COMMENT

Phosphorus release by zooplankton

Peters and Rigler (1973) reported on the primitive state of measuring the rates of P release by zooplankton. They emphasized the variability in published rates and suggested that much of the disparity resulted from experimental artifacts. Values were greatest for experiments in which radiotracer release was measured and lowest for experiments in which reactive molybdate phosphorus release was measured. Peters and Rigler believe that uptake of phosphorus by ultraplankton lowers the estimates obtained in the latter experiments.

They found the lowest rates for zooplankton were those that we reported from Cayuga Lake (Barlow and Bishop 1965). In our paper, the rates were reported in three forms: table 1 summarized the average values, fig. 1 illustrated the rates against body weight, and regression equations relating the rates to body weight were presented on page R18. Peters and Rigler used the regression equations.

Unfortunately, the legend for the horizontal axis in our fig. 1 was unclear and the values that we gave for coefficients in the equations actually were for the logarithm to the base 10 of the coefficients. The horizontal axis which was published as log wt $\mu g \times 10^{-1}$ was intended to indicate the logarithm to the base 10 of the dry weight in micrograms of 10 individuals. The corrected equations are:

Epilimnetic zooplankton

in epilimnion (20°C) $R = 4.5 \times W^{-0.69}$
in hypolimnion (5°C) $R = 2.3 \times W^{-0.45}$

Hypolimnetic zooplankton

in epilimnion (20°C) $R = 22.7 \times W^{-0.92}$
in hypolimnion (5°C) $R = 7.2 \times W^{-0.99}$

where R is the release rate (μg-atoms P g^{-1} hr^{-1}), W is the dry weight (μg $individual^{-1}$), and the numerical values are constants estimated by the least squares method. These corrections bring the values much more in line with those in our table 1.

To compare predictions based on the corrected regressions with two kinds of estimates from Peters and Rigler, we will consider an individual weighing 5 μg. This size is within the range used by Peters and Rigler but is larger than those we studied in Cayuga Lake, so that the predictions are subject to possible errors introduced through extrapolation. The estimated release rates at 20°C are 0.05 and 0.16 μg P mg^{-1} hr^{-1} for epilimnetic and hypolimnetic zooplankton.

One comparison is with a prediction based on the multiple regression in Peters and Rigler (p. 830) in which release rates were related to temperature, food concentration, time after removal from radioactive food, body weight, and food phosphorus concentration. The temperature and body weights are as above. Food concentration is 15,000 cells ml^{-1} to coincide with measured values in Cayuga Lake (B. Peterson personal communication). The food phosphorus concentration is taken as 50% of the sestonic phosphorus that passes through a 120-μ net: a typical value for Cayuga Lake is 0.0047 μg P ml^{-1} (B. Peterson personal communication). Time after removal from radioactive food is zero minutes. The predicted value of the release rate is 0.53 μg P mg^{-1} hr^{-1}.

The other comparison is with a prediction based on the multiple regression in Peters and Rigler (p. 831) that related ingestion rates with food phosphorus concentration, temperature, and body weight. Their equation was based on the results of experiments in which the food phosphorus concentrations were uncertain; values derived from the equation, therefore, should be viewed with caution. With the above data for Cayuga Lake, the estimated ingestion rate is 0.49 μg P mg^{-1} hr^{-1}. A value of 54% for the assimilation efficiency, as suggested by Peters and Rigler, yields a release rate of 0.27 μg P mg^{-1} hr^{-1}.

The estimates of release rates based on radiotracers and illustrated here differ from each other by about twofold. They differ from the average estimate based on molybdate reactive phosphorus measurements in our earlier studies by threefold to fivefold. We believe that, although experiments with radiotracers may yield somewhat higher estimates, there is insufficient evidence that these estimates are more reliable than those obtained using the reactive molybdate analysis. We also believe that the limited variability of the estimates of zooplankton P release compared with the great variability of other parameters in the P cycle of lakes does not warrant despair with the reactive molybdate phosphorus technique of determining zooplankton P release or the general problems of estimating these rates.

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Fluoride: Global circulation

Kilham and Hecky (1973) convincingly demonstrated that the high levels of fluoride in East African surface waters are due to rock weathering. However, they have extended the interpretation of their data to the global circulation of fluoride in a way that is unjustified.

Kilham and Hecky propose, contrary to the views of Carpenter (1969), that the majority of fluoride entering the World Ocean is derived from weathering and not from atmospheric recycling of oceanic fluoride. To support this thesis they suggest that the F:Cl ratios in atmospheric precipitation quoted by Carpenter (0.03–0.12 kg kg^{-1}) are due primarily to fluoride from volcanic emanations, anthropogenic activity, and atmospheric dust of continental origin. Bewers (1972) has shown that the average F:Cl ratio in atmospheric precipitation required to account for all the fluoride in rivers is only 0.013 kg kg^{-1}. While we admit that even this figure requires considerably more efficient transport of marine fluoride than chloride through the atmosphere, one cannot conclude, as Kilham and Hecky have done, that this must infer the existence of elevated (relative to seawater) F:Cl ratios in marine aerosols. It is indeed pertinent to this discussion that Wilkniss and Bressan (1971, 1972) have established that the F:Cl ratio in marine aerosols is close to that of seawater, but to assume that aerosols are the only agents of fluoride transport from the oceans to the atmosphere is premature. Calculation of the hydrogen fluoride flux across the sea–air interface, based on the model of Liss and Slater (1974), suggests that sufficient fluoride to account for the concentrations of this element found within the hydrologic cycle can enter the atmosphere in gaseous form.

In their work on the MacKenzie River basin, whose waters and sediments have fluoride concentrations close to that of the world average river, Reeder et al. (1972) concluded that precipitation is a primary