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STUDIES ON THE EFFECTS OF POLLUTION ON THE DIATOM COMMUNITIES OF THE ST. LAWRENCE RIVER NEAR MONTREAL

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Abstract. A study was conducted to establish the physico-chemical and biological characteristics of two water masses (St. Lawrence and Ottawa) just before they meet near Montreal. The two water masses show marked differences in physico-chemical properties and in the composition of algal communities they support. As compared with that of St. Lawrence River, the water of Ottawa River shows lower values of alkalinity, conductivity, total hardness and chlorides. The value of pH is also slightly lower. But the quantity of Silica and Ammonia present in the Ottawa River is much higher. There is a marked difference in the composition of Algal communities supported by the two water masses. Over 100 species of Diatoms were found to colonize the artificial substrates (glass slides), of which only about 40 species were found to be common in both waters. Some 38 species were found only in St. Lawrence River and another 39 species only in Ottawa River. The two water masses also differed in supporting other groups of algae. *Cladophora glomerata* was very abundant in Ottawa River, whereas,it was absent or very rare in St. Lawrence River. On the other hand, some members of Zygnemaceae (like *Sirogonium sticticum*, *Spirogyra sp.*, *Mougeotia sp.*, and *Zygnema sp.*) were very abundant in St. Lawrence River and very rare in Ottawa River.

INTRODUCTION

The St. Lawrence River receives water from the Ottawa River, some before the island of Montreal (west end of the island) and some after it (east end). During their course past the island, they receive large quantities of sewage and industrial waste. To study the effect of these pollutants on the biotic communities of the two rivers, a research project was started last summer (1973). The present report is based on the data collected at four stations located at the west end of the island.

The difference in the physical nature of the waters of the Ottawa and the St. Lawrence Rivers is very pronounced. The water of the Ottawa River is relatively more turbid and brownish in color, whereas that of the St. Lawrence River is less turbid and greenish in color. Blackwell noticed this difference as early as 1869 when he referred to the water of the Ottawa River as "brown, peaty-colored waters" (Blackwell 1869).

The first detailed chemical analysis of the two water masses was conducted by Brundritt (1963). He also noticed the difference in the planktonic populations of the two water masses. Cardinal (1964) studied the seasonal variation in the phytoplankton population of Lake St. François, which is a few miles upstream of the St. Lawrence River. As far as the authors are aware, no detailed study has been done on the Diatom communities of the two water masses using identical techniques. However, several workers have found Diatoms as reliable indicators of stream conditions (Bahls 1973; Patrick 1953; Palmer 1963, 1969; Round 1951).

We started a project last summer to study the effects of pollution created by the Island of Montreal on the algal communities (mainly diatoms) of the St. Lawrence River. This river also receives water from the Ottawa River just before it reaches de Island of Montreal. We decided to study the following three aspects of the problem:

(a) Physico-chemical and biological characterization of the two water masses (St. Lawrence and Ottawa Rivers).

(b) Changes in the structure of diatom communities supported by the St. Lawrence River after it has received the municipal and industrial wastes

(c) Effects of individual pollutants on these diatom species under controlled laboratory and simulated stream conditions.

The present report concerns the first aspect of the problem.

MATERIALS AND METHODS

Sampling Stations (Fig. 1)

After a general survey of the area where the two rivers meet, four stations were chosen for this study, two in the Ottawa River and two in the St. Lawrence. Station No. 1 was on the south shore of Ile Perrot; Station No. 2, on the north shore of Pointe-des-Cascades facing Station No. 1. Both of these stations were in the brown water (Ottawa River).

Station No. 3 was not far from Station No. 2 but on the south shore of Pointe-des-Cascades. Station No. 4 was near the village of Maple Grove on the north-west shore of the mainland. Both of these stations (No. 3 and No. 4) were in the green water (St. Lawrence River).

Sampling of the Diatoms

Regular microscope glass slides were used as standard artificial substrates in all four stations. The technique employed for this was very similar to the one described by Dr. Ruth Patrick (Patrick *et al.* 1954; Patrick and Hohn 1956). From 8 to 10 glass slides were placed in a simplified version of a Catherwood Diatometer and left in the water for at least two weeks. During this period, a large number of diatom species colonized on the slide surfaces.

Cleaning of Diatoms

After two weeks or more, the slides were removed from the water and taken to the laboratory. The diatoms were scraped from the slides and cleaned by boiling with a mixture of hydrochloric and nitric acids. Excess acid was poured off and the diatoms were washed several times with distilled water until traces of the acids were removed. The cleaned diatom frustules were stored in ethanol.

Permanent slides were prepared and the diatoms were identified under oil immersion objectives.

Chemical Analysis of Water

Most of the chemical analyses were done using the HACH kit model DR-El. The pH and alkalinity were determined right in the field. Other analyses were carried out in the laboratory within 3 to 5 hours after sam pling.

DISCUSSION

The two water masses (Ottawa and St. Lawrence Rivers) show distinct physico-chemical features. Our result was found to be very similar to the previous studies on the nature of the two rives (Brundritt 1963 Pageau and Levesque 1970; Pageau 1972). The data on the chemical nature of the two water masses is summarized in the Table 1 and represented

FIG. 1. The Ottawa and St. Lawrence Rivers near Montreal showing four sampling stations.

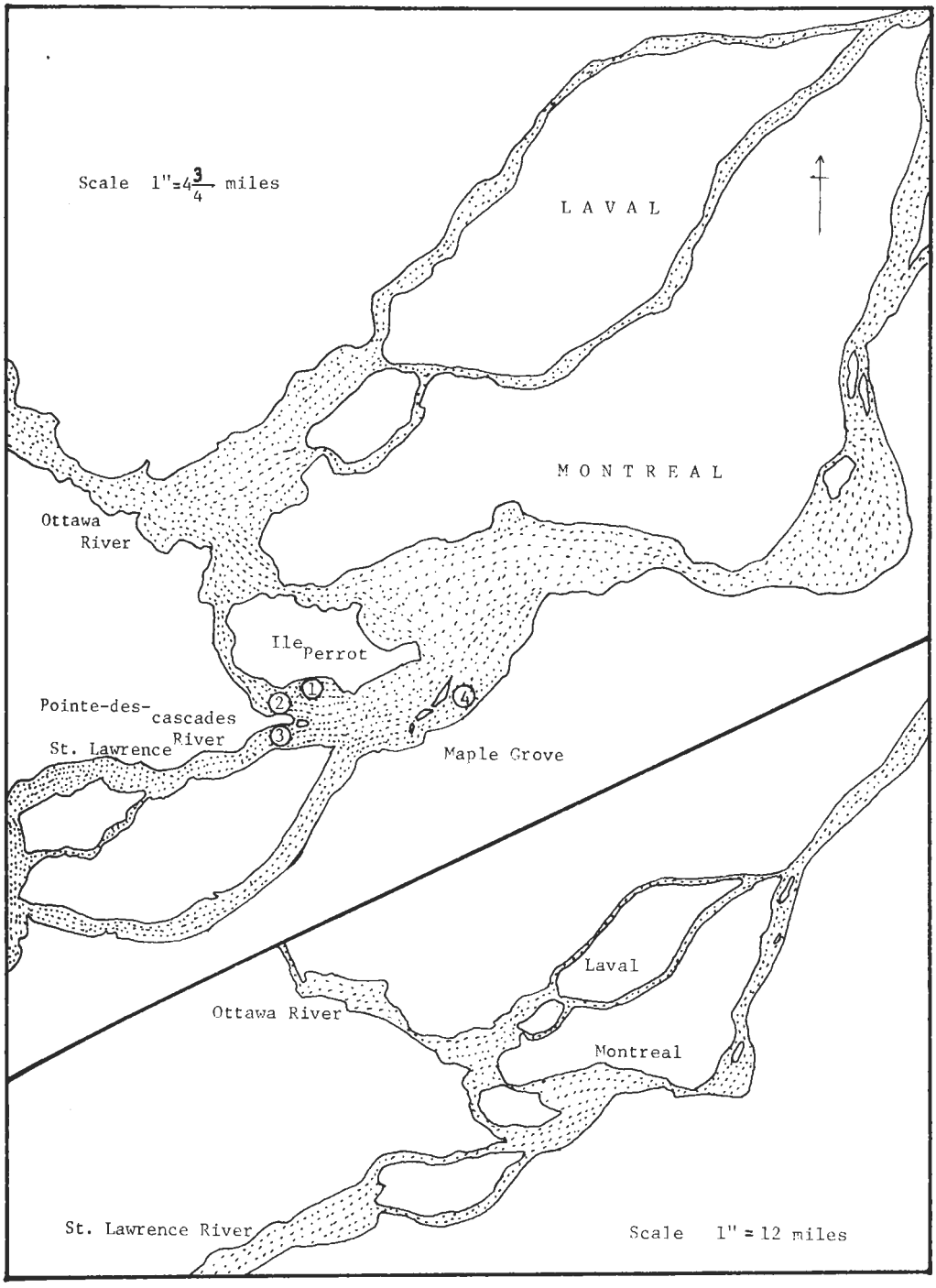

TABLE 1. Chemical analyses of brown and green waters

Parameters		Brown water	Green Water
pH		7.25 - 8.5	7.8 - 8.7
Turbidity	Jackson turbidity unit	4 - 40	0 - 20
Alkalinity	mg/lit. ($CaCO_3$)	20 - 40	65 - 90
Conductivity	μ mho/cm	60 - 125	250 - 310
Hardness (total)	mg/lit. ($CaCO_3$)	30 - 45	110 - 140
Hardness (calcium)	" "	20 - 40	80 - 100
Silica	mg/lit.	0 - 9.8	0 - 1.1
Sulphates	"	8 - 80	13 - 47
Orthophosphates	"	0 - 0.21	0 - 0.08
Iron	"	0 - 0.28	0 - 0.05
Chlorides	"	5 - 20	30 - 45
Ammonia	"	0.2 - 0.4	0 - 0.08
Nitrites	"	0 - 0.005	0 - 0.0165

graphically in Fig. 2.

The brown water was found to be much more turbid than the green water. It showed lower values of alkalinity, total and calcium hardness and chlorides. But the quantities of ammonia and silica were much higher in the brown water than in the green (Fig. 2). Higher quantities of silica may be the reason for luxuriant growth of some species of diatom in the brown water.

Brundritt (1963) noted that the surface brown water was neutral and green water alkaline. Our study indicates that even the brown water is slightly alkaline.

The glass slides in the two water masses were colonized by over 130 different entities of diatoms, 39 of which were found exclusively in the brown water and 36 only in green water. Most of the species found in the two water masses were not that common. The predominant species of both waters was *Cocconeis placentula* although it was more numerous in the brown water than in the green. In the brown water *Cocconeis placentula* constituted over 80% of the diatom population. Other abundant species in the brown water consisted of *Achnanthes lanceolata*, *Synedra pulchella* and *Melosira granulata*. In the green water, the abundant species were *Navicula cryptocephala*, *N. anglica*, *Nitzchia linearis*, *Fragillaria pinnata* and *Gyrosigma spencerii* (Table 2).

Over 80% of the slide surface was covered with diatoms. Ocassionally, species of green algae also colonized the slides. In the green water, it was *Coleochate sp.*, but in the brown water it was *Stigeoclonium sp.* and some times *Oedogonium sp.* and *Ulothrix sp.*

FIG. 2. Graphic representation of the data on the chemical analyses of the brown and green waters presented in Table I.

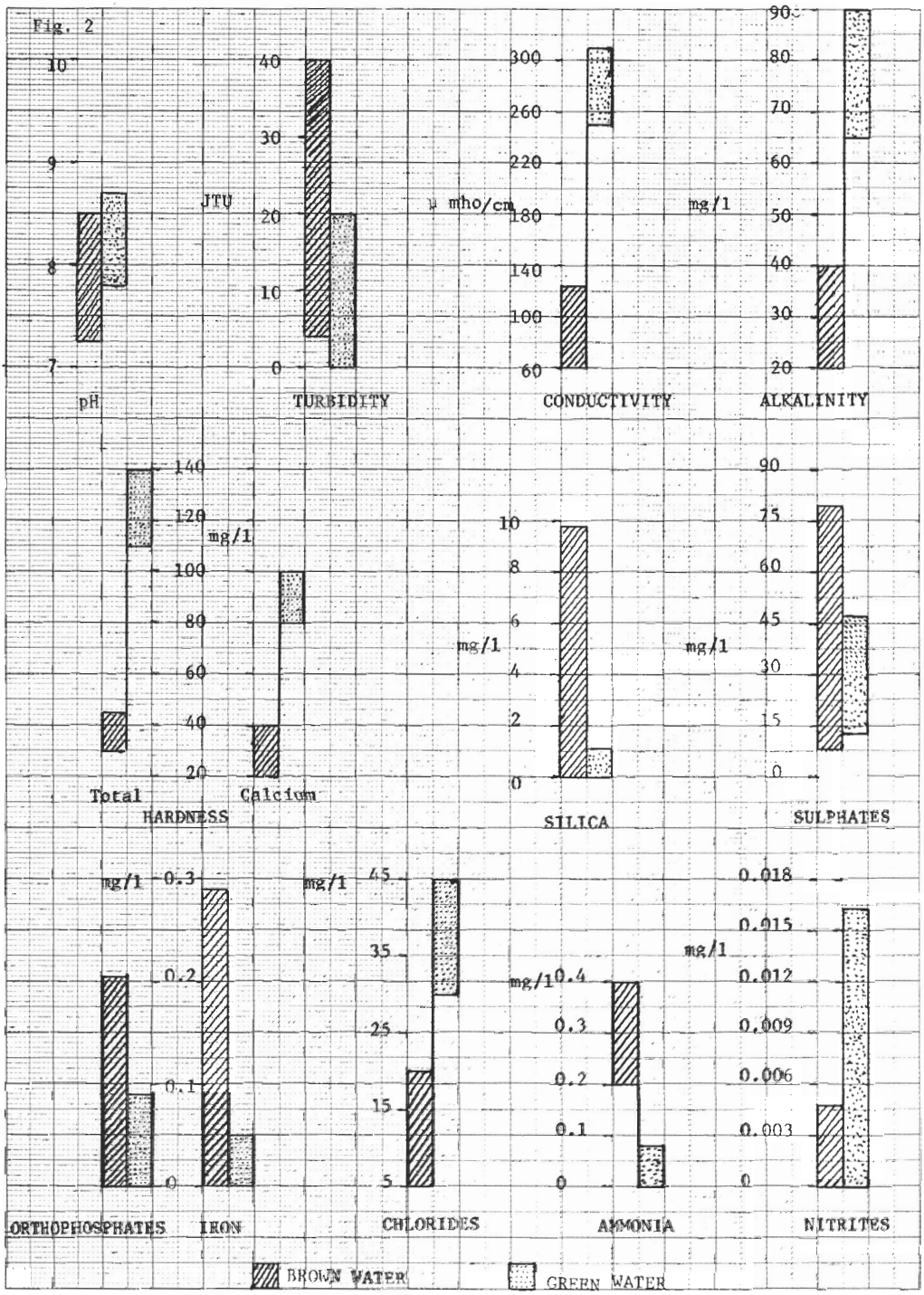

TABLE 2. List of dominant and abundant species of diatoms

Brown water	Green water
Cocconeis placentula (dominant)	*Cocconeis placentula* (dominant)
Achnanthes lanceolata	*Navicula cryptocephala*
Synedra pulchella	*N. anglica*
Melosira granulata	*Nitzschia linearis*
	Fragillaria pinnata
	Gyrosigma spencerii

In addition to the periphytic communities on the glass slides, other dominant and abundant species of each station were also examined. In the brown water, *Cladophora glomerata* and *Stigeoclonium sp.* were found to be dominant most of the time, whereas, in the green water it was usually members of Zygnemaceae *(Sirogonium strictum, Spirogyra sp., Zygnema sp.* and *Mougeotia sp.)*.

The above observations indicate clearly that there are considerable differences in the physico-chemical nature of the two water masses (Fig. 2), as well as in the composition of the algal communities they support (Table 2).[1] Research is being continued to study the effect of pollutants added to the two water masses as they flow past the island of Montreal. Data from chemical analyses of water and the structure of algal communities from 3 downstream stations are being analysed to determine the change in the water chemistry and the algal communities and will form the subject of another publication. Most of the dominant species have also been isolated into axenic or unialgal cultures. Experiments are underway to study the effects of the individual pollutants on these diatom species.

Using identical methods, we have been able to establish the nature of the diatom communities supported by each of the two water masses (St. Lawrence and Ottawa Rivers). At present, it is difficult to say which particular physico-chemical parameter or parameters are responsible for the difference in the structure of the diatom communities. The authors are fully aware of the complexities of the problem. After completion of the third phase of the project we hope to be able to understand the problem better.

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[1] A complete list of Diatom Species colonizing the glass slides in the two water masses can be obtained by writing to the authors.

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