WATER QUALITY ASSESSMENT OF THE LANGAT RIVER, SELANGOR, MALAYSIA USING THE NATURAL ALGAL PERIPHYTON COMMUNITY AND LABORATORY BIOASSAYS OF TWO *CHLORELLA* SPECIES

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ABSTRACT

The physico-chemical conditions in ten sampling stations off the headwaters of the Langat River, Selangor, Malaysia were studied. Monitoring was done twice a month from June to December 1980. Changes in water quality were observed downstream. A total of 35 taxa of periphyton in four main divisions of algae were identified. The decrease in the number of species in downstream stations could be due to changes in the river rather than to chemical pollution. Two species of *Chlorella,* namely, *C. pyrenoidosa* and C. *vulgaris,* were grown in filtered river water obtained from the different sampling stations to assess their growth responses. Results suggest that pollution in the Langat River was caused mainly by heavy siltation rather than chemical pollutants.

INTRODUCTION

It has been documented by the Environmental Protection Society Malaysia that 42 of the country's rivers are polluted and another 23 threatened by human activities. However, only a few studies have been conducted on these rivers. Most of the water pollution programs in Malaysian rivers have been undertaken to assess the toxicity of pollutants.

This work is part of a series of surveys to study the effect of impoundment on a river ecosystem. The study assessed the quality of the waters of Langat River and determined the major cause of water pollution. Changes in the periphyton community as well as the growth of two *Chlorella* species cultured under laboratory conditions in water obtained from the river were used as indicators of water pollution. The area chosen for the study was the headwaters of the Langat River in the state of Selangor, flowing in the geographical region of Latitudes 3°05'N to 3°13'N and Longitudes 101°47'E to 101°53'E. The river flows along the valleys of hills about 1 000 ft above sea level. The area was chosen because of: (1) the construction of the dam at the upper reaches of the river that has resulted in a change in the physical characteristics of the river; (2) an increase in human activities along the river, such as establishment of towns and a rubber-processing factory, tin mining, and paddy cultivations; (3) the utilization of water from the dam as a source of water supply going through two treatment plants, 18 miles and 30 miles away, and (4) the increase of human settlers along the river, creating domestic "tips" at various points along the river.

MATERIAL.S AND METHODS

Ten stations were established along the course of the river, each approximately set 4.44 km apart, except for Stations 2, 3, and 4 which were located in one area. Station 4 receives water from a mountain stream, Station 2 from the reservoir, and Station 3 from waters used to turn the turbines of a power plant operated by the National Electricity Board.

Water samples were collected at each station twice a month from June to December 1980. Other physical parameters that were measured included pH using a pH meter, air and water temperatures, current velocities, conductivity using a YSI 33-meter, and water depth and transparency. The concentrations of sodium and potassium ions in the water samples were determined using the flame photometer, nitrate-nitrogen (NO_3-N) by the Brucine method, and phosphate-phosphorus (PO_4-P) by level II of the calorimetric method. A slight modification in the phosphate determination was the use of butan-1-10 instead of hexanol. The amount of total suspended and dissolved solids was also determined at each station.

Samples of periphyton were collected from each station by scrapping stones and rocks covered with algae. River water used in the culture of *Chlorella* was collected from each station in 5-liter plastic bottles. On reaching the laboratory, 25 ml of the river water was coursed through a 0.45 µm millipore filter paper into sterile flasks. One ml each of *Chlorella vulgaris* and *C. pyrenoidosa* pure cultures was washed in 5% sodium bicarbonate and then innoculated aseptically into separate flasks. There were two replicates for each water sample. The initial density of cells in the inoculum was also determined. The cultures were incubated under white light provided by two fluorescent tubes 120 cm above the flasks and a 12-hour light and 12-hour dark cycle. Growth of the cultures was quantified by counting the number of cells in each flask up to a period of seven days after innoculation, using a haemacytometer. Growth of the *Chlorella* cultures was measured using the intrinsic growth rate, *r*:

$$r = \frac{\ln N_t - \ln N_o}{t}$$

where: N_t = number of cells at time t;

N = number of cells at time 0;

t = maximum time when N_t occurs.

RESULTS

Analyses of the data on the physico-chemical properties of the river water showed that the pH was generally lower at the downstream stations. The highest value was recorded at Station 1 (pH = 7.6) and the lowest at Station 10 (pH = 6.2). Water temperatures were constant at the different stations except in Station 3 (21.9°C) which receives water from the power station. The water used to turn the turbines originates from streams in the mountain and is piped to the power station resulting in lower temperature. In contrast, downstream stations were characterized by higher temperature (28.5"C). Data on dissolved oxygen and carbon dioxide showed a drop in D.O. downstream after Station 8, with Station 10 recording the lowest value of 7.05 mg l^{-1} and a corresponding increase in dissolved carbon dioxide (6.05 mg l^{-1}) • The level of phosphate-phosphorus in the river water was generally low, varying from a low of 29.25 µg l^{-1} at Station 3 to a maximum of 72 µg l^{-1} at Station 10. Nitrate-nitrogen values fluctuated from station to station. The highest (45.17 mg l^{-1}) was recorded at Station 1; downstream stations recorded lower values.

The amount of both suspended and dissolved solids increased at the downstream stations with a corresponding decrease in the water transparency. The suspended solids increased at an average of 20 mg l^{-1} at each station from a minimum value of 30.6 mg l^{-1} at Station 3 to a maximum value of 193.3 mg l^{-1} at Station 10. The amount of dissolved solids at Station 9 (91.3 mg l^{-1}) was almost double that recorded upstream at Station 3 (55 mg l^{-1}).

A qualitative survey of the periphyton flora recorded 23 species of algae belonging to four major divisions. The diatoms were the most abundant.

Bioassay studies conducted utilizing two species of *Chlorella, C. pyrenoidosa* and *C. vulgaris,* showed the maximum *r* for both species was recorded in cultures utilizing river water from downstream stations, e.g., the highest *r* value was recorded at Station 10 while lower values were recorded at the upstream stations.

DISCUSSION

The physical and chemical data from the ten stations indicated a change in water quality further downstream. In general, stations further downstream showed low D.O. and pH levels and high concentrations of total suspended and dissolved solids, nitrate-N_2, and phosphate-phosphorus. These observations suggest that the Langat River may already be polluted. The more acidic conditions downstream could be attributed to wastes discharged from the rubber factory as well as from domestic sources. Phosphates came mainly from detergents especially in Station 6 where the water is intensively used for daily human activities. Nitrates originated mainly from the dam as shown by the increase in its value at Station 1 as a result of increased degradation of organic matter, viz, vegetation in the newly impounded dam.

Construction work at the dam as well as road-building near Station 8 could account for the high levels of both suspended and dissolved solids that are brought downstream.

The distribution of periphyton at all 10 stations showed a general decrease; in the total number of species toward the downstream stations. However, as the environmental conditions at each station change when the river becomes deeper further downstream, the decrease in the number of species could be due to the physical change in the depth of the river rather than a result of pollution. The influence of physical changes is a common problem encountered in the use of biotic indicators of pollution in natural communities. The major parameters that determined the composition of the periphyton community in Langat River appeared to be the nature of the river beds and the velocity of the water currents.

It was hoped that the use of the laboratory culture of *Chlorella* to determine the effect of any pollutant on the test organism would minimize the problem posed by differences in environmental conditions. The higher cell numbers of *Chlorella* grown in water obtained from stations further downstream could indicate that growth of the alga was not determined by any specific chemical substance present in the water medium since there was a decrease in pH and a rise in PO_4-P and NO_3-N downstream. In preparing the medium for the culture of *Chlorella,* the river water was previously filtered. Filtration removed most of the solid particles. The change in the quality of water further downstream is apparently caused by the high levels of total suspended and dissolved solids. Pollution of Langat River, on the whole, then is due to heavy siltation as a result of dam and road constructions.