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CONCENTRATION AND TRANSPORT OF ^{32}P AND ^{65}Zn BY COLUMBIA RIVER PLANKTON

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Concentration and Transport of ^{32}P and ^{65}Zn by Columbia River Plankton[1]

Most large rivers contain a biologically significant phytoplankton population. Radioecological studies of this community in the Columbia River have been in progress at this laboratory for several years. This paper describes aspects of the concentration and transport of ^{32}P and ^{65}Zn by net plankton past a point 16 km below the reactor areas on the Hanford Atomic Products Operation reservation in southeastern Washington.

Coopey (1953), Robeck, Henderson, and Palange (1954), Davis, Watson, and Palmiter (1956), and Davis (1960) have published data on the radionuclide content of Columbia River plankton. Improved radioanalytical techniques have since permitted a more precise evaluation of the radionuclide burden of the plankton. This and significant changes in hydrologic conditions in the river, led to the measurements reported in this note.

I would like to acknowledge the capable field and laboratory assistance of Mr. T. K. Andrews, Jr.

METHODS

Plankton samples were collected twice monthly from several stations along a transect across the river. Data presented are averages of the analyses for each station. Unequal distribution of velocity, volume, and reactor effluent plumes dictated sampling at several points. Water was pumped from 1.5 m below the surface, using an Oceanic Instruments submersible plankton pump, and filtered through a No. 20 mesh plankton net (68 meshes/cm) suspended in a barrel of water to minimize filtering pressure. The term plankton, as used in this paper, includes both the living and dead organic matter retained by this net. Inorganic silt and sand were mostly eliminated by repeated decanting after settling. Water filtered for each sample varied from 500 to 3,000 liters, depending on the abundance of plankton. Gravimetric and radioassay techniques were similar to those described by Cushing (1967). Two composited water samples were taken from the sampling stations for chemical analyses after filtration through a 0.45-μ filter. Dissolved PO_4^{3-} was measured by the phosphomolybdate blue method (Murphy and Riley 1962) with slight modifications for local conditions; Zn^{2+} was determined by extraction with dithiozone from one sample. Dissolved ^{32}P and ^{65}Zn were determined in the second sample after further concentration and organic chemical extraction.

RESULTS AND DISCUSSION

The seasonal patterns of ^{32}P and ^{65}Zn concentrations in net plankton are shown in Fig. 1a. Lowest seasonal values coincided with the spring-summer high water period. River flow increases in May, reaches a maximum in June, and gradually declines to normal levels by September. Contribution of reactor effluents to the river remains relatively constant; hence, the greatest dilution of radionuclides occurs during periods of greatest river volume. This period also coincides with the seasonal increase of plankton biomass. This combination of environmental factors resulted in lower concentrations of radionuclides per unit weight of plankton. This relationship is supported by the seasonal variations in the concentration factors (ratio of nCi/g wet wt of plankton to nCi/ml water)[2] which were lowest during the spring and summer. Concentration factors for ^{32}P ranged from 5,000 to 118,000 and for ^{65}Zn from 300 to 19,000; highest values for both isotopes occurred in fall and winter. Seasonal fluctuations of the dissolved stable and radioactive isotopes of both elements in the water were generally similar. Concentration factors for Columbia River net plankton published by

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[2] nCi = nanocurie = 10^{-9} Curie. Editor.

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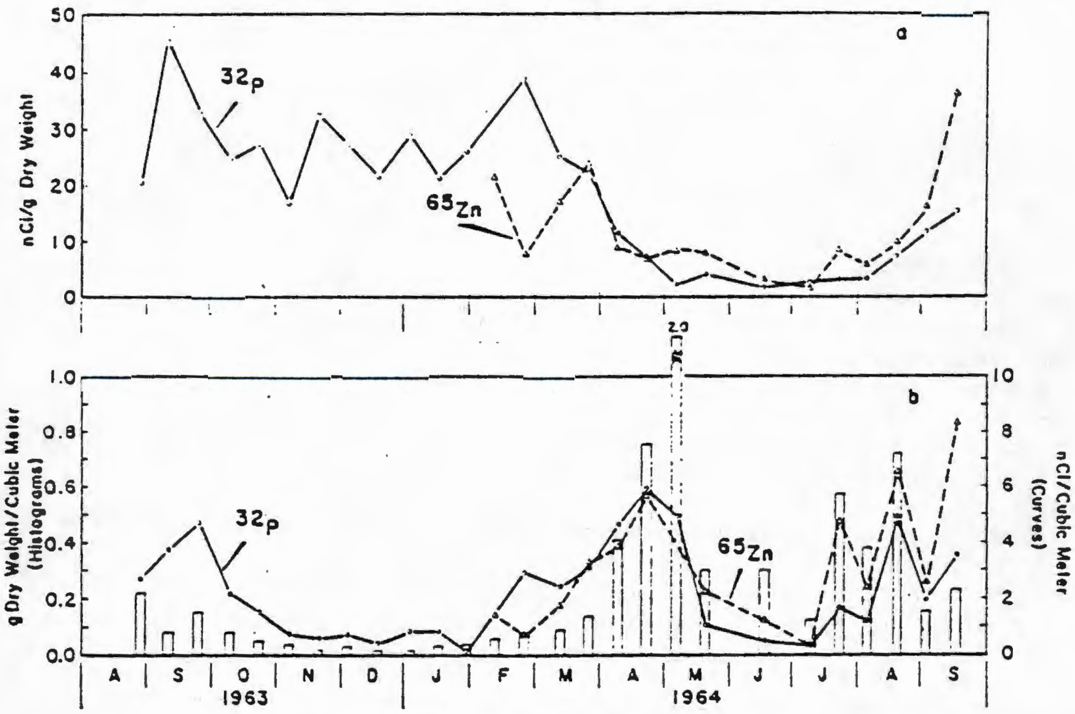

FIG. 1. a. Concentration of ^{32}P and ^{65}Zn by net plankton. b. Concentration of net plankton and associated ^{32}P and ^{65}Zn in water.

Coopey (1953) and Davis et al. (1956) were much lower because their measurements were reported as total beta activity. This means that counts of water samples were inflated by a number of radionuclides that were not concentrated in the plankton. Coopey's seasonal curve, however, was similar to that found in the present study. The seasonal variation in radionuclide concentration was also similar to that found by Robeck et al. (1954), Davis et al. (1956), and Davis (1960).

Fig. 1b shows the seasonal pattern of net plankton biomass/m^2 of water and the amount of associated ^{32}P and ^{65}Zn. Seasonal fluctuations of these measurements were similar, although not entirely synchronous. Lowest values occurred during fall and winter; seasonal peaks were found in spring and late summer. The spring peak of plankton is mainly *Asterionella*, while the later increase is dominated by *Fragilaria* sp. (Cushing 1964). Recent studies of net plankton, in conjunction with nutrient cycling studies in the Columbia, show that *Fragilaria* may be increasing markedly in numbers, particularly in spring. Biomass variations were similar to those found by Coopey (1953), although greater by a factor of about two in this study. Both the species change and biomass increase are probably related to the completion, since the previous studies, of two power dams immediately upstream from the Hanford reservation.

Estimates of the daily transport of plankton biomass and ^{32}P and ^{65}Zn associated with the plankton can be made by combining the data in Fig. 1b with the flow values (U.S. Geological Survey 1963–1964) of the Columbia River on that day. The quantity of plankton transported ranged from 0.3×10^4 kg dry wt/day on 2 January to 38.5×10^4 kg dry wt/day on 22 July. The amount of ^{32}P transported by plankton ranged from 0.002 Ci/day on 29 January to 1.43 Ci/day on 19 August; the range for ^{65}Zn was from 0.14 Ci/day on 26 February to 3.8 Ci/day on 22 July. The transport of radionuclides was low and relatively stable during periods of low river flow and increased with random fluctuations during high flows. Despite lower radionuclide concentrations and concentration factors in spring and summer, more ^{32}P and ^{65}Zn are transported by the plankton at this time due to the increased plankton biomass being carried by the greater river flow.

Comparing these data with estimates of total transport of ^{32}P and ^{65}Zn at a site 35 km below the study area (Wilson 1965), the radioactivity associated with plankton at the study site was approximately 1 to 2% of the total river transport of each of these radionuclides. Thus, in spite of the high concentrations and concentration factors of the plankton as compared to other constituents of the river, the actual relative transport by this community is quite small.

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