PHYTOPLANKTON COMMUNITY OF AN ACIDIFIED, HEAVY METAL—CONTAMINATED LAKE NEAR SUDbury, ONTARIO: 1973–1977

N. D. Yan

Limnology and Toxicity Section, Water Resources Branch, Ontario Ministry of the Environment.

(Received 6 July 1978; revised 26 September 1978)

Abstract. Phytoplankton data for 1973 to 1977 from Clearwater Lake, an acid- and heavy metal-contaminated lake near Sudbury, Ontario are presented. *Peridinium inconspicuum* (Lemmermann) comprised between 30 and 55% of the average, ice-free period biomass of 0.33 to 0.73 mg l⁻¹ and is considered indicative of acidic lakes if it forms a substantial portion of the total biomass. The data were compared with those from three other contaminated and ten uncontaminated lakes in Ontario. The phytoplankton communities of all contaminated lakes were dominated by *P. inconspicuum* while chrysophytes dominated the uncontaminated lakes. Community biomass was better correlated with phosphorus concentration than with hydrogen ion concentration. There was some evidence of reductions of biomass in lakes with the highest heavy metal concentrations. Limitations of phytoplankton data collected in synoptic surveys are discussed.

1. Introduction

Recently, several (regional or synoptic) studies of lakes affected by atmospheric deposition of acidic substances have demonstrated that acidification of lakes is accompanied by a reduction in numbers of phytoplankton species (Hörnström et al., 1973; Almer et al., 1974; Leivestad et al., 1976; Kwiatkowski and Roff, 1976). The number of samples collected from each lake in these studies, however has been restricted, often to a single sample. The communities have been sampled at one depth, either at one half the Secchi disk depth (Kwiatkowski and Roff, 1976) or at the surface (Hörnström et al., 1973). Nets have been employed to integrate samples through the euphotic zone (Leivestad et al., 1976). These techniques fail to account for vertical inhomogeneities in phytoplankton distribution (Fee, 1976) or for potentially large, short-term (Vogel et al., 1976) or seasonal fluctuations in biomass and species composition of communities sampled at one depth (Willen, 1969) or through the euphotic zone (Kling and Holmgren, 1972). If plankton nets are employed, the techniques underestimate the biomass of nannoplankton (Kalff, 1972). As a result, the data generated from these studies cannot be used to describe quantitatively the biomass and community structure of the phytoplankton of any specific lake, to differentiate between communities of different lakes, or to attribute causes, empirical or otherwise, to observed changes in community structure. Data that can be used for such purposes are presented herein.
Lakes near Sudbury, Ontario that have been acidified and contaminated by heavy metals have been investigated for many years (Gorham and Gordon, 1960; Beamish and Harvey, 1972; Stokes, 1975; Conroy et al., 1975). Since 1973 we have studied Clearwater Lake and three other lakes (Middle, Hannah and Lohi) that have been contaminated by atmospheric deposition of acids and heavy metals (Dillon et al., 1977). While the chemistry of the latter three lakes has been manipulated by experimental additions of neutralizing and fertilizing agents (Scheider and Dillon, 1976) we have not adjusted the chemistry of Clearwater Lake. We have also investigated water chemistry and phytoplankton populations of ten Precambrian Shield Lakes that are not overtly acid- or heavy metal-contaminated.

The objectives of this paper are:

1. To describe seasonal and annual variations in the biomass and species composition of the phytoplankton community of Clearwater Lake;
2. To investigate the extent to which typical relationships between phosphorus concentration and phytoplankton community parameters are influenced by acidification and heavy metal contamination of lakes; and
3. To assess the reliability of information obtained in less intensive studies of phytoplankton communities of acidic lakes.

2. Methods

Samples were collected at weekly or biweekly intervals at the deepest spot in each lake for the periods of time shown in Table I. Samples for chemical analyses were collected to within 1 m of the lake bottom; phytoplankton samples were collected through the euphotic zone, defined as twice the Secchi disk (23 cm diameter) depth.

During periods of spring and fall overturn, water was collected by lowering a 2.5 cm i.d. weighted tygon tube to the appropriate depth, clamping it at the surface, raising the lower end of the tube by an attached line and emptying it into a polyethylene bucket which had been previously acid-washed (5% HCl) and rinsed at least three times with distilled water and three times with lake water. When the temperature difference between lake surface and bottom was > 4°C lake water was collected with a 6 l Van Dorn bottle at 2 m intervals through the appropriate depth. A single volume-weighted sample was obtained by dispensing into the bucket an amount of water from each sampling depth proportional to the volume of that lake stratum. Separate samples for different analyses were then taken from the bucket. Cu and Ni samples were preserved with 1 ml 1⁻¹ concentrated nitric acid and analyzed by atomic absorption spectrophotometry after nitric-sulfuric digestion; total P was determined by persulfate digestion on unfiltered samples (Ontario Ministry of the Environment, 1975). Measurements of pH were performed within a few hours using either a Corning Digital 109 or a Radiometer 22 pH meter after appropriate buffer calibrations.