TRANSACTIONS, ILL. STATE ACAD. SCI.
Vol. 68, No. 2 (1975)

# UPTAKE OF CADMIUM AND NICKEL BY SALVINIA

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## ABSTRACT

The uptake of cadmium and nickel by Salvinia, an aquatic fern, was monitored over a three-week period. The concentration factor was found to be approximately 1000, indicating a potential hazard to animals higher in the food chain.

## INTRODUCTION

Several types of potentially hazardous substances are known to become concentrated as they move up the food chain. The classic example, DDT, has been shown to accumulate in fatty tissue and detoxify very slowly. (Stoker, 1972b)

Very similar in respect to bioconcentration are toxic heavy metals (Stoker, 1972a; Josephson, 1974). Recent studies have shown that aquatic plants are particularly prone to incorporate these metals, particularly those with extensive plant structure in contact with water (Cearly, 1973). One such species of water plant which occurs widely is Salvinia, a floating fern with a large exposed root-like rhizoid system.

This study was undertaken to investigate the uptake of nickel and cadmium by Salvinia. This species is widely distributed (Benson, 1957) and has the potential for extensive incorporation into the food chain.

## MATERIALS AND METHODS

### Reagents

Stock solutions of cadmium and nickel were prepared from reagent grade salts and distilled deionized water, and were acidified to prevent precipitation. Metal content of the stock solutions was determined by titration with primary standard quality EDTA using well-established methods (Meites, 1963). All metal salt solutions were stored in polyethylene containers.

Reagent grade concentrated nitric was used in the acid digestion procedure. The lot of acid used was analyzed for cadmium and nickel by graphite furnace atomic absorption. Less than 0.02 PPM of cadmium

or nickel was found. Great care was taken to avoid contamination of the acid; it was kept tightly closed in a dust free storage area.

Apparatus

A Beckman Model 5 pH meter with a glass multielectrode was used for pH measurement.

A Beckman Fieldlab oximeter with membrane electrode was used to determine dissolved oxygen.

Metal concentrations were determined with a Perkin Elmer model 360 atomic absorption spectrophotometer equipped with an HGA 2100 graphite furnace and a slotted laminar burner. Both Perkin Elmer and Westinghouse hollow cathode lamps were used with the instrument.

A Kimble microliter pipet with disposable plastic tips was used with the graphite furnace atomic absorption measurements.

Procedure

Aerated and acclimatized water was spiked to $\sim$0.10 PPM with addition of stock metal solutions. Three liters of such treated water were placed in large beakers and approximately 5 grams of Salvinia were added. The containers with plants were placed in the Illinois State University greenhouse under fluorescent lamps which had a 14 hour photoperiod. Samples were taken periodically over three weeks.

Water quality parameters were monitored over the uptake period. Average values were: temperature - 23.0° C, dissolved oxygen - 8.4 PPM, hardness - 160 PPM ($CaCO_3$), and pH - 7.1. All values showed less than 5% variation over the three week period. Samples were aerated to maintain dissolved oxygen levels.

Samples of approximately 200 mg were taken, thoroughly washed, dried for 30 minutes at 180°C, and weighed, and placed in a clean 50 ml pyrex beaker. Exactly 10.00 ml of reagent grade nitric was added, and the samples were digested in a fume hood approximately 45 minutes. The ashed samples were cooled, transferred quantitatively to a clean 25 ml volumetric and diluted to volume with distilled, deionized water.

Flameless atomic absorption was used for analysis of control sample and samples taken at 1-3 days. Flame atomic absorption was used for all other samples. Instrumental settings were those prescribed by the manufacturer (Perkin-Elmer Corp. 1973-1974). Standard addition was used to minimize matrix effects, and results were calculated using a least squares program on a Wang programmable calculator.

An acid blank was analyzed for cadmium and nickel, and the values subtracted to correct for the small amounts in the nitric acid used.

## RESULTS

A large bioconcentration was observed for both cadmium and nickel. As can be seen in the table, the heavy metal levels rose to a maximum level and remained nearly the same for the course of the experiment.

TABLE

Cadmium and Nickel Uptake

Cadmium

| Length of Exposure (Days) | Concentration (ug/g) |
|---|---|
| 0 | 2.3 |
| 1 | 61 |
| 2 | 94 |
| 3 | 116 |
| 5 | 120 |
| 10 | 156 |
| 15 | 152 |
| 21 | 157 |

Nickel

| Length of Exposure (Days) | Concentration (ug/g) |
|---|---|
| 0 | 2.6 |
| 1 | 60 |
| 2 | 88 |
| 5 | 142 |
| 8 | 161 |
| 13 | 165 |
| 19 | 165 |
| 21 | 164 |

## DISCUSSION

The initially high values for cadmium and nickel are further evidence for the bioconcentration of these metals. Analysis of the water used for growing Salvinia showed that this water contained 0.006 PPM (6 PPB) cadmium and 0.010 PPM (10 PPB) nickel. The bioconcentration factor, the ratio of the final concentration in the plant material to the concentration in the water, is seen to be about 400 for cadmium and 300 for nickel in the control samples. This is consistent with the order of magnitude of the concentration factor for the plants exposed to water with added heavy metal. The overall factor for the uptake experiment is approximately 1000 for both cadmium (0.106 - 157 PPM) and nickel (0.110 - 165 PPM).

It is interesting to note that a large difference in toxicity was observed in the two uptake samples. Nickel apparently has little short term effect on the plants, as contrasted to the yellowing and loss of turgor observed with the cadmium treated plants.

Further experiments are in progress to evaluate the uptake of mercury and lead in Salvinia by these methods.

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