Pentaneura sp., Harnischia spp., Tendipes nervosus, and Psectrocladius sp., frequently; Procladius sp., Glyptotendipes senilis, Polypedilum illinoense and Coelotanypus concinnus, occasionally. The trichopteran larva Cyrnellus fraternus was collected regularly in both samplers. The most common mayfly nymphs were Caenis sp. and Stenonema sp. The damselfly Argia sp. occurred more irregularly.

The clam Corbicula fluminea was more numerous at Louisville than at Cincinnati. The crustaceans, worms, and mollusks occurred sporadically in both the cubical and cylindrical samplers. Both of these artificial substrate samplers collected bryozoan and coelenterate colonies. Because of the inconsistency in the collections of invertebrate groups that prefer the mud and silt bottoms of the rivers, dredge or trawl samples should be collected to supplement artificial substrate data.

Comparison of organisms collected from Wabash and Ohio Rivers

The Wabash River has different stream characteristics than those of the Ohio River. Data from the Wabash River is included in this

report to offer a comparison of the effectiveness of artificial substrate sampling in two different environments. The Ohio River is approximately 20 ft. deep at the sampling locations whereas the Wabash River is scarcely 6 ft. deep. The Wabash has many shallow, sandy areas that account for warmer water temperatures during the summer months than the Ohio River. The Wabash receives considerable organic enrichment that enhances the growth of large populations of omnivorous and filter-feeding macroinvertebrates. A greater variety and a larger number of individuals were collected by both samplers at New Harmony than at Louisville or Cincinnati.

At New Harmony, a few stonefly nymphs, Acroneuria sp., were collected in both the cubical and cylindrical samplers. Glyptotendipes lobiferus, Tanytarsus sp., Cryptochironomus sp., Calopsectra sp., one ceratopogonid species and Simulium sp. were found at New Harmony, but not at the Ohio River locations. A greater diversity of caddisfly species were collected at New Harmony than at either Ohio River location. Hydropsyche orris, Potamyia flava, and Leptocella sp. were collected regularly along with Cyrnellus fraternus larvae in the Wabash. One cylindrical substrate sample collected in September contained burrowing mayfly nymphs Hexagenia, which are usually collected from the sediments. Both samplers were suspended only one foot from the bottom during the sampling interval, which was still within the euphotic zone. The samplers collected damselfly and dragonfly nymphs represented by Argia, Gomphus, Dromogomphus, and Neurocordulia. The clam Corbicula fluminea was collected in one cubical substrate sampler.

A considerable increase in the variety and number of individuals occurred in the Wabash River samples in contrast to the Ohio River samples (Table V.).

Comparison of effectiveness of cubical and cylindrical substrate samplers

The Table V. summary of data during 1965 from the three locations collected by cubical and cylindrical substrate samplers shows that one sampler may collect more species than the other but the differences are small. The total number of individuals collected by each sampler varied, but one sampler does not consistently collect more individuals than the other per sampling interval.

Table I. Macroinvertebrates collected from the Ohio River at Cincinnati, Ohio, 1965

Organism	Sampling Interval				Type Sampler
	June 8 to July 16	July 16 to Aug. 25	Aug. 25 to Oct. 6	Oct. 6 to Nov. 16	
Diptera Tendipedidae	32	92	5	5	Cubical
	35	60	15	4	Cylindrical
Trichoptera	151	267	135	12	Cubical
	144	107	62	7	Cylindrical
Ephemeroptera	4			2	Cubical
	2	1	1		Cylindrical
Odonata Zygoptera	1	3		1	Cubical
			2	2	Cylindrical
Crustacea Decapoda		1			Cubical
					Cylindrical
Turbellaria			2		Cubical
				3	Cylindrical
Mollusca Pelecypoda	1			3	Cubical
					Cylindrical
Bryozoa		X		X	Cubical
		X	X		Cylindrical
Coelenterata	X	X	X	X	Cubical
	X	X	X	X	Cylindrical
Total No. Individuals	189	363	142	23	Cubical
	184	168	80	16	Cylindrical
Total No. Species	8	12	6	8	Cubical
	6	9	8	6	Cylindrical

X = present but not counted

Table II. Macroinvertebrates collected from the Ohio River at Louisville, Kentucky, 1965

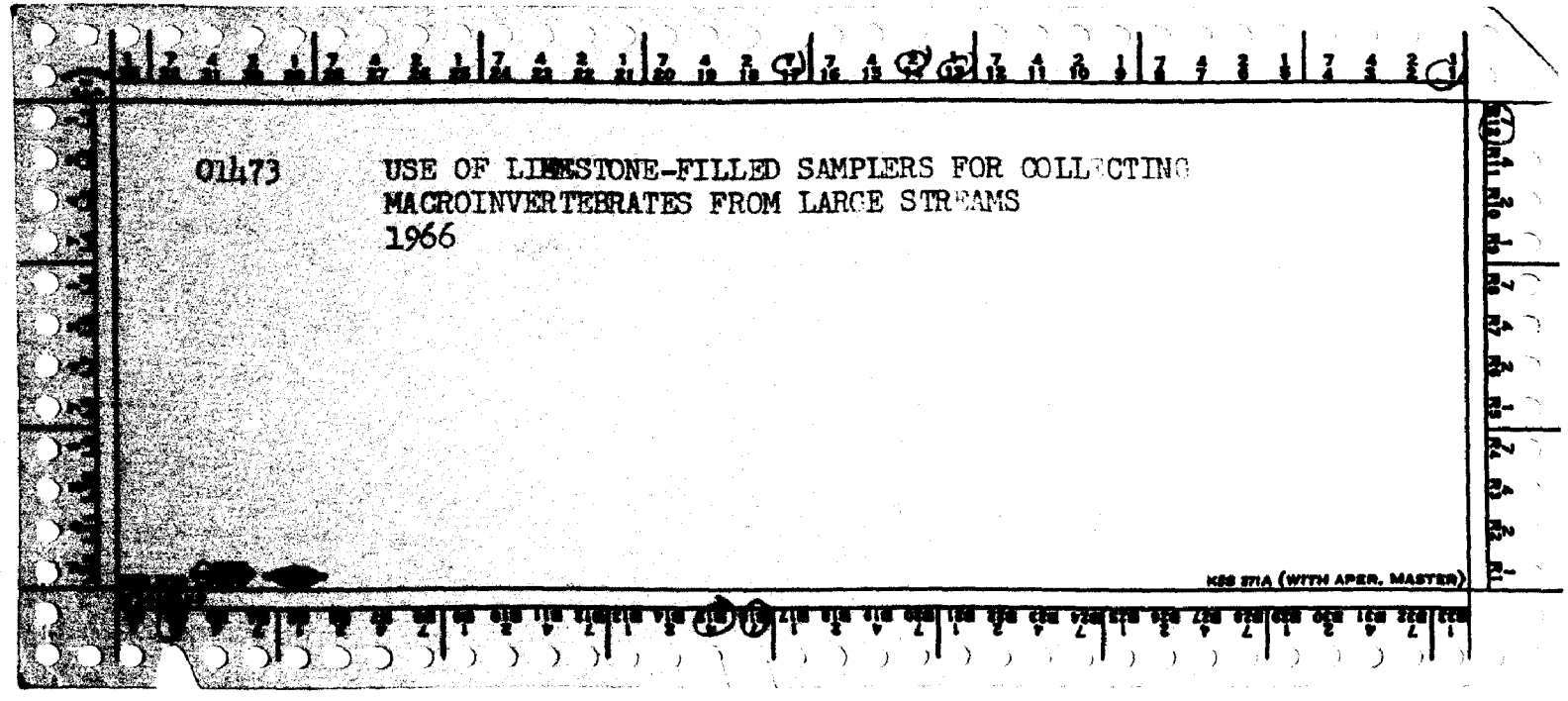
Organism	Sampling Interval				Type Sampler
	May 7 to June 15	June 15 to Aug. 10	Aug. 10 to Sept. 28	Sept. 28 to Nov. 12	
Diptera					
Tendipedidae	40	90			Cubical
	35	119	8	9	Cylindrical
Trichoptera	4	53	67	5	Cubical
	5	152	91	6	Cylindrical
Ephemeroptera	31		1		Cubical
	21				Cylindrical
Odonata					
Zygoptera	2	5	7		Cubical
		1			Cylindrical
Crustacea					
Decapoda	7		1		Cubical
	1				Cylindrical
Amphipoda	2	6	2	1	Cubical
			1	6	Cylindrical
Annelida					
Oligochaeta		1			Cubical
					Cylindrical
Turbellaria	1	73	3		Cubical
		37	2		Cylindrical
Mollusca					
Pelecypoda		124	12	1	Cubical
		62	6	4	Cylindrical
Gastropoda		10	1	5	Cubical
			2	2	Cylindrical
Bryozoa		X			Cubical
		X			Cylindrical
Coelenterata	X		X	X	Cubical
	X	X	X	X	Cylindrical
Total No.	87	362	94	18	Cubical
Individuals	62	371	110	31	Cylindrical
Total No.	16	16	10	7	Cubical
Species	13	16	8	10	Cylindrical

X = present but not counted

Table III. Macroinvertebrates collected from the Wabash River at New Harmony, Indiana, 1965

Organism	Sampling Interval			Type Sampler
	Aug. 10 to Sept. 29	Sept. 29 to Nov. 17	Nov. 17 to Dec. 20	
Diptera				
Tendipedidae	91	480	74	Cubical
	217	492	54	Cylindrical
Other	2		1	Cubical
	1			Cylindrical
Trichoptera	108	40	23	Cubical
	300	66	77	Cylindrical
Plecoptera			2	Cubical
	4		5	Cylindrical
Ephemeroptera	3	56	10	Cubical
	48	80	13	Cylindrical
Odonata				
Anisoptera	7	49	1	Cubical
	7	32		Cylindrical
Zygoptera	44	56	10	Cubical
	32	36	2	Cylindrical
Coleoptera	6	8	3	Cubical
	7	8	2	Cylindrical
Crustacea				
Decapoda	1			Cubical
	1		2	Cylindrical
Amphipoda	1			Cubical
				Cylindrical
Isopoda			3	Cubical
	6			Cylindrical
Oligochaeta		12	30	Cubical
		16	35	Cylindrical
Hirudinea				Cubical
	1			Cylindrical
Turbellaria		20	8	Cubical
	5	12	17	Cylindrical
Mollusca				
Pelecypoda	5	28	5	Cubical
	9	12	1	Cylindrical
Gastropoda			1	Cubical
	1			Cylindrical
Bryozoa	X	X	X	Cubical
	X	X	X	Cylindrical
Total No. Individuals	268	749	170	Cubical
	640	758	207	Cylindrical
Total No. Species	24	20	21	Cubical
	31	23	18	Cylindrical

X = present but not counted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USE OF LIMESTONE-FILLED SAMPLERS FOR COLLECTING
MACROINVERTEBRATES FROM LARGE STREAMS
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Table IV. Macroinvertebrates collected at Cincinnati (C) and Louisville (L) on Ohio River and at New Harmony (N) on Wabash River, 1965

Organism	Cubical sampler			Cylindrical sampler		
	C	L	N	C	L	N
Diptera						
Tendipedidae						
Pelopiinae						
Pentaneura sp.	X	X	X	X	X	X
Coelotanypus concinnus	X	X	X		X	X
Procladius culiciformis	X	X	X		X	X
Hydrobaeninae						
Psectrocladius sp.	X	X	X	X	X	X
Cricotopus sp.		X			X	
Hydrobaenus sp.					X	X
Tendipedinae						
Tendipes (*Limnochironomus*) sp.		X			X	
T. nervosus	X	X		X	X	
T. modestus					X	X
Cryptochironomus sp.			X	X		X
Polypedilum sp.	X		X		X	X
P. illinoense		X				
P. ophioides					X	
Tanytarsus sp.			X			X
Calopsectra sp.			X			X
Harnischia sp.	X	X	X	X	X	X
H. abortiva		X			X	
Glyptotendipes senilis	X	X		X	X	
G. lobiferus			X			X
Simulidae						
Simulium sp.			X			
Ceratopogonidae (1 sp.)			X			X
Trichoptera						
Cyrnellus fraternus	X	X	X	X	X	X
Hydropsyche orris			X			X
Potamyia flava			X			X
Leptocella sp.			X			X
Macronemum sp.						X
Arthripsodes sp.					X	
Agraylea sp.					X	
Ephemeroptera						
Stenonema sp.	X	X	X	X	X	X
Caenis sp.		X	X		X	X
Tricorythodes sp.				X		X
Hexagenia sp.						X

(contd)

Table IV.(contd). Macroinvertebrates collected at Cincinnati (C) and Louisville (L) on Ohio River and at New Harmony (N) on Wabash River, 1965

Organism	Cubical sampler			Cylindrical sampler		
	C	L	N	C	L	N
Plecoptera						
Perlidae			X			X
Acroneuria sp.						X
Odonata						
Zygoptera						
Argia sp.	X	X	X	X	X	X
Anisoptera						
Gomphus sp.			X			X
Dromogomphus sp.			X			X
Neurocordulia sp.			X			X
Erpetogomphus sp.			X			X
Coleoptera						
Stenelmis sp.			X			X
Crustacea						
Amphipoda						
Gammarus sp.		X	X		X	
Isopoda						
Asellus sp.			X			X
Decapoda						
Orconectes obscurus	X	X	X		X	X
Cambarus sp.						X
Oligochaeta		X	X			X
Turbellaria	X	X	X	X	X	X
Hirudinea						X
Mollusca						
Gastropoda						
Bulimidae (1 sp.)		X			X	
Viviparidae (1 sp.)						X
Planorbidae (1 sp.)		X				
Physa sp.		X			X	
Somatogyrus sp.		X	X			
Pelecypoda						
Corbicula fluminea	X	X	X	X	X	
Sphaerium sp.			X			X

(contd)

Table IV.(contd). Macroinvertebrates collected at Cincinnati (C) and Louisville (L) on Ohio River and at New Harmony (N) on Wabash River, 1965

Organism	Cubical sampler			Cylindrical sampler		
	C	L	N	C	L	N
Bryozoa						
Pectinatella sp.	X	X		X	X	
Plumatella repens			X			X
Lophopodella sp.			X			X
Colenterata						
Cordylophora sp.	X	X		X	X	
Hydra sp.		X				

Table V. Comparison of macroinvertebrate collections, 1965

Location	Sampler	Number of Species[a]	Number of Species in all samples	Number individuals in all samples
Ohio River at Cincinnati (4 samples)	Cubical	16		717
	Cylindrical	14		448
	Both		18	
Ohio River at Louisville (4 samples)	Cubical	26		561
	Cylindrical	28		574
	Both		32	
Wabash River at New Harmony (3 samples)	Cubical	34		1187
	Cylindrical	39		1605
	Both		43	

[a]Excluding the Oligochaeta.

Literature Cited

Cauthron, F. F. 1961. A survey of invertebrate forms of the Mississippi River in the vicinity of Baton Rouge, Louisiana. Masters Thesis, unpublished, Louisiana State University.

Flint, Oliver S. 1964. Notes on some nearctic Psychomyiidae with special reference to their larvae. Proc. U. S. Nat. Mus., 115:467-481, No. 3491, Smithsonian Inst.

Henson, E. B. 1965. A cage sampler for collecting aquatic fauna. Turtox News, 43(12):298-299.

Hester, F. E., and J. S. Dendy. 1962. A multiple-plate sampler for aquatic macroinvertebrates. Trans. Amer. Fisheries Soc., 91(4):420-421.

Scott, D. C. 1958. Biological balance in streams. Sewage and Industrial Wastes, 30(9):1169-1173.