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Quantitative Determination of Trace Metals in Two Species of Fish in the Cannon River

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ABSTRACT - Samples of fish were taken from three stations along the Cannon River and comparatively analyzed for concentrations of Copper and Mercury in their muscle tissue by atomic absorption spectrophotometry. Samples from different stations showed a difference in metal concentration.

This research investigated primary and secondary feeding fish to determine and compare copper and mercury concentrations within and between species of fish caught from separate environments representing increasing concentrations of trace metal wastes in the water. The common carp and sucker represented the bottom feeding fish in the study, and the crappie represented the secondary feeders. Twenty five fish of each species were taken from each station to provide the statistical base.

Three stations were chosen along the Cannon River. Station 1 was located approximately 10 miles upstream from Faribault, Minnesota, on the Straight River. This station represented a relatively clean environment for the fish. Station 2 was located approximately 1/2 mile upstream from Dundas, Minnesota. This station included Faribault effluents but stilll represented a relatively clean environment due to its distance from the city (13 miles). Stations 3 was established 1 mile downstream from Northfield, Minnesota, where the sewage treatment plant releases effluent into the river. A dam located in Faribault prevents mixing between fish from station 1 and 2 and another dam located in Northfield isolates station 3 from 2.

Atomic Absorption Spectrophotometer used

For both the mecury and copper analysis a Perkin Elmer 303 Atomic Absorption Spectrophotometer was used.

The copper analysis was by flame technique described by Edward Leonard in "The Determination of Copper in Fish by Atomic Absorption Spectrophotometry." The procedure uses a wet ash technique which employs perchloric acid and nitric acitd to digest sample tissue.

After the samples were digested and prepared for analysis, they were aspirated directly into the atomic absorption apparatus. The instrument was calibrated with aqueous copper solutions in the range of .1 - 10 ppm. Readings were then recorded for each sample, plotted on a calibration curve and analyzed statistically. To insure purity, only reagent grade chemicals and de-ionized distilled water was used for dilutions, rinsings, and digestions. A number of blank samples were run at random intervals to make sure that contamination from chemicals, water, or air were not entering.

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For the mercury analysis a flameless technique described in "Analytical Determination of Mercury" published by the Chlorine Institute was used. After the samples were digested and prepared for analysis, they were aerated through the atomic absorption apparatus. Readings were plotted on a calibration curve and analyzed statistically by station in the same manner as copper.

Copper Test Results

Bottom feeders from station 1 showed a mean copper level of 8.21 ug/g of fish tissue with a standard deviation of .146 ug/g. Bottom feeders from stations 2 showed a mean value of 6.75 ug/g of tissue with a standard deviation of 1.39 ug/g. Bottom feeders from station 3 showed a mean value of 13.74 ug/g of tissue with a standard deviation of 8.27 ug/g.

Since the test is not being repeated on a single specimen, the standard deviation reveals little. Because of natural deviation between individuals a moderate standard deviation is expected. The T-test showed less than a 75% probability that station 1 values differed from station 2. However a comparison of station 2 and 3 showed a greater than 95% level of confidence that they were different. Figure 1 shows a graph of comparitive ppm values for fish from stations 1, 2, and 3.

Crappie values showed a change from bottom feeders when concentrations were compared. Copper concentration in crappie tissues was nearly identical for stations 2 and 3. Tissue from station 2 showed a mean copper concentration of 6.82 ug/g of tissue with a standard deviation of .79 ug/g. Tissue from station 3 showed a mean concentration of 7.11 ug/g with a standard deviation of .98 ug/g. Figure 2 shows the comparative copper concentration in crappie tissue for station 2 and 3.

The difference in crappie concentration levels for copper was only .28 ug/g of tissue versus a difference of 6.1 ug/g of tissue in bottom feeders comparisons between stations.

The difference in concentration levels, and station differences for the crappie and bottom dweller; could be due in part to differences in feeding habits between the species. Work done at Carleton College in Northfield, Minnesota, showed high concentration of copper in the sludge of the Scheldahl drainage ditch and in the river mud. Through its feeding habits the crappie avoids any ingestion of mud, while for the bottom feeder mud is an important source of food.

Mecury test results

Bottom feeding fish from station 1 showed an average Mercury level of .40 ug/g of tissue with a standard devia-

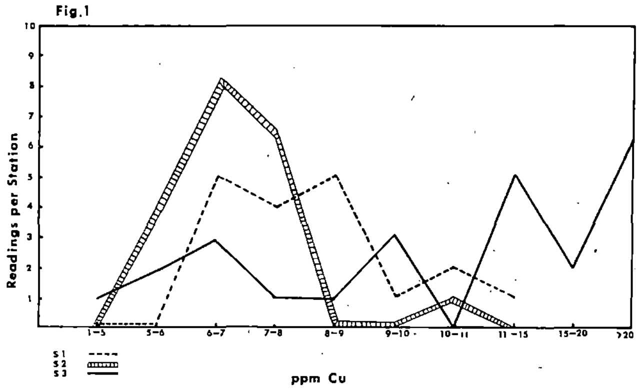

FIGURE 1. Copper concentration distribution curve for bottom feeding fish from stations 1, 2 and 3.

tion of .12 ug/g. Bottom feeding fish from station 2 showed an average mercury level of .38 ug/g of tissue with a standard deviation of .14 ug/g. Bottom feeders from station 3 showed a mean mercury level of .49 ug/g of tissue with a standard deviation of .24 ug/g.

Application of the T-test showed less than a 50% chance that stations 1 and 2 were different and showed a 80-90% chance that station 1 and 2 differed from station 3. Figure 3 is a graph comparing mercury concentration values from the three stations.

Mercury concentration in crappies showed the same difference from bottom feeders that was found among copper samples. Mercury concentration in tissue from station 2 was .28 ug/g with a standard deviation of .20 ug/g. The mean mercury concentration in tissues from station 3 was .22 ug/g of tissue with a standard deviation of .10 ug/g. This finding is illustrated in figure 4.

Water samples taken by the Minnesota Pollution Control Agency showed the water above Scheldahl's effluent entrance to have concentrated less than 10 ug/l copper. The water below the Scheldahl ditch had a copper level of 27 ug/l of water. The MPCA also reported Mercury concentrations above the area of Scheldahl's effluent to have less than .05 ug of mercury per liter of water. Analysis of water downstream from the Scheldahl drainage ditch had a level of .05 ug of mercury per liter of water. Findings of the MPCA in 1971 add verification to findings of this study showing increasing concentration of trace metals in the water.

During this research the weights of the fish were graphed and compared against the concentration of Cu

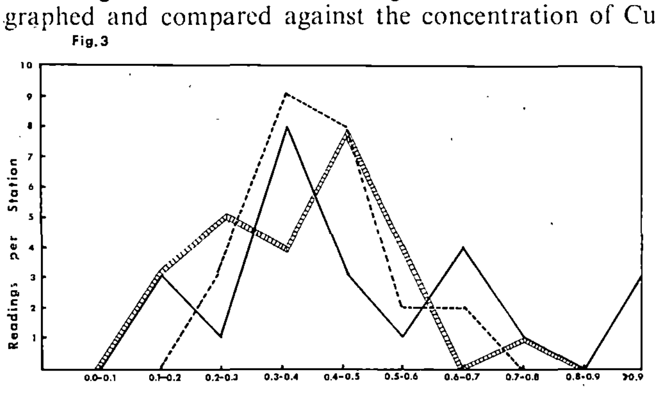

FIGURE 3. Mercury concentration distribution curve for bottom feeding fish from stations 1, 2, and 3.

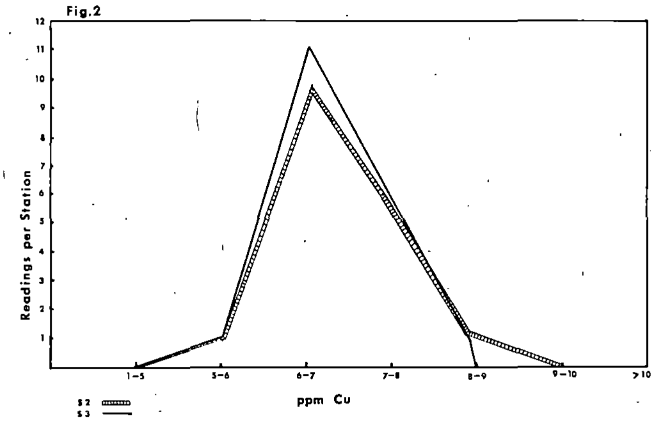

FIGURE 2. Copper concentration distribution curve for secondary feeders from stations 2 and 3.

and Hg found. Except for very general trends there proved to be no correlation between increasing fish weights and increasing concentration of trace metals studied.

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References

ARMSTRONG, F.A. UTHE, J.F. 1971. Semi-automated Determination of Mercury in Animal Tissues. *At. Abs. Newsl.*, 10:5, pp 101-103.

CHLORINE INSTITUTE. 1971. Analytical Methods for Determination of Mercury.

LEONARD, EDWARD N. 1971. The Determination of Copper in Fish Tissues by Atomic Absorption Spectrophotometry. *At. Abs. Newsl.*, 10:4, pp. 84-85.

MARINE, GENE. AND ALLEN, JUDITH K. 1972. Food Pollution: A Violation of our Inner Ecology. New York, Holt Rhinehard and Winston.

MINNESOTA POLLUTION CONTROL AGENCY. 1971. Memorandum on investigation of Cannon River and sources of wastes in and near Northfield. St. Paul.

UNDERWOOD, E.J. 1971. *Trace Elements in Human and Animal Nutrition.* New York, Academic Press.

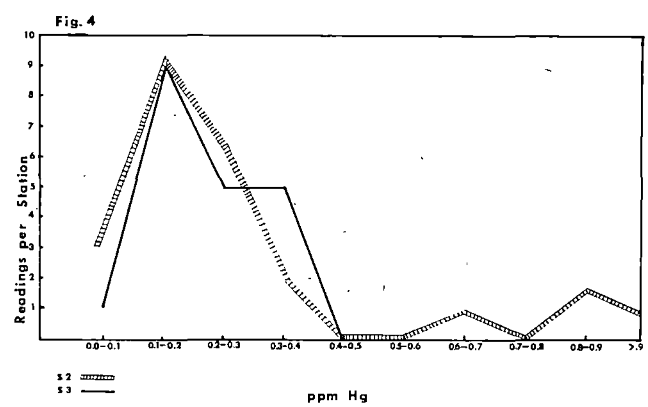

FIGURE 4. Mercury concentration distribution curve for secondary feeders from stations 2 and 3.