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A regulated river ecosystem in a polluted section of the Upper Vistula*

3. Bio-assay of water trophy

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Abstract — An algal growth test was used to show the high trophy of the water of the Upper Vistula. The trophy declined gradually downriver, this being connected with processes of self-purification. The reservoir in Łączany brought about further inhibition of these processes, and shifted the decline in water trophy to lower sections of the river.

Key words: regulated river, pollution, algal assay, trophy.

1. Introduction

The method of algal growth tests is becoming increasingly common in assays of water fertility. According to literature data (Bednarz 1984), it works well in determining differences in the fertility of water, and in pinpointing small fluctuations in trophy in one site of study, especially if observations are carried out over a longer period of time. Using algal tests, the inhibiting or toxic effect of pollutants present in water can also be shown.

In Poland, such assays of water trophy embraced some rivers of Upper Silesia (Bednarz 1985), the River Nida (Starzecka et al. 1988), and the sylvan Tarczówka stream (Bednarz et al. 1984).

The aim of the present work was to determine the trophy of the water and its changes in the Vistula on a section between kilometres 33 and 58 of its course, which receives no sewage (Dumnicka, Kownacki 1988a). It was also the purpose of the work to assess the effect of the water stage at Łączany on the fertility of the waters investigated.

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2. Study area, material, and methods

A detailed description of the study area has been given by Dumnicka and Kownacki (1988a). The studies of water trophy were carried out over a year from December 1982 to December 1983. Samples were taken at approximately monthly intervals directly from the mid-current at 6 stations situated along a 25 kilometre section of the Vistula (fig. 1). Altogether 70 samples of water were taken. After the seston had been removed from it, cultures of *Chlorella pyrenoidosa* Chick.,

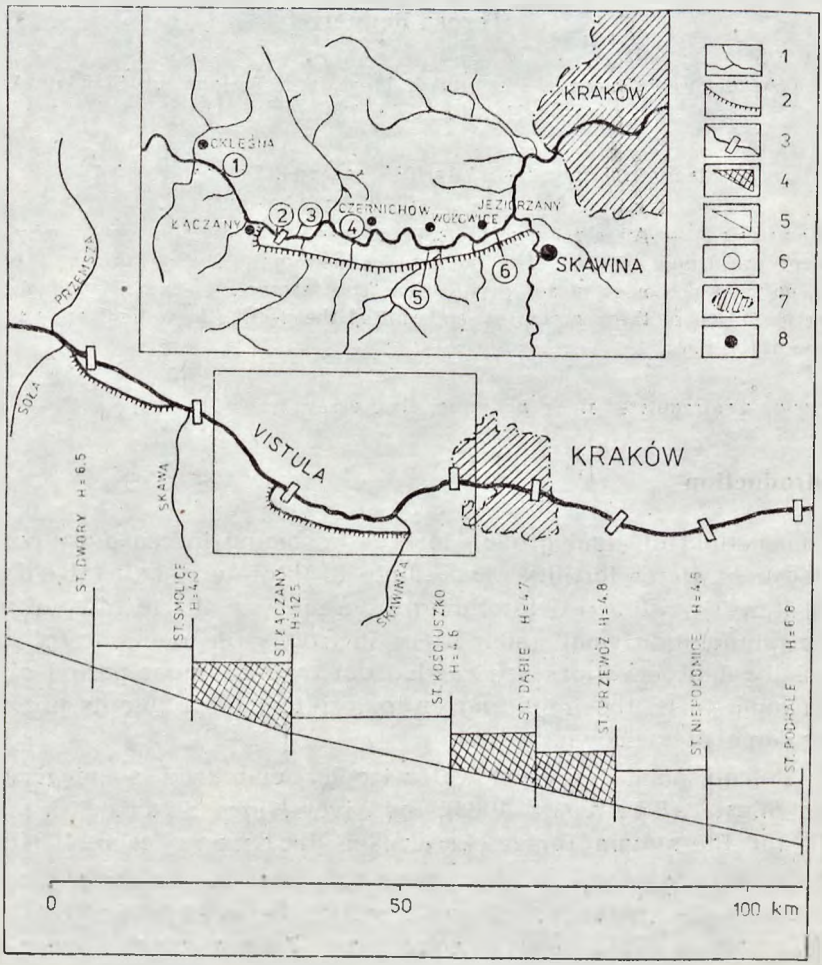

Fig. 1. The Upper Vistula, showing cascade building and stations on the investigated river section. 1 — rivers, 2 — canal; 3 — water stages, dams; 4 — water stages built; 5 — water stages under construction and planned; 6 — stations; 7 — cities; 8 — towns and villages

strain No 366, taken from a former collection of algae of the Institute of Zootechnics in Zator (Bednarz, Nowak 1971), were kept in the water under laboratory conditions. Cultures of alga grown on mineral substrate L_5m (Jankowski 1964) served as the control. Test and control cultures of algae were cultivated by the method of Bednarz (1985).

3. Results

The algal growth test on *Chlorella pyrenoidosa* showed a high fertility of the waters of the Vistula at all the stations (over 50% of the yield of the control cultures) (Table 1). On average in the study year

Table I. Yield of Chlorella pyrenoidosa cultures (in % of the control ones), cultivated on Upper Vistula water from Stations 1-6

Date of sampling	Stations					
	1	2	3	4	5	6
82.11.09	67.2	49.4	48.1	61.7	50.3	49.4
82.12.14	70.1	[illegible]	109.6	47.0	47.0	92.1
83.01.26	65.1	60.6	94.5	90.6	40.7	50.0
83.03.15	92.6	99.6	60.3	53.7	93.8	-
83.04.27	88.5	60.8	78.5	57.7	-	106.1
83.06.07	69.2	63.7	55.8	55.3	41.3	47.4
83.07.04	49.9	53.7	63.4	63.1	48.8	50.1
83.07.25	50.5	54.2	64.4	64.2	59.9	58.8
83.08.29	55.9	41.8	50.0	44.9	40.6	71.4
83.09.20	106.2	97.4	96.5	81.9	69.8	97.4
83.10.25	105.2	112.5	114.3	95.1	91.9	94.6
83.12.12	92.1	90.4	90.8	56.3	44.5	53.2
Mean	[illegible]	69.5	74.0	61.0	56.6	69.4

(fig. 2a), 63.1% of the growth in the control cultures was obtained. Changes in water trophy, of a distinctly seasonal nature, were noted (fig. 2b). The water of the following, in succession, had the highest trophic potential: from a station situated immediately below the dam (Station 3), from the river above the reservoir in Łączany (Station 1), and in the reservoir itself (Station 2). The waters of Station 5 in Wołowice had the lowest trophy (fig. 2b).

On all the sampling dates, a tendency was observed for the trophy of the water to decrease downriver from Station 3 to 5. A small increase in fertility usually took place at Station 6, while the trophy of the upper section (from Station 1 to 3) remained at a high level throughout the period of investigation. As a rule, there was a distinct increase in water trophy immediately below the reservoir (Station 3) (Table I).

On some dates (especially in autumn), greater yields of *Chlorella*, in terms of dry weight, were obtained than in the control cultures, this

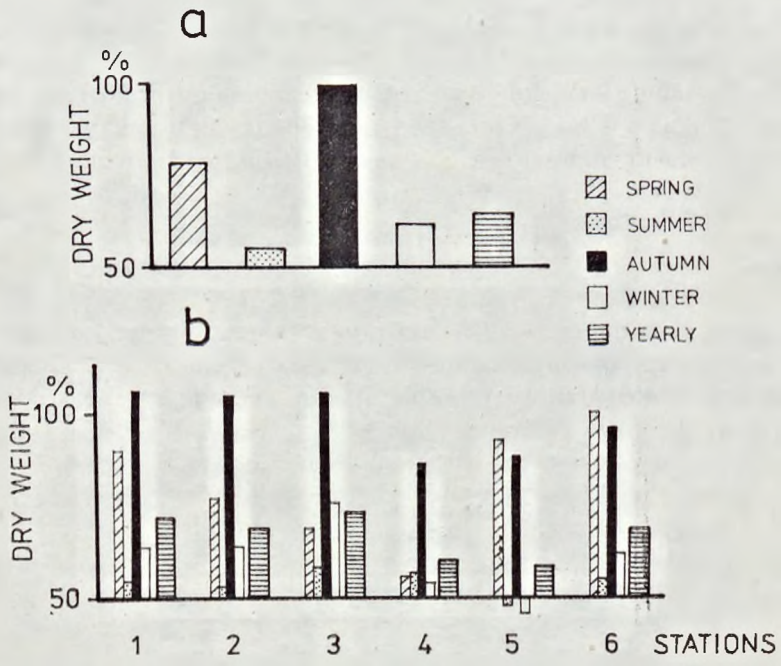

Fig. 2. Yields of dry weight of *Chlorella pyrenoidosa* cultures (in % of the yield of control cultures), on average for the investigated section of the Vistula (a), and for particular stations (b)

causing an increase in the mean values (fig. 2, Table I).

Two trophic maxima were recorded during the year, a higher autumn and a lower spring one, and a summer trophic minimum. This occurred consistently at all the stations. It also showed up in the means computed for the whole river section investigated (fig. 2a).

4. Discussion

The decrease in the trophic potential of the water in the section between Stations 1—5 is evidence of self-purification processes and of the absence of any input of nutrients from the outside into the water. The subsequent increase in trophy at Station 6 may be evidence of an unregistered inflow of sewage on the last investigated section of the river.

The observed summer trophic minimum with a high level of nutrients in the water (Kasza 1988) results from an increase in the load of pollution in the river. The autumn and spring maxima in turn reflect a high level of nutrients, coupled with their poorer utilization by the plant organisms living there. Besides nutrients, on some dates, most

frequently in autumn, the waters of the Vistula were rich in compounds of organic carbon which served as a growth substrate for *Chlorella*. The presence of these compounds, being an additional source of nutrients for the algae, caused *Chlorella* to give higher yields of dry weight than in the control cultures (mineral substrate L_5m). These data might also indicate some disturbance in the development of organisms in the river, resulting from pollution.

It is true that a rise in trophy at Station 3 below the dam in Łączany compared with Station 1 above the dam and Station 2 in the Łączany Reservoir itself shows that some mineralization of the organic matter takes place within the reservoir, but at the same time evidences disturbances in the processes of self-purification in the river, brought about by damming. The latter led to the inhibition of nutrient utilization by aquatic organisms and its shift to more distant sections of the river. This is demonstrated by the gradual decline in water trophy recorded at successive stations along the course of the river.

The patterns shown by using a growth test on the alga *Chlorella pyrenoidosa* have been confirmed in parallel studies of seston (Bednarz, Żurek 1988), periphyton (Kwandrans 1988), and in microbiological observations (Starzecka 1988). In the biological studies, the water at Station 1 was assessed to be the most polluted, followed by that at Station 2, the relatively least polluted being at Station 5. Station 6, where an increase in water trophy occurred, showed an increase in pollution in other biological studies (Bednarz, Żurek 1988, Dumnicka, Kownacki 1988b, Kwandrans 1988, Starzecka 1988). No such pattern was found in the studies of water chemistry (Kasza 1988).

5. Polish summary

Ekosystem uregulowanego i zanieczyszczonego odcinka Górnej Wisły

3. Biotestowa ocena trofii wody

Opierając się na glonowym teście wzrostowym prowadzonym na *Chlorella pyrenoidosa* Chick, szczep nr 366, oceniano trofię wód Wisły na 25 km odcinku rzeki, obejmującym stopień wodny w Łączanach (ryc. 1). Badania prowadzono w okresie rocznym, na 6 stanowiskach. Wykazano spadek trofii wód, występujący na odcinku rzeki poniżej stopnia wodnego, związany z procesami samooczyszczania. Spiętrzenie wody w Łączanach powodowało zahamowanie tego procesu (tabela I). Stwierdzono, że trofizm wód wykazywał sezonowość. Największą trofię miały wody w sezonie jesiennym, a najmniejszą w letnim (ryc. 2). Minimum letnie miało związek z hamującym wzrost glonu działaniem zanieczyszczeń.

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