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The Role of Benthos and Plankton Studies in a Water Pollution Surveillance Program

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INTRODUCTION

In 1957 the Public Health Service began a program of collecting basic data on the physical, chemical, and biological characteristics of the water in rivers and lakes of the United States. These characteristics are related to water pollution and can be used in its prevention and control. The program, initially designated the National Water Quality Network, grew from a Network of 57 stations in 1957 to 125 by the end of 1962. In early 1964 the name of the activity was changed to the Water Pollution Surveillance System (WPSS). There are now 131 stations in the surveillance system. Operation of these stations is dependent upon local cooperators who collect most samples and perform those analyses that must be performed soon after collection to measure river and lake conditions. Participants include more than 120 local water, sewage or other public utilities; health departments; industries; universities, and state water pollution control agencies.

The participants perform many of the conventional analyses such as temperature, dissolved oxygen, pH, biochemical oxygen demand, turbidity, etc. They also collect and send water samples to the Surveillance System laboratory in Cincinnati, Ohio, for additional analyses.

Annual published compilations listing results of analyses, stream flow records, and other significant information for each station are made available to participants and others who have use for the data. These WPSS compilations include data on the following: physical and inorganic chemicals; coliforms; radioactivity for gross alpha, gross beta, and strontium-90; organic chemicals; trace elements; plankton, and benthos.

PURPOSE OF BENTHOS AND PLANKTON DATA

Benthos and plankton data are used by the WPSS stations to help characterize water quality. The data collected on populations and community structure may show trends of water quality changes caused by increases in pollution or by decreases resulting from construction of pollution abatement works.

Benthos and plankton populations of a stream are examined periodically to determine their response to the total environment. Physical and chemical characteristics are important properties of the environment and, therefore, knowing these characteristics is essential to correct interpretation of population characteristics.

Frequently, information on temperature, dissolved oxygen, nutrients, or toxic materials can be used to explain either low or high populations of aquatic life. Some population changes result from one or more small environmental changes not ordinarily measurable by chemical or physical means.

DATA COLLECTION

Benthos studies were begun in 1962 to obtain information on the biota at or near stations, to relate the populations to water quality characteristics, and to evaluate the trend of pollution through a periodic sampling program. Benthos were collected by WPSS biologists at six stations in the Ohio River Basin in 1962. In 1963, 19 stations on the Ohio and its tributaries were visited for the purpose of collecting biota and making observations of station characteristics and environmental factors. Additional collection of bottom fauna, particularly in the Lower Mississippi River Basin, were made in 1964.

WPSS biologists collect qualitative and quantitative samples from the substrate. These samples are preserved and returned to the laboratory where they are sorted, identified, and recorded for later evaluation.

Plankton samples have been collected since the program was begun in 1957. Polyethylene bottles with a capacity of nearly three liters are sent to personnel at the stations. The bottles, which contain merthiolate preservative, are filled with water and mailed to the central laboratory for plankton analysis. During the period discussed in this report, samples were collected twice monthly.

STATION DESCRIPTIONS

The usefulness of benthos and plankton data in water pollution surveillance can be illustrated with data from three stations where different conditions prevail. These stations are Huntington, West Virginia, and Addison, Ohio, on the Ohio River and Winfield Dam on the Kanawha River. The Addison station is approximately 265 miles downstream from Pittsburgh. The Ohio River begins at Pittsburgh as the confluence of the Allegheny and Monongehela Rivers. The Allegheny River receives oil-field brines, acid-mine drainage, and mill wastes in its headwaters and tributaries, and the Monongehela River is polluted by acid-mine drainage and a variety of industrial wastes including those from large metal-processing factories. The upper reaches of the Ohio River receive domestic and industrial wastes from Pittsburgh and other sites downstream.

The Addison reach of the river is impounded by Gallipolis Lock and Dam located approximately 18 miles downstream, and the station is approximately two miles upstream from the confluence of the Ohio and Kanawha Rivers. Plankton samples at Addison are taken routinely by personnel of the Ohio Valley Electric Corporation at the intake of the Kyger Creek Power Plant. The Huntington station is located approximately 38 miles below the confluence of the Kanawha and Ohio Rivers. The river in this reach is impounded by Greenup Lock and Dam located approximately 36 miles downstream. Plankton samples are collected routinely at the intake of the Huntington water treatment plant by plant personnel.

The Kanawha River receives domestic wastes and a variety of chemical wastes, including synthetic organic compounds and metals from a large industrial complex in the Charleston area. The Winfield Dam Station is located approximately 26 miles downstream from Charleston, and 30 miles from the Ohio River. Plankton samples are collected at the turbine intake of the Winfield Dam Power Plant by plant personnel.

BENTHOS STUDIES OF THE KANAWHA RIVER

Results of quantitative sampling in the Kanawha River in 1963 below the Winfield Dam (Table I) clearly indicate the serious effect of pollution on bottom fauna. The benthos was characterized by a fairly large population of worms with other species of animals merely incidental (Figure 1). The worm population attained maximum numbers of 860 per sq ft in July. Qualitative sampling above

TABLE I

AVERAGE STANDING 1963 CROP OF BENTHOS IN THE KANAWHA RIVER BELOW WINFIELD DAM

Bottom was black muck and leaf detritus. Results expressed as mean number of animals per sq ft. The letter "P" indicates that the organism was present, but at an average population of less than one per sq ft. Figures are rounded to whole numbers.

Animals	May	July	November
Oligochaeta	471	860	364
Tendipedidae	P	P	-
Coleoptera: Elmidae	P	-	-
Total Number	472	860	364
Number of Species	3	2	1
Total number of species	3		

and below the Winfield Dam confirmed that the population was restricted. Other than the worms, two species of beetle larvae and one midge larva were the only kinds of animals found in 26 samples. This limited fauna showed that the Kanawha River at Winfield was unable to support normal benthic populations.

Sampling near the mouth of the Kanawha River at Point Pleasant, West Virginia, indicated that a worm population existed at the same level of magnitude as at Winfield (800-900 per sq ft). Midge larvae, though not in large numbers, were more common than at Winfield, indicating that river conditions improved downstream from Winfield closer to the mouth of the river.

BENTHOS STUDIES OF THE OHIO RIVER AT ADDISON, OHIO

Quantitative bottom samples taken near Addison during 1963 revealed that at least 14 species inhabited the soft bottom of the river (Table II). Qualitative sampling revealed at least six more species of fauna.

The worm population was greatest in July with a moderate-sized population averaging 183 worms per sq ft. Four species of midge larvae were among the fauna. In the November samples *Coelotanypus concinnus* was very abundant.

Worms feed on the organic matter in bottom sediments, and their abundance generally reflects the nutrient content of these sediments. The dominant midges in the population are predators; the large population of these predators partly accounts for the low worm population.

The asiatic clam *Corbicula fluminea* was found in the first samples collected at Addison in December 1962. A qualitative trawl sample taken in November 1963 brought up numerous young clams. This species has recently migrated up the Ohio River and become established at Addison. The *Corbicula* is a significant pest organism. It clogs cooling coils and water lines, and its abrasive shell damages raw water pumps.

BENTHOS STUDIES OF THE OHIO RIVER AT HUNTINGTON

The standing crop of benthos at Huntington (Table III) included 16 species. The worm population reached an average of 295 per sq ft in July. The asiatic clam *Corbicula* was present in subdominant numbers. Very small specimens of the mussel *Leptoclea* sp. were found. Six species of midge larvae were represented in the fauna, with *Cryptochironomus digitatus* and *Coelotanypus concinnus* dominating.

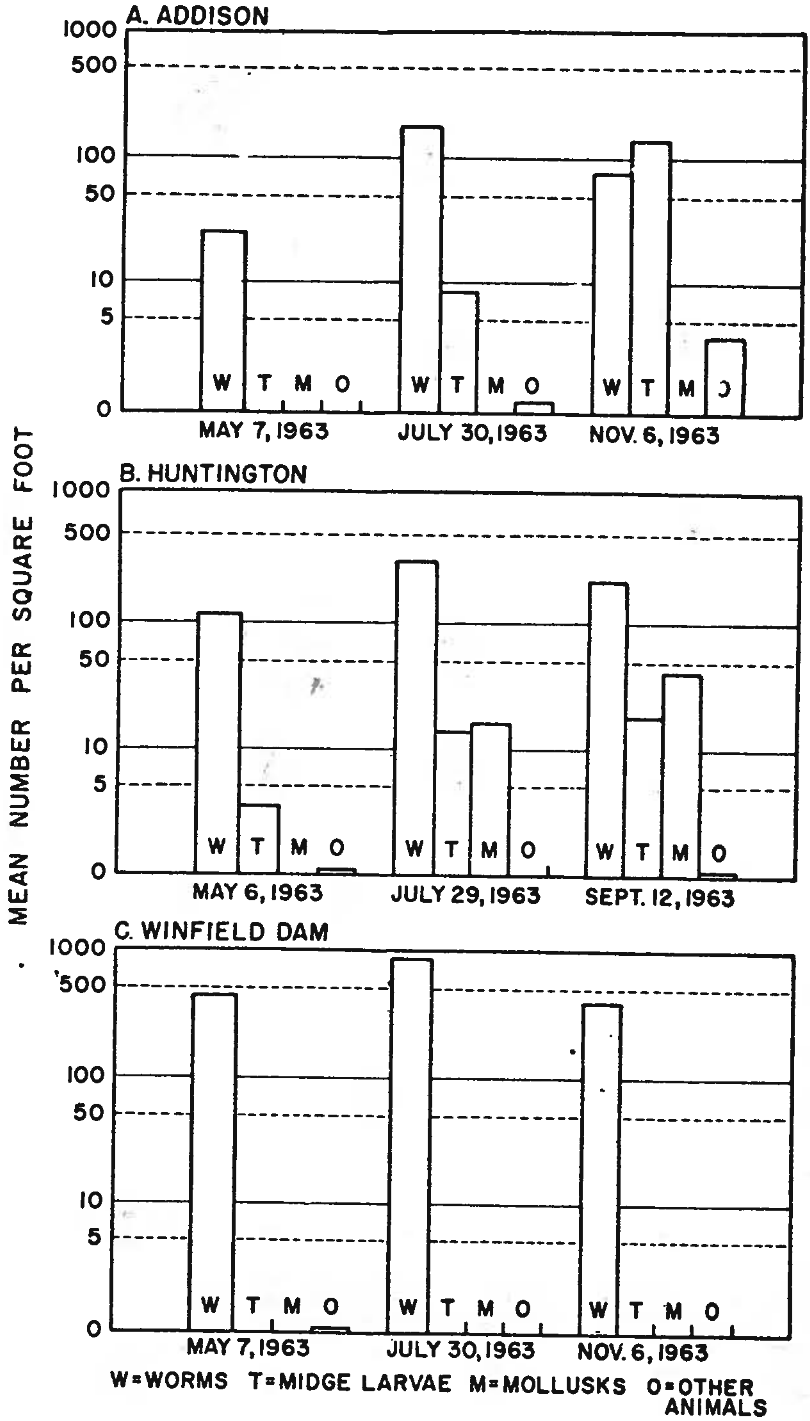

Figure 1 - Histograms representing average standing crops of benthos in the Ohio River at A) Addison, Ohio, and B) Huntington, W. Va., and in the Kanawha River below the C) Winfield Dam on three days in 1963.

TABLE II

AVERAGE STANDING 1963 CROPS OF BENTHOS IN THE OHIO RIVER ABOVE ADDISON, OHIO

Bottom was soft silty clay. Results expressed as mean number of animals per sq ft. The letter "P" indicates that the organism was present, but at an average population of less than one per sq ft. Figures are rounded to whole numbers.

Animals	May 7	July 30	Nov. 6
Worms			
Oligochaete worms	26	183	79
Leeches	P	-	-
Nematoda	P	-	-
Mollusca: Snails: - Somatogyrus sp.	-	-	1
Insects:			
Coleoptera larvae	P	-	-
Diptera: Tendipedidae:			
Tendipedinae			
Cryptochironomus digitatus	-	1	7
Tendipes sp.	-	-	P
Pelopiinae			
Coelotanypus concinnus	-	P	135
Procladius culiciformis	P	7	3
Culicidae:			
Chaoborus punctipennis	-	P	
Crustacea:			
Ostracoda:			
Candona sp.	-	P	1
Bryozoa (Statoblasts)			
Lophopodella carteri	-	P	P
Pectinatella magnifica	-	-	P
Plumatella sp.	-	P	P
Total Number	27	191	229
Number of species	5	8	11

Total number of species: 14

COMPARISONS OF THE BENTHOS DATA

A summary comparison of data from three stations (Figure 1) shows differences in general trophic levels. The average numbers of worms per sq ft in 1963 were 565 at Winfield, 203 at Huntington, and 96 at Addison. Averages for midge larvae at the same locations were one, 13, and 52 per sq ft, respectively.

On the basis of data on benthic fauna, the Kanawha River at Winfield contains more organic matter than the Ohio at Huntington, and the Ohio more at Huntington than at Addison. The scarcity of fauna other than worms at Winfield suggests the existence of toxic substances in the water, in addition to low oxygen concen-centrations in summers.

The higher number of *Tendipedinae* midges at Huntington than at Addison suggests smaller dissolved oxygen concentrations at Huntington, but not small enough to restrict the fauna seriously. The number of species was about the same

TABLE III

AVERAGE STANDING 1963 CROPS OF BENTHOS IN THE OHIO RIVER AT HUNTINGTON, WEST VIRGINIA

Bottom was dark silty clay with leaves. Results expressed as mean number number of animals per sq ft. The letter "P" indicates that the organism was present, but at an average population of less than one per sq ft. Figures are rounded to whole numbers.

Animals	May	July	Sept.
Worms:			
Oligochaetae	117	295	196
Lumbricidae	-	1	P
Nematoda	P	-	P
Mollusca: Clams: Corbicula fluminae	-	14	31
Leptodea sp.	-	1	2
Snails: Somatogyrus sp.	-	P	7
Insects:			
Trichoptera: Oecetis sp.	P	-	-
Diptera: Tendipedidae			
Tendipedinae			
Cryptochironomus digitatus	2	9	7
Cryptochironomus sp.	P	-	-
Polypedilum halterale	-	1	3
Tendipedinae pupa	1	P	-
Pelopiinae:			
Coelotanypus concinnus	P	3	8
Procladius culiciformis	-	P	-
Pentaneura monilis	-	P	-
Bryozoa (Statoblasts)			
Lophopodella carteri	P	P	P
Total Number	120	332	272
Number of species	6	12	10

Total number of species: 16

at Huntington as at Addison. The higher organic loading at Huntington probably reflects contributions from the Kanawha River upstream.

PLANKTON ANALYSES

Analyses are performed for three types of plankton: (1) micro-invertebrates, (2) "total live algae," and (3) diatoms.

Rotifers, crustacea, and other micro-invertebrates in a one-liter water sample are allowed to settle for 24 hrs. The sediment is placed in a special slide, 80 x 50 x 2 mm., and the organisms are enumerated under a compound microscope at 100x magnification. The counts are reported as organisms per liter.

A "total live algae" count is obtained from one ml of the sample by scanning two 50-mm. strips on a Sedgwick-Rafter slide under 200x magnification using a Whipple micrometer disc. An appropriate correction factor is used to convert the counts to units per ml. Each single cell or natural aggregate of cells (colony) occupying up to 300 square microns (μ^2) is counted as one unit. Large colonies are enumerated according to a modified areal-unit method in which aggregates

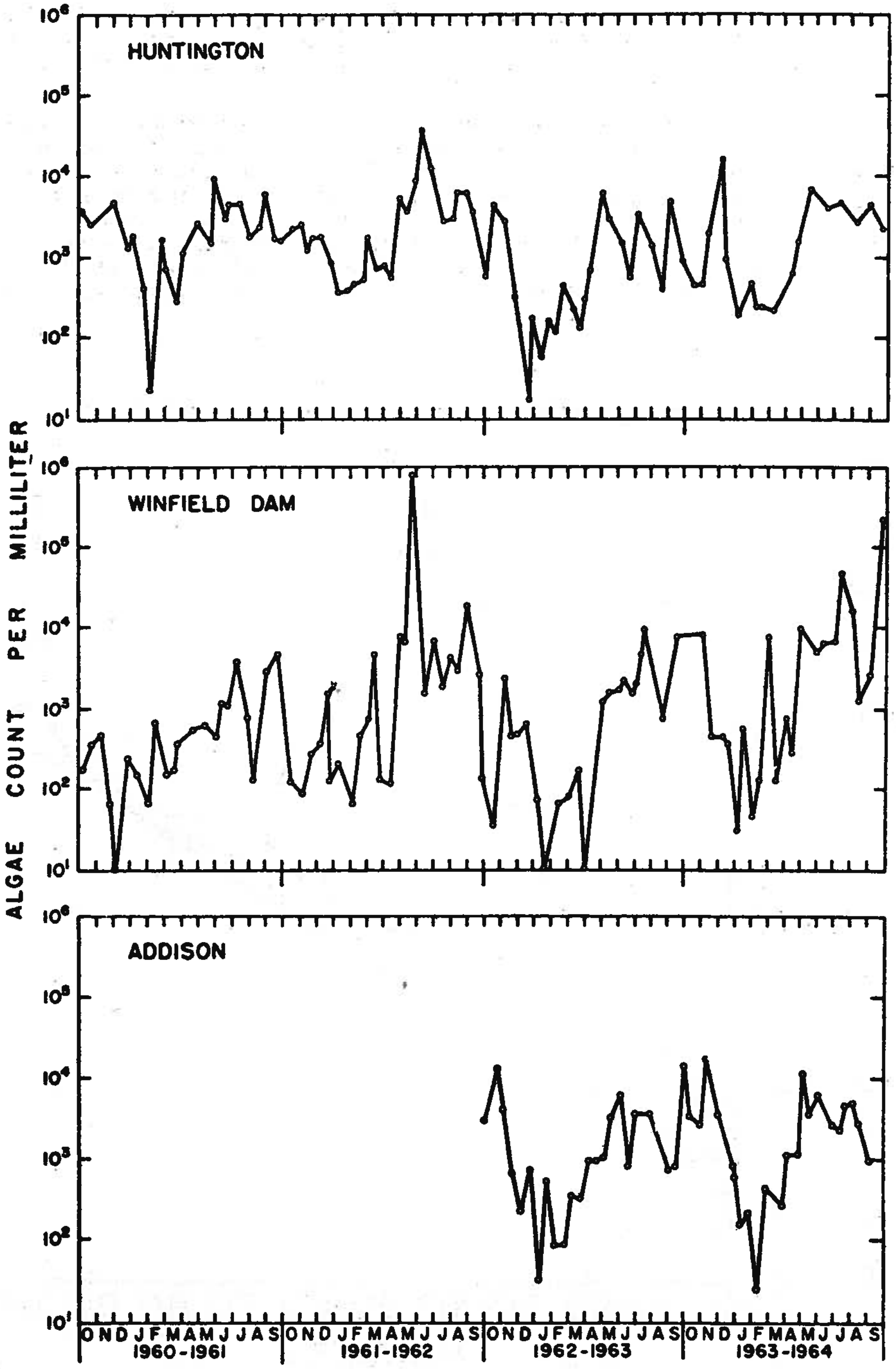

Figure 2 - Total algae counts at three stations on the Ohio and Kanawha Rivers.

occupying 300 to 1,000 μ^2 are counted as two units, those occupying 1,000 to 2,500 μ^2 as three units, those occupying 2,500 to 5,000 μ^2 as four units, and those occupying more than 5,000 μ^2 as five units. About 95 per cent of all cell aggregates fall into size one or two.

Identification and proportional census of diatom species are done from sediment obtained by settling one liter of the sample 48 hrs. A small portion of the sediment is placed on a No. 1 coverglass and dried on a warming table. The sediment on the coverglass is ashed over a hotplate, and permanent slides are made with hyrax mounting medium. Counts are made with 90x apochromatic oil immersion objectives and 10x oculars containing a Whipple micrometer disc. Random strip counts are made until the total number of units reaches 200 to 300. Areal units the same as those described for Sedgwick-Rafter counts of total algae are used.

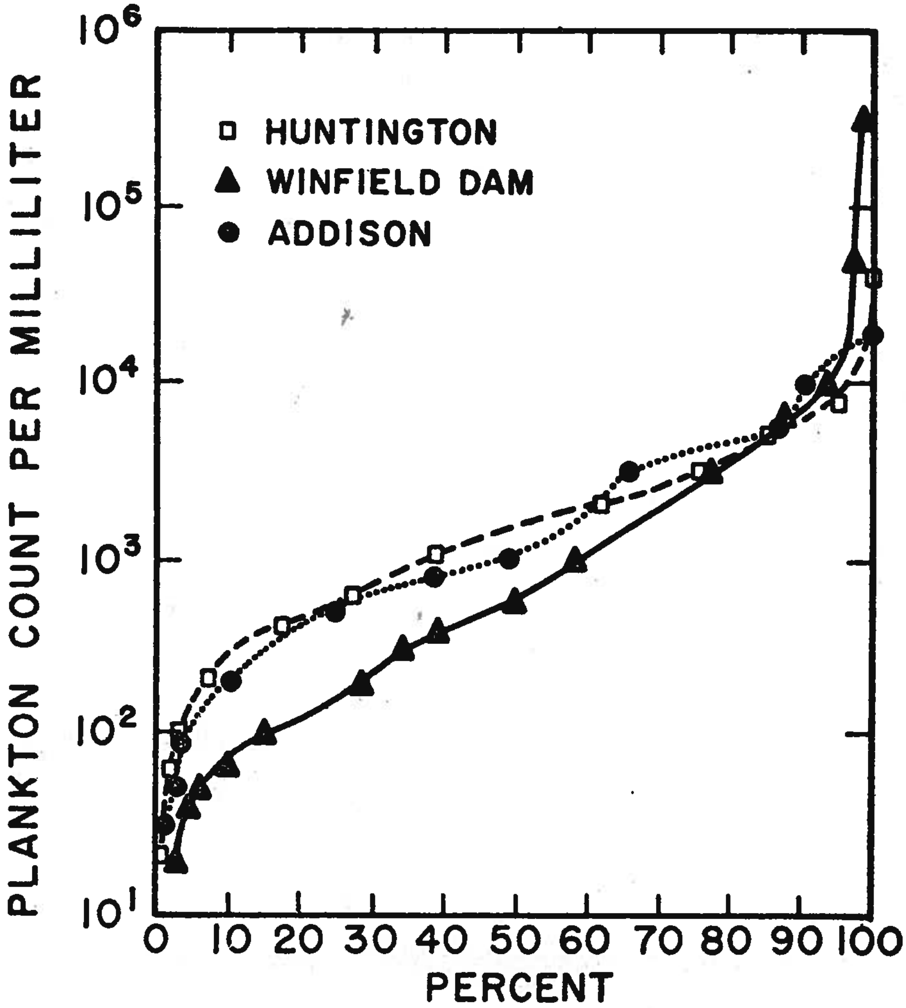

Figure 3 - Per cent of samples in which plankton counts were less than indicated value.

SEDGWICK-RAFTER DATA

Total phytoplankton counts at all three stations indicate moderate to high levels of enrichment (Figure 2). The counts at Addison and Huntington are similar, falling in the same range and having similar means -- approximately 2,000 organisms per ml. Data from Winfield Dam show a greater number of very high and very low counts, the very high indicating enrichment and the very low occasional acute toxicity. Total algae counts at this station have exceeded 200,000 per ml. These high populations consisted largely of coccoid blue-green and green algae, indicating a very high concentration of nutrients. On the other hand, more than one-third of the counts (units) were less than 300 per ml and one-half were less than 600 (Figure 3). Low counts of 100 per ml or fewer occurred in the late summer and fall of 1961 and 1962 when temperatures were still favorable and flows were low. This strongly suggests the presence of toxic wastes. Zinc has been reported in the Kanawha River at concentrations of 0.116 to 0.144 mg/l in quarterly composite samples (1). Carbon adsorption column extracts from samples taken at this station indicate a higher level of dissolved organic compounds in the Kanawha than in the Ohio at Huntington or Addison (Figure 4). Since the greater portion of the carbon column extracts are chloroform soluble, it is likely (2) that they are largely synthetic compounds (Figure 5). The toxic effects of these compounds may have contributed to low plankton counts. High BOD's and high levels of dissolved solids at Winfield Dam suggest that algal blooms would occur more often if toxic industrial wastes were not present.

The annual mean phytoplankton counts at Winfield Dam increased substantially during the period October 1960 through September 1964, but appeared to achieve greater stability during the later years. This suggests a decrease in the levels of toxic materials at this station. No long-term population trends are evident at Addison or Huntington.

The three most frequently occurring nondiatom algae were the same at all three stations. These were *Scenedesmus*, *Chlamydomonas*, and *Akistrodesmus* (Table IV), all of which are considered to be very tolerant of pollution (3,4). The relative abundance of *Actinastrum*, *Crucigenia*, *Pediastrum*, and *Chrysococcus* at Addison is indicative of moderate concentrations of nutrients and relatively lower levels of toxic wastes than at Huntington or Winfield Dam. Nearly all of the algae appeared less frequently in the Kanawha than in the Ohio River, emphasizing the rigorous conditions in the Kanawha. However, most of the genera occurred with greater frequency and in greater numbers in the Kanawha during the last two years of the four-year study period.

A number of genera of algae show markedly lower frequencies of occurrence at the Kanawha station (Table V) than at Addison and Huntington. The absence or relative scarcity of *Anabaena*, *Cosmarium*, *Gomphosphaeria*, *Pediastrum*, *Staurastrum*, *Tetraedron*, , and *Tetrastrum* at the Kanawha station can hardly be ascribed to oligotrophy (low nutrient water) and is most likely the result of their sensitivity to one or more pollutants. Although some of these algae occur in Palmer's list of "most tolerant genera" (4), he implies that their tolerance rating is related to domestic (sewage) wastes. Since a large part of the wastes in the Kanawha River are of industrial origin, the relations reported by Palmer may not be expected to obtain here.

Out of a total of 99 genera of algae (exclusive of diatoms) found at these stations, only two genera had a substantially higher frequency of occurrence at Winfield Dam than at Huntington or Addison. These were the green flagellates *Pandorina* and *Eudorina*, which are known to be pollution tolerant (Table V). Other than at Winfield Dam, *Pandorina* occurred at a frequency greater than three per cent only at the stations at New Harmony on the Wabash River (15 per cent), Evansville on the Ohio River (nine per cent), and Cincinnati on the Little Miami River (10 per cent), which have the highest BOD's and orthophosphate levels among the 13 stations in the Ohio River basin. Eudorina occurred at a frequency greater than three per cent only at Winfield Dam. The higher frequency of occurrence of these two genera in the Kanawha River indicates that they have a high level of tolerance for industrial as well as domestic wastes.

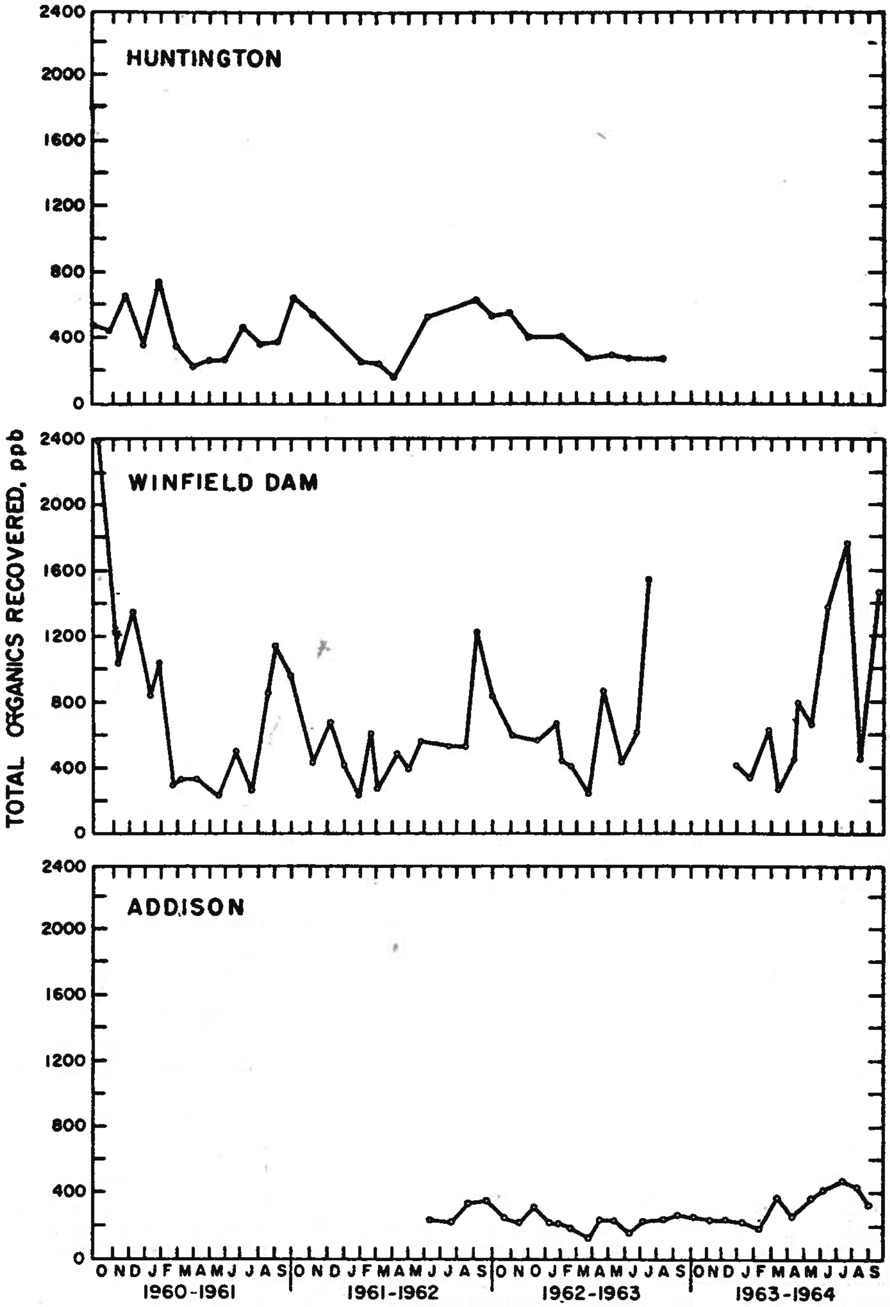

Figure 4 - Total organics recovered from river water by carbon adsorption method.

Evidence of an effect of the Kanawha River on conditions in the Ohio River at Huntington was noted in the less frequent occurrence of the sensitive forms, *Actinastrum, Chrysococcus, Cosmarium, Pediastrum,* , and *Tetraedron*, at Huntington than at Addison, and in the more frequent occurrence of the blue-green algae, especially the filamentous forms. These effects are expected because of the organic enrichment contributed by the Kanawha to the Ohio River at Huntington and the accompanying dilution of the Kanawha toxic wastes in the Ohio.

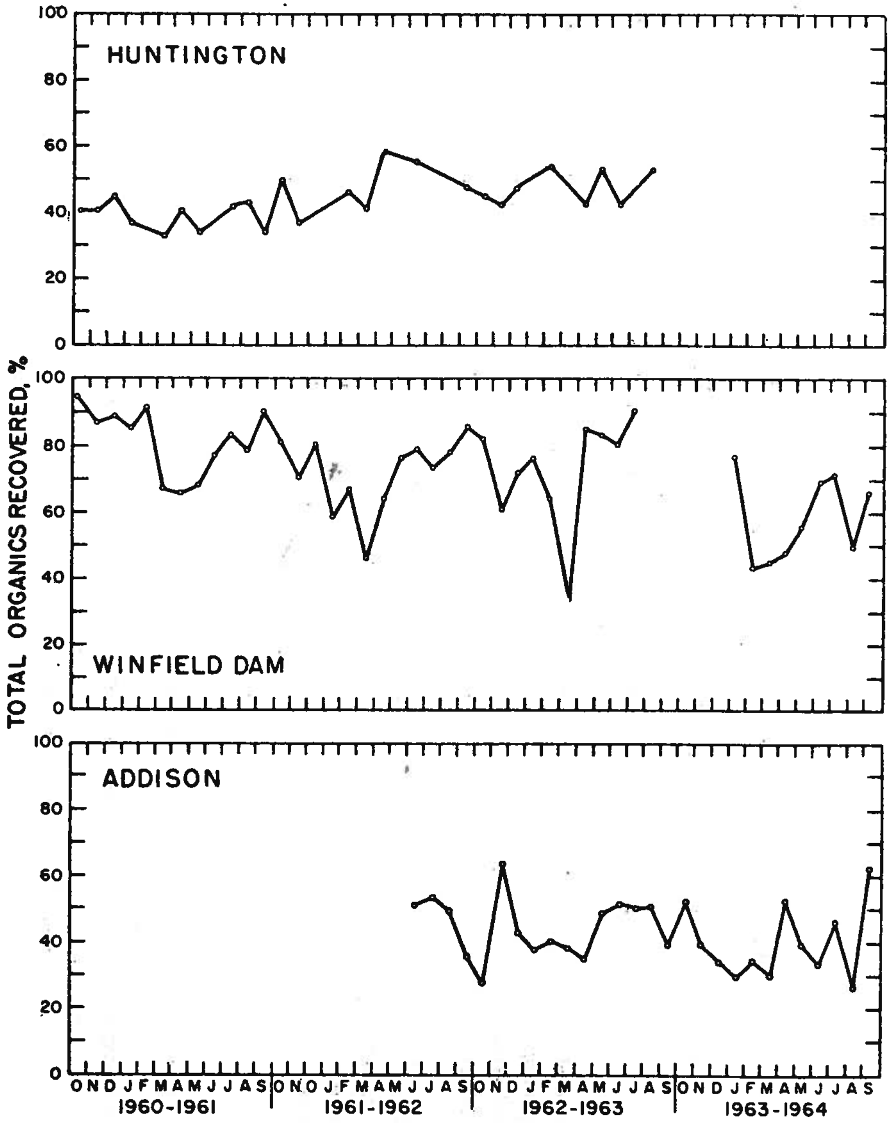

Figure 5 - Per cent of total organics recovered by chloroform extraction of carbon adsorption column.

TABLE IV

TEN MOST FREQUENTLY OCCURRING GENERA OF NONDIATOM ALGAE[(a)]

Rank	Ohio River, Huntington, W. Va. Genus	Per Cent Occurrence	Ohio River, Addison, Ohio Genus	Per Cent Occurrence	Kanawha River, Winfield, W. Va. Genus	Per Cent Occurrence
1	Scenedesmus	69	Scenedesmus	72	Chlamydomonas	49
2	Chlamydomonas	63	Ankistrodesmus	59	Scenedesmus	46
3	Ankistrodesmus	51	Chlamydomonas	59	Ankistrodesmus	40
4	Dictyosphaerium	34	Actinastrum	39	Oocystis	28
5	Anacystis	32	Crucigenia	39	Euglena	22
6	Oocystis	32	Pediastrum	37	Crucigenia	19
7	Trachelomonas	31	Chrysococcus	35	Trachelomonas	19
8	Actinastrum	30	Oocystis	33	Kirchneriella	18
9	Crucigenia	24	Dictyosphaerium	28	Tetradesmus	18
10	Micractinium	23	Micractinium	24	Anacystis	16

(a) Huntington - October 1, 1958 to September 30, 1964

Addison - October 1, 1962 to September 30, 1964

Winfield - October 1, 1960 to September 30, 1964

TABLE V

PER CENT OCCURRENCE DURING THE PERIOD OF RECORD. [(a)]

Genus	Station: Ohio River Huntington, W. Va.	Ohio River Addison, Ohio	Kanawha River Winfield, W. Va.
Actinastrum	30	39	17
Anabaena	12	4	0
Chromulina	19	13	8
Chrysococcus	15	35	7
Closterium	8	7	3
Cosmarium	7	11	0
Eudorina	2	0	10
Gomphosphaeria	9	4	0
Pandorina	3	0	15
Pediastrum	23	37	3
Staurastrum	19	17	1
Tetraedron	8	22	1
Tetrastrum	12	13	3

(a) See footnote in Table IV for period of record.

DIATOM DATA

A summary examination of the diatom data revealed several superficial similarities in the populations at the three stations. The average number of diatom species was nearly the same (Figure 6). The similarity in diatom species numbers was somewhat unexpected considering the relationship that usually prevails between pollution levels and species diversity (5, 6). At all three stations Sedgwick-Rafter Counts showed that 66 to 69 per cent of the diatoms were alive.

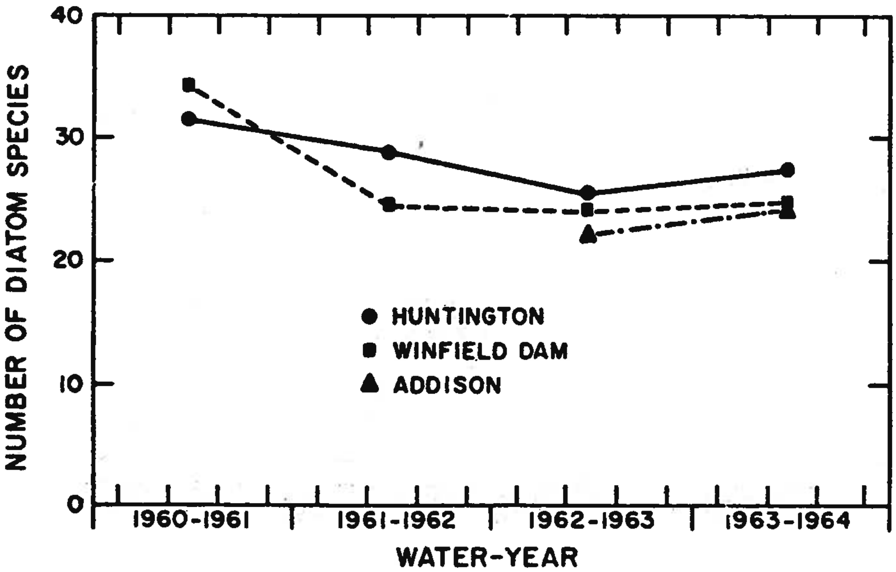

Figure 6 - Average number of diatom species in plankton samples.

The percentages of both live pennates and live centrics were somewhat higher at Addison than at the other two stations. Progressively lower percentages were present at Huntington and Winfield, indicating that conditions were most rigorous at Winfield Dam.

The dominant diatom in the Ohio River was *Melosira ambigua* (Figure 7), whereas in the Kanawha River it was *Cyclotella pseudostelligera* (Figure 8). *Cyclotella meneghiniana, Synedra ulna* and *Stephanodiscus hantzschii* ranked high among the dominant species at all three stations (Table VI); they are well known

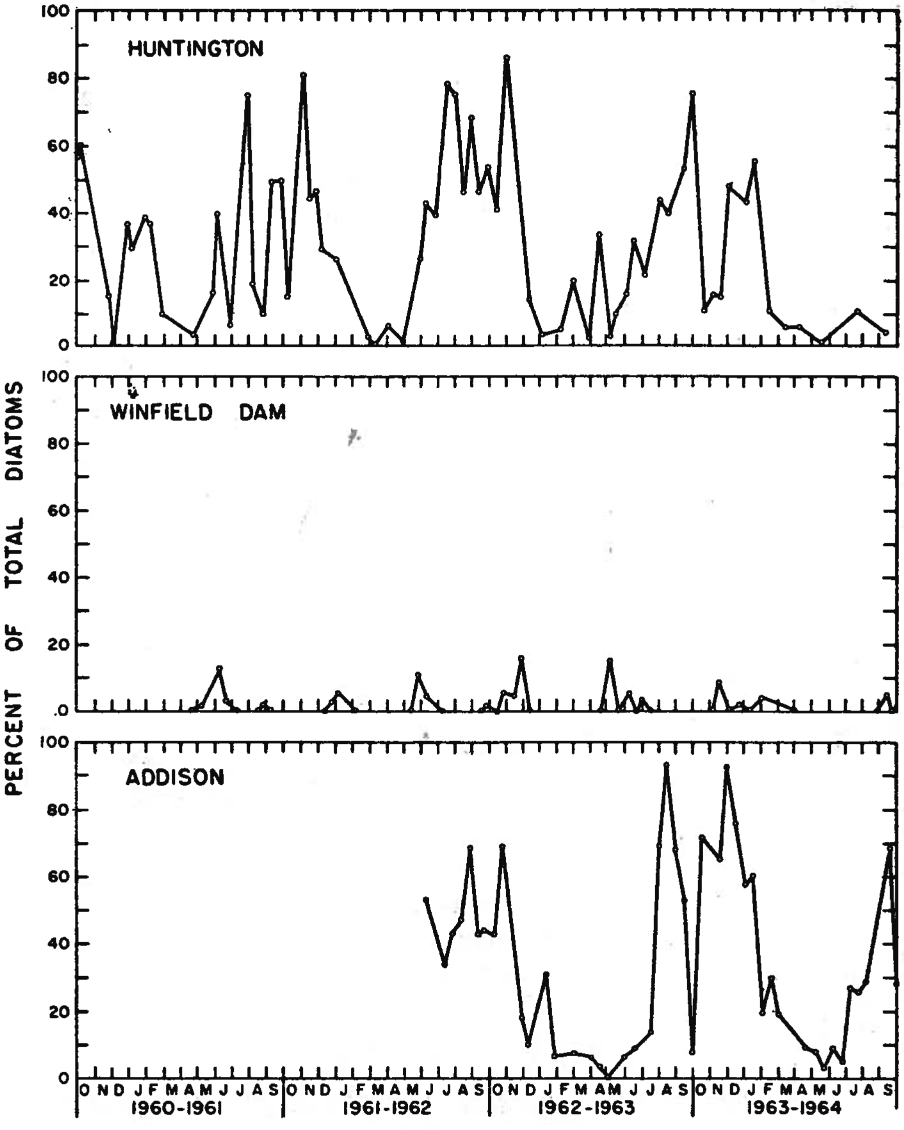

Figure 7 - Occurrence of Melosira ambigua expressed as per cent of total diatoms.

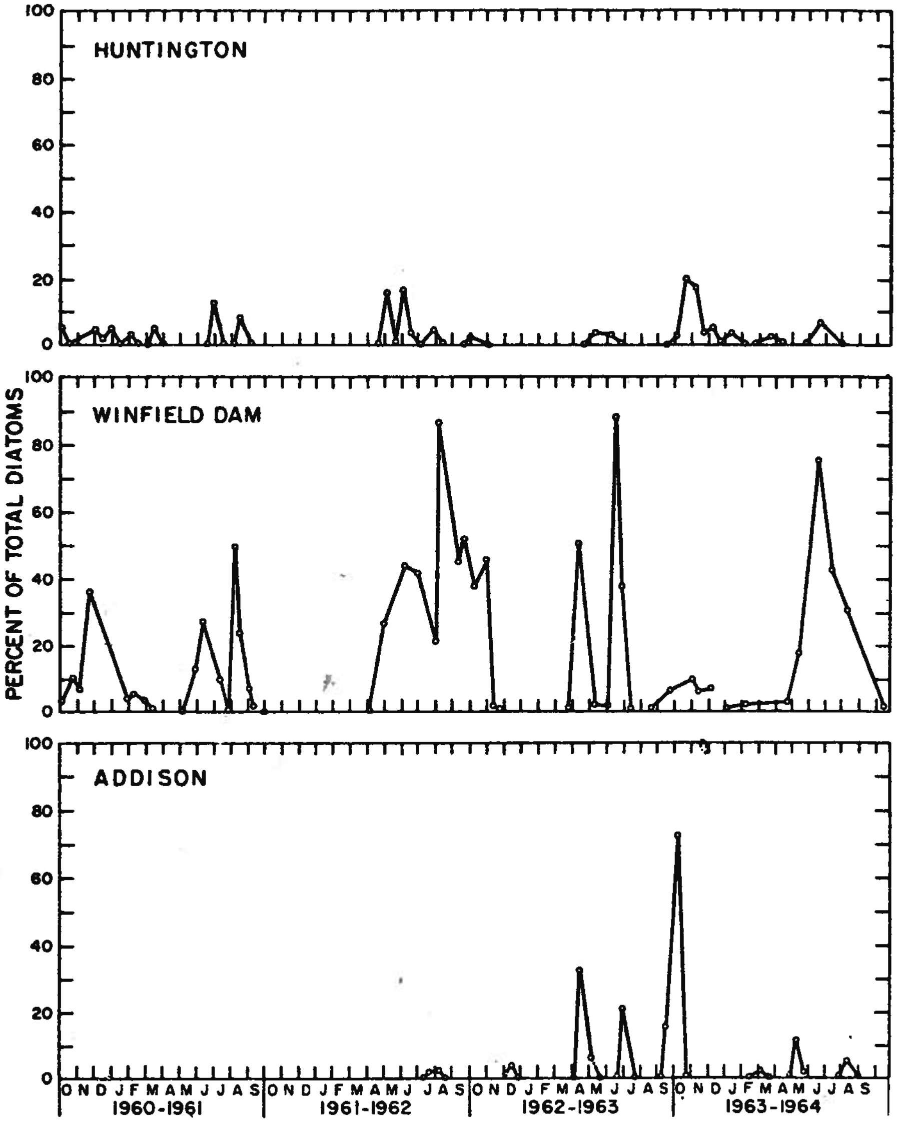

Figure 8 - Occurrence of Cyclotella pseudostelligera expressed as per cent of total diatoms.

for their pollution tolerance (7, 8). *M. ambigua* is abundant throughout the Ohio River and in the Allegheny River. It was present in 95 to 100 per cent of the samples and was the most abundant diatom 43 per cent of the time at Addison and 55 per cent of the time at Huntington. It was present in 65 per cent of the samples from Winfield Dam, but occurred as the most abundant diatom at this station only once in the past four years. It occurred with similar frequency (57 per cent) in the Monongehela River, but was found in only 23 per cent of the samples from the Wabash River, and in only 10 per cent of the samples from the Little Miami River. It did not occur in these three tributaries as a dominant. Though *M. ambigua* is present in the Monongehela and Kanawha Rivers a large share of the time, apparently it is prevented from achieving the degree of abundance that it

TABLE VI

THE FREQUENCY OF OCCURRENCE OF SPECIES OF DIATOMS THAT WERE DOMINANTS (AMONG THE FIRST FOUR MOST ABUNDANT) IN 10 PER CENT OR MORE OF THE SAMPLES, (a) AND THE PERCENT OF THE TIME THAT THEY WERE NOT ONLY DOMINANTS BUT WERE ALSO THE MOST ABUNDANT DIATOM

	Ohio River Huntington, W. Va.			Ohio River Addison, Ohio			Kanawha River Winfield, W. Va.		
Rank	Diatom	Per Cent occur as dom.	Per Cent[b] occur as 1st dom.		Per Cent occur as dom.	Per Cent occur as 1st dom.		Per Cent occur as dom.	Per Cent occur as 1st dom.
1	Melosira ambigua	84	66	Melosira ambigua	71	60	Cyclotella pseudostelligera	45	57
2	Synedra ulna	58	28	Cyclotella meneghiniana	71	7	Synedra ulna	45	33
3	Cyclotella meneghiniana	55	9	Synedra ulna	50	14	Stephanodiscus hantzschii	36	29
4	Melosira granulata	39	0	Stephanodiscus hantzschii	38	44	Cyclotella meneghiniana	35	26
5	Stephanodiscus hantzschii	34	30	Melosira distans	38	25	Achnanthes minutissima	29	42
6	Synedra acus	28	9	Melosira granulata	21	0	Nitzchia spp.	20	16
7	Melosira distans	20	12	Synedra acus	17	14	Melosira varians	18	33
8	Diatoma vulgare	12	10	Cyclotella pseudostelligera	12	40	Cyclotella stelligera	18	25

TABLE VI (Continued)

THE FREQUENCY OF OCCURRENCE OF SPECIES OF DIATOMS THAT WERE DOMINANTS (AMONG THE FIRST FOUR MOST ABUNDANT) IN 10 PER CENT OR MORE OF THE SAMPLES, [(a)] AND THE PERCENT OF THE TIME THAT THEY WERE NOT ONLY DOMINANTS BUT WERE ALSO THE MOST ABUNDANT DIATOM

	Ohio River Huntington, W. Va.			Ohio River Addison, Ohio			Kanawha River Winfield, W. Va.		
Rank		Per Cent occur as dom.	Per Cent[(b)] occur as 1st dom.		Per Cent occur as dom.	Per Cent occur as 1st dom.		Per Cent occur as dom.	Per Cent occur as 1st dom.
9	Asterionella formosa	12	10	Synedra nana	12	20	Diatoma vulgare	15	10
10	Melosira varians	11	0	Asterionella formosa	10	0	Melosira granulata	15	20
11	Cyclotella pseudostelligera	10	25	Nitzschia spp.	10	0	Fragilaria crotonensis	14	22
12							Nitzschia spp.	14	0
13							Melosira ambigua	12	12
14							Navicula sp.	11	0

[(a)] Huntington - 80 samples
Addison - 42 samples
Winfield - 66 samples

[(b)] For example: Milosira ambigua was a dominant at Huntington in 84 per cent of the samples, and 66 per cent of the time it occurred as a dominant it was also the most abundant (or 1st dominant).

enjoys in the Ohio River. This diatom is widely distributed in the United States (19), and is reported to occur in oligotrophic to eutrophic waters in Europe (10). Its distribution in the Ohio River basin characterizes it as eurytrophic (tolerant of a wide range of nutrients), but it does not tolerate very high levels of pollution.

C. pseudostelligera, on the other hand, occurred in great abundance in the Little Miami, Wabash, and Allegheny Rivers, and along the mainstem of the Ohio River from time to time, demonstrating greater adaptability than *M. ambigua.* Its role as the dominant diatom at Winfield Dam is unique in the basin, and because it is very pollution tolerant, indicates consistently high levels of organic enrichment in the Kanawha River. *C. meneghiniana.* also occurs throughout the

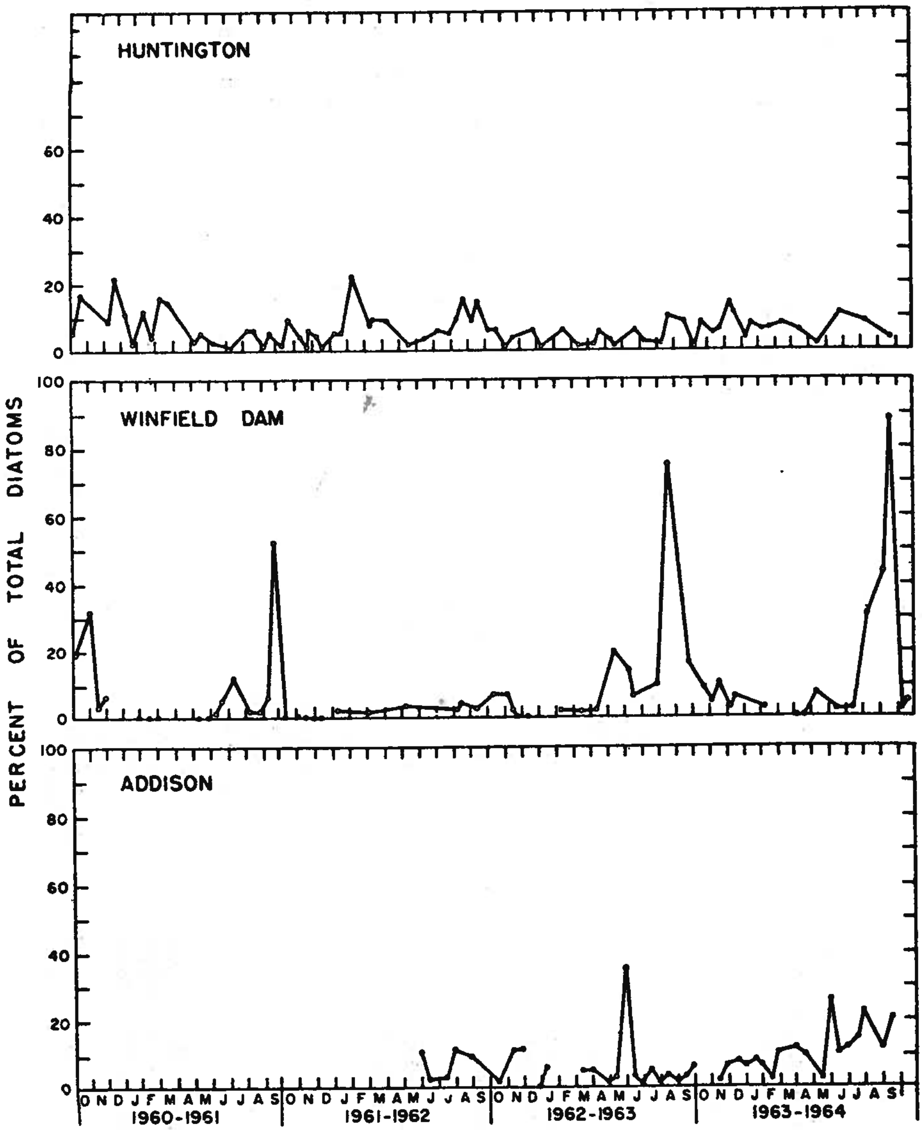

Figure 9 - Occurrence of Cyclotella meneghiniana expressed as per cent of total diatoms.

TABLE VII

THE PER CENT OCCURRENCE OF ZOOPLANKTON IN SAMPLES FROM HUNTINGTON, ADDISON, AND WINFIELD DAM, AND THE MAXIMUM POPULATION (ORGANISMS/LITER) OBSERVED FOR EACH GENUS DURING THE PERIOD OF RECORD

	Ohio River at Huntington, W. Va.		Ohio River at Addison, Ohio		Kanawha River at Winfield, W. Va.	
	Per Cent Occurr.	Maximum Population	Per Cent Occurr.	Maximum Population	Per Cent Occurr.	Maximum Population
ROTIFERS						
Keratella	57	2320	48	2490	19	130
Brachionus	44	300	52	123	12	218
Polyarthra	46	430	52	435	15	75
Synchaeta	30	110	33	36	12	60
Trichocerca	24	312	43	314	5	123
CRUSTACEA						
Cyclops	31	54	48	28	7	80
Bosmina	34	36	28	15	3	2
Moina	17	36	24	57	4	32

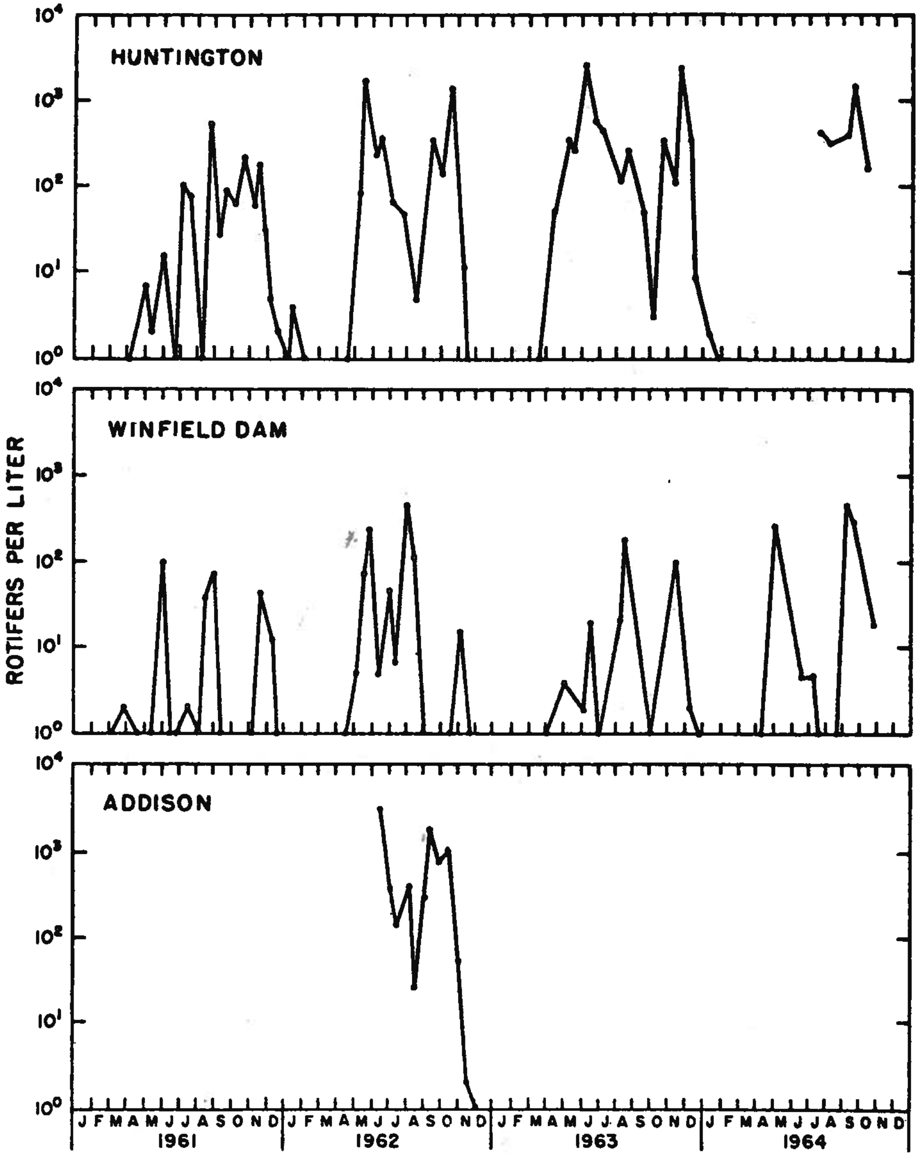

Figure 10 - Rotifer populations at three stations in the Ohio and Kanawha Rivers.

basin, generally reaching maximum abundance during late summer and early fall when temperatures are still high and flows are low. It is especially abundant in the Little Miami and Wabash Rivers. Since C. meneghiniana prefers highly enriched waters, its greater abundance at Winfield Dam than Addison or Huntington (Figure 9) indicates a higher level of enrichment at this station. Its sensitivity to certain wastes in the Kanawha River apparently prevents it from reaching the abundance in that river that it does in the Little Miami and Wabash Rivers.

The significance of the abundance of Achnanthes minutissima at Winfield Dam (Table VI) is unknown. It is considered to be a benthic form, and its presence with Melosira varians (also a benthic form), which is a mesosaprobic diatom (11), indicates that it is pollution tolerant.

ZOOPLANKTON

The dominant rotifers at all three stations were Keratella, Brachionus, Polyarthra, Synchaeta, and Trichocerca (Table VII). The frequency of occurrence of all rotifers was much less at Winfield Dam and maximum populations were generally much lower than at Addison or Huntington (Figure 10). At Winfield Dam, Keratella, an omnivorous rotifer, showed the greatest reduction in numbers. The microcrustacea dominated by Cyclops, Bosmina, and Moina, also occurred much less frequently at Winfield Dam than at Addison or Huntington, but the population maxima were not as greatly affected. In general, the zooplankton are very sensitive to pollutants, and their behavior in the Kanawha River indicates the presence of harmful substances at concentrations sufficiently high to seriously interfere with their development.

SUMMARY AND CONCLUSIONS

Data obtained from benthos and plankton samples at Water Pollution Surveillance System stations are used to characterize the quality of water at these stations. The populations at the three stations are distinctly different with respect to the occurrence and abundance of genera and species of benthos and plankton. These population differences can be used in a surveillance system to estimate levels of enrichment and to detect influences of toxic materials when proper consideration has been made of physical effects.

A continuing program of regular sampling is very useful for establishing normal population characteristics and for detecting significant population changes that are related to pollution or other water quality characteristics. The value of the continuing sampling program increases with time by providing a more complete and reliable record.

Data on the benthos and plankton communities supplement physical and chemical data. The responses of biological populations to pollution-induced changes can be detected and associated with chemical and physical variations when appropriate and adequate records are obtained.

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