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Ecology of some waters in the forest-agricultural basin of the River Brynica near the Upper Silesian Industrial Region*

5. Bacteriological characteristics of the waters

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A b s t r a c t — The work concerns the bacteriological characteristics of some water bodies in Upper Silesia, i.e. the River Brynica, the dam reservoir at Kozłowa Góra, Lake Chechło-Nakło, and the Świerklaniec park pond. In the period May 1976 — May 1979 quantitative changes in heterotrophic bacteria, which carried out the conversion of nitrogen and sulphur compounds, were determined. The quality of the investigated waters was classified according to four purity classes which varied in the value of the biological and chemical indices of pollution, from class I, very pure waters, to class IV, very strongly polluted waters.

K e y w o r d s: rivers, dam reservoirs, lakes, ponds, bacteria, water purity.

1. Introduction

Bacteria efficiently affect the flow of energy and the cycling of elements in the environment, owing both to the active uptake of dissolved organic matter even at very low concentrations of cells, reaching a few million microorganisms per 1 dm^3 of water (W r i g h t, H o b b i e 1965, 1966, V a c c a r o, J a n n a s c h 1966, W i l l i a m s 1970, R o b i n s o n et al. 1973, W r i g h t 1970), and to their ability of using minimal concentrations of this matter, even of the order of 100 μg dm^{-3} of water (Z o B e l l, G r a n t 1943). In consequence of metabolism, i.e., mutually

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connected processes of nourishment, energy uptake, and synthesis of cell components, the growth and development of bacteria are significant indices of the content of nutrients in the water. Associated with abiotic factors, above all with the chemical features of the water, the bacteriological characteristics permit evaluation of its state of purity or pollution (Ostrowski 1976, Starzecka et al. 1979).

In the period 1976—1979 the waters of the River Brynica, the dam reservoir at Kozłowa Góra, the Chechło-Nakło artificial lake, and the Świerklaniec park pond were investigated. The aim of the work was to characterize the bacteria and to determine the purity of the investigated waters.

2. Study area

The investigation was carried out at eight stations: 1, 2, 3a, 3d, 4, 5, 6, and 7a. Their description and distribution in the study area are given in fig. 1 and Table I. They have been described in detail by Zięba (1985).

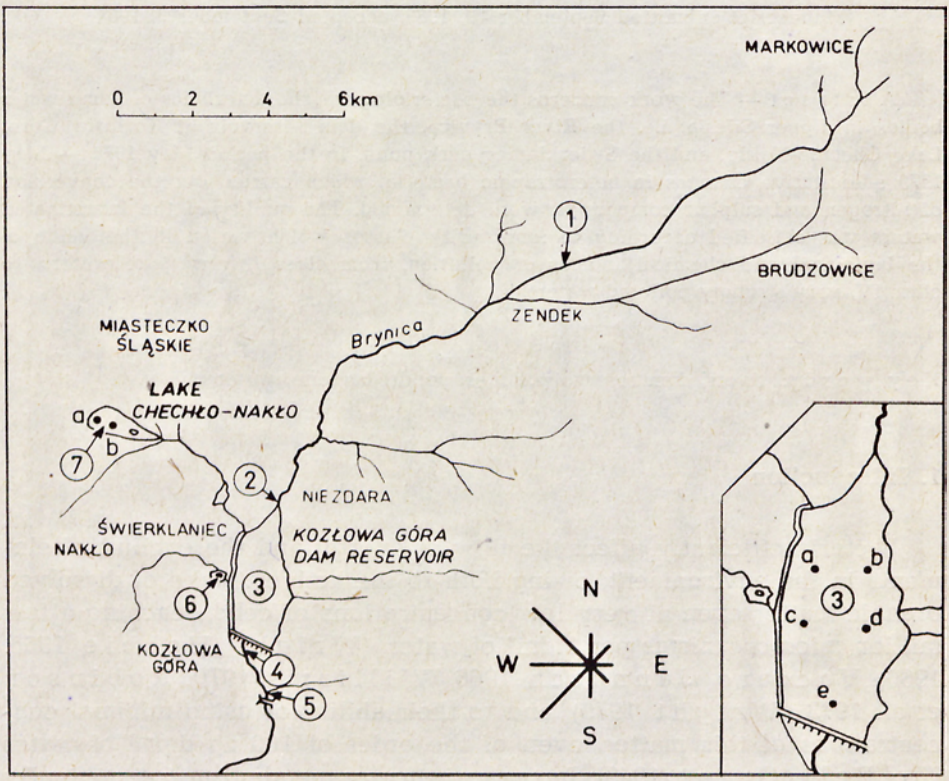

Fig. 1. Distribution of the investigated stations and wind rose. Stations: 1—7

Table I Brief description of the investigated stations

Station	No	Situation	Width of the riverbed (m) area (km^2)	Depth (m)	Current	Plants	Character of the bottom
River Brynica	1	at Zendek	0.5-1.5	0.2-0.5	medium	single tufts of submersed plants	sand, in places muddy sand
	2	at Niezdara	3.0-4.0	0.2-0.7	slow	single tufts of submersed and emergent plants	muddy sand, in places sand and mud
Dam reservoir at Kozłowa Góra	3	at Kozłowa Góra					
	a	upper section	mean 4.62	0.5-1.8		none	mud, in places muddy sand
	b		maximum				
	c	lower section	up to 6.21	1.8-3.0		none	mud
	d						
	e	near the dam		up to 5.0		none	mud
River Brynica	4	near the dam	1.0-1.2	0.2	medium	none	bed lined with stones
	5	below the dam - 1.5 km	2.0-3.0	0.3-0.7	slow	numerous emergent plants	sand, muddy sand and detritus
Park pond	6	at Świerklaniec, inshore	0.06	1.2-1.5		tufts of the submersed plants	mud and detrirus
Lake Chechło-Nakło	7	at Chechło		0.3-0.6		single tufts of emergent plants	sand and muddy sand
	a	inshore	0.66				
	b	central zone		2.3-2.5		tufts of Charasp.	muddy sand

3. Material and method

In the water samples which were collected on 15 dates the following factors were determined: the total number of heterotrophic bacteria, the number of proteolytic bacteria, using the plate method, and the titre of ammonifying, denitrifying, and protein decomposing with hydrogen sulphide releasing bacteria. The value of the titre was converted to the number, using the McCrady statistical tables (Collins, Lyne 1970, Rodina 1968). The media used in the study were described by Starzecka (1979). The quality of the water was determined using a 4-class scale, on the basis of the following ten indices: the total number of heterotrophic bacteria, the number of ammonifying, H_2S releasing and denitrifying bacteria, and the BOD_5 value, content of oxygen dissolved in the water, content of organic matter expressed by oxidability, and the concentration of $N—NO_3$, $N—NH_4$ and $P—PO_4$. In the applied classification four purity classes are accepted; they are characterized by the following numerical values: class I 1.0—1.5 (very pure water), class II 1.5—2.5, class III 2.5—3.5, class IV 3.5—4.5 (very strongly polluted water) (Starzecka et al. 1979). The data of BOD_5 and chemical indices used in the classification are quoted by Bombówna (1985).

4. Results

4.1. Bacteriological characteristics of waters in the River Brynica, the dam reservoir at Kozłowa Góra, the Chechło-Nakło artificial lake, and the Świerklaniec park pond

In the forest sector of the River Brynica (station 1), in the backwaters of the Kozłowa Góra reservoir (station 2), and below the outflow of the Brynica from the reservoir (station 4) similar total numbers of heterotrophic bacteria were found; they varied from 10^3—10^4 cells ml^{-1} of water (fig. 2 A, A_1, A_2). During the entire investigation period distinctly larger numbers of heterotrophic bacteria, varying from 10^4—10^5 cells ml^{-1} of water were noted at station 5, i.e., 1.5 km below the dam of the reservoir. It was also there that the maximum number, reaching 10^6 cells ml^{-1} of water, was found in October 1977 (fig. 2 A_3).

Proteolytic bacteria which decomposed large molecules of protein substances occurred in small numbers at stations 1 and 4. Greater numbers of these bacteria, in the order of 10^4 cells ml^{-1} of water were found at station 5 in October 1977 and at station 2 in August of the same year and in June and August 1978 (fig. 2 B, B_1, B_2, B_3).

In the water of the investigated stations the number of ammonifying bacteria which desaminated nitrogen compounds, ranged from 10^2—10^6 cells ml^{-1} of water and was characterized by similar periodic changes. Their maximum occurrence reached 10^6 cells ml^{-1} of water and was found in August 1977 at station 2 and in May and June 1978 at stations 1 and 5, respectively. It should be noted that in the backwaters of the reservoir a considerable numbers of these bacteria, reaching 10^5 cells ml^{-1} of water, was maintained for a fairly long time, i.e., from February to June 1978 (fig. 2 C, C_1, C_2, C_3).

In the period May 1976 to February 1977 bacteria decomposing protein substances with release of H_2S were not numerous, varying from a few to some hundreds of cells in 1 ml of water in the forest sector (station 1), in the backwaters of the reservoir (station 2), and at a distance of 800 m below the dam (station 4). A distinct increase in their number to the order of 10^3 cells ml^{-1} of water was observed at these stations in summer 1978, while during a great part of the investigation period the number of H_2S releasing bacteria was distinctly larger at station 5, usually reaching 10^4 cells ml^{-1} of water (fig. 2 D, D_1, D_2, D_3).

In the group of denitrifying bacteria the smallest variation in the number of cells, ranging within two orders of magnitude, was noted in the River Brynica at stations 1 and 5. There was a greater variation in the number of denitrifiers at stations 2 and 4 with a maximum of 10^5 cells ml^{-1} of water in the sector above the reservoir (station 2) observed in August 1979 (fig. 2 E, E_1, E_2, E_3).

The dam reservoir at Kozłowa Góra was characterized by a small

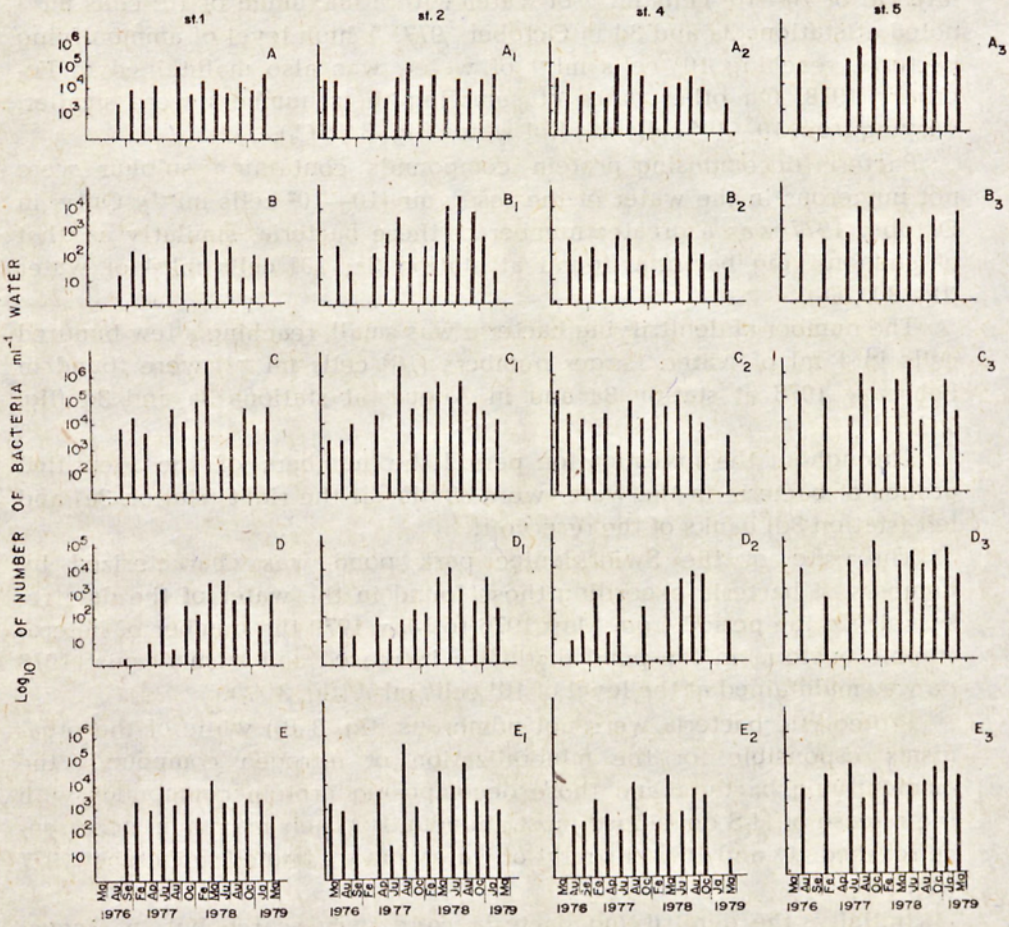

Fig. 2. Changes in the number of bacteria in the period 1976—1979 at stations: 1, 2, 4, 5 of the River Brynica. A—A_3 — general group of heterotrophic bacteria; B—B_3 — proteolitic bacteria; C—C_3 — ammonifying bacteria; D—D_3 — bacteria producing H_2S; E—E_3 — denitrifying bacteria

number of bacteria in the water. The total number of heterotrophic bacteria was uniform over the entire period of the investigation and ranged from a few hundred to several thousand cells in 1 ml of water (fig. 3 A, A_1). Among the identified groups the proteolytic bacteria were represented by the smallest numbers (fig. 3 B, B_1) and the ammonifying bacteria by the largest ones. The number of the latter varied within a wide interval of 10—10^6 cells ml^{-1} of water with a maximum of 10^6 cells ml^{-1} noted at stations 3a and 3d in October 1977. A high level of ammonifying bacteria, reaching 10^5 cells ml^{-1} of water, was also maintained in February 1978. On other dates of sampling their numbers were smaller, varying from 10—10^4 cells ml^{-1} of water (fig. 3 C, C_1).

Bacteria decomposing protein compounds containing sulphur were not numerous in the water of the reservoir (10—10^2 cells ml^{-1}). Only in October 1977 was a greater number of these bacteria, similarly as that of ammonifying bacteria, found at station 3a: 10^6 cells ml^{-1} of water (fig. 3 D, D_1).

The number of denitrifying bacteria was small, reaching a few hundred cells in 1 ml of water. Larger numbers (10^3 cells ml^{-1}) were found in February 1978 at station 3a and in August at stations 3a and 3d (fig. 3 E, E_1).

Throughout the investigation period the numbers of the identified groups of bacteria in the water were similar at the right (station 3a) and left (station 3d) banks of the reservoir.

The water of the Świerklaniec park pond was characterized by numbers of bacteria exceeding those found in the water of the dam reservoir. In the period from May 1976 to May 1979 the number of heterotrophic bacteria in the pond distinctly increased and from August 1978 on was maintained at the level of 10^4 cells ml^{-1} (fig. 3 A_2).

Proteolytic bacteria were not numerous (fig. 3 B_2) while of the organisms responsible for the mineralization of nitrogen compounds the ammonifying bacteria and those decomposing protein compounds with the release of H_2S developed most abundantly. Their maximum occurrence reached 10^6 and 10^5 cells ml^{-1} of water and was noted in October 1977 (fig. 3 C_2, D_2).

Initially, the denitrifying bacteria were very scarce but in August 1978 they reached the level of 10^4 cells ml^{-1}. From October 1978 to May 1979 their number was maintained at the level of a few thousand cells in 1 ml of water (fig. 3 E_2). It should be stressed that as compared with the reservoir at Kozłowa Góra the variation in the number of bacteria was greater in the water of the pond. From year to year the tendency to increased development of bacterial microflora was also observed in the pond.

In the water of Lake Chechło-Nakło similar periodical changes in the number of identified bacteria groups were found. The maxima occurr-

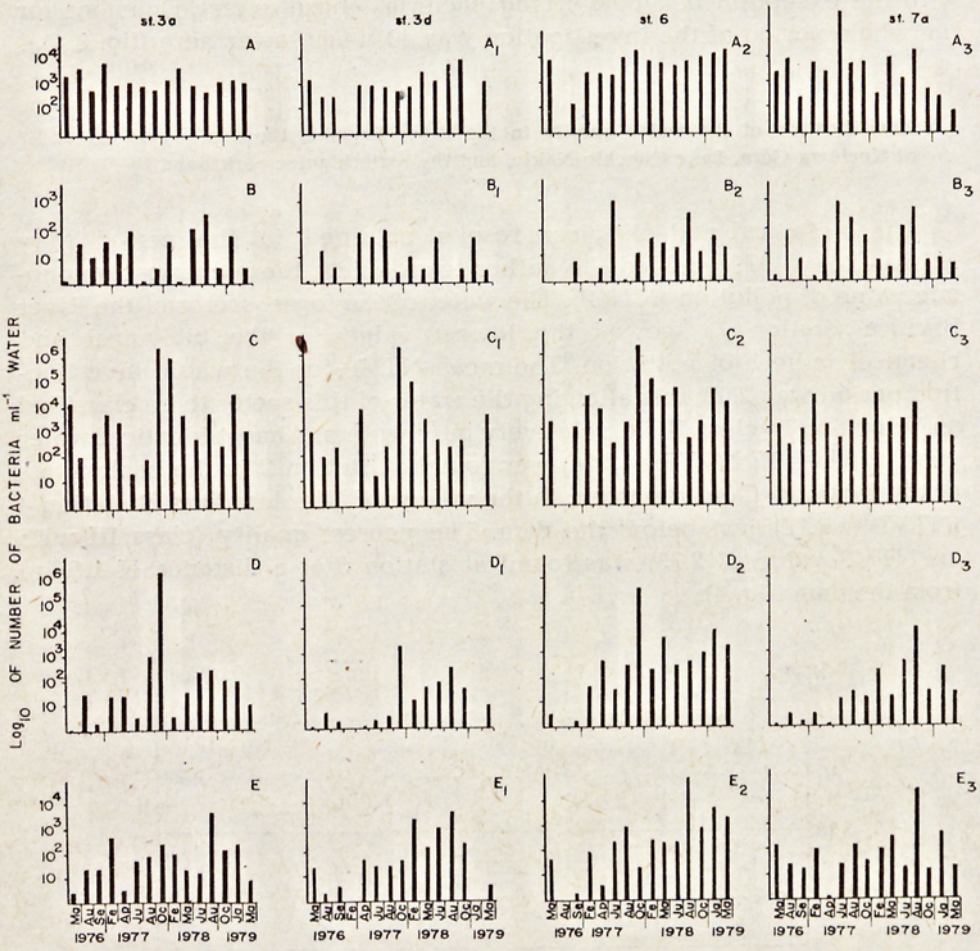

Fig. 3. Changes in the number of bacteria in the period 1976—1979 at stations: 3a, 3d, 6, 7a. A—A_3 — general group of heterotrophic bacteria; B—B_3 — proteolitic bacteria; C—C_3 — ammonifying bacteria; D—D_3 — bacteria producing H_2S; E—E_3 — denitrifying bacteria

ed at the same times, usually in the summer (fig. 3 A_3, B_3, C_3, D_3, E_3), with the exception of the ammonifying bacteria whose two maxima of 10^4 cells per 1 ml of water were noted in February 1977 and 1978 (fig. 3 C_3). It should also be stressed that the numbers of the particular groups of bacteria in the water of Lake Chechło-Nakło were similar to those noted in that of the Kozłowa Góra reservoir and the Świerklaniec park pond, with the exception of ammonifying bacteria whose average number for the whole period of the investigation was 40 times lower here (fig. 3 C_3).

4.2. Classification of the water quality in the River Brynica, the dam reservoir at Kozłowa Góra, Lake Chechło-Nakło, and the Świerklaniec park pond

The biological and chemical results obtained in the period May 1976 — May 1979 enabled the author to calculate the numerical taxonomic value of pollution (NTVP). The water of the forest sector of the River Brynica (station 1) showed the lowest values of the biological and chemical indices of pollution. The mean NTVP for the whole investigation period was 2.09, this allowing the water of this sector to be classified as belonging to class II, i.e. relatively pure waters. Almost identical water quality (class II, NTVP = 2.14) was found at station 2 in the backwaters of the Kozłowa Góra reservoir, in the village of Niezdara, and at station 4 (NTVP = 2.17) just below the dam. The poorest quality (class III with an NTVP value of 2.73) was found at station 5 at a distance of 1.5 km from the dam (fig. 4).

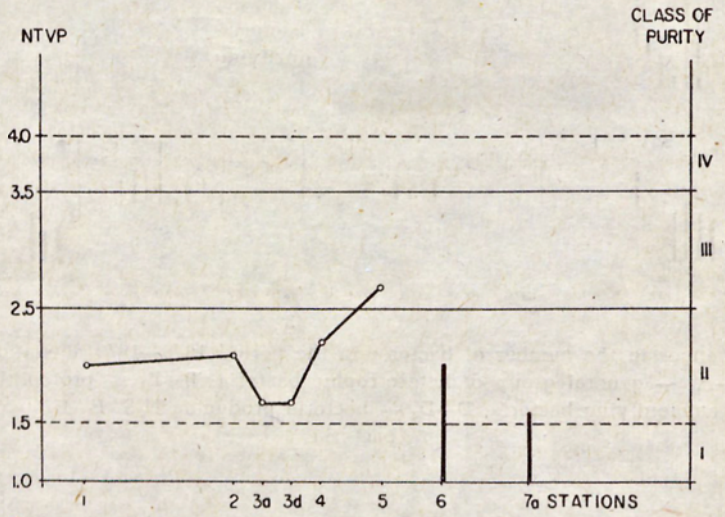

Fig. 4. Classification of water purity at stations: 1, 2, 3a, 3d, 4, 5, 6, 7a. NTVP — numerical taxonomic value of pollution for the whole investigation period 1976—1979

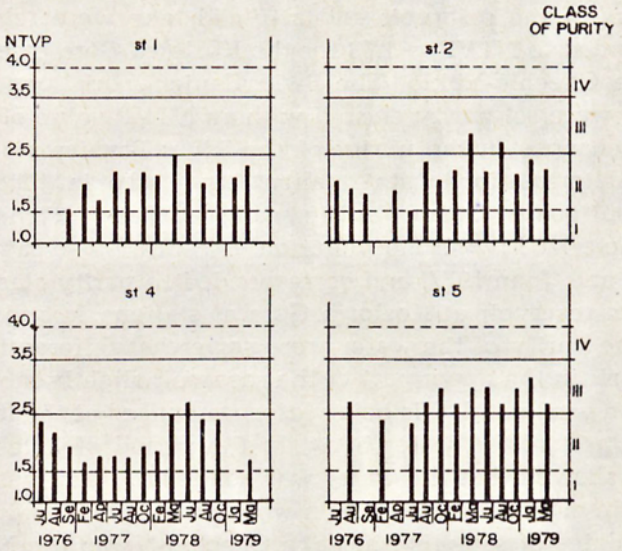

Fig. 5. Changes in water purity of the River Brynica (stations: 1, 2, 4, 5) in the period 1976—1979. NTVP — numerical taxonomic value of pollution

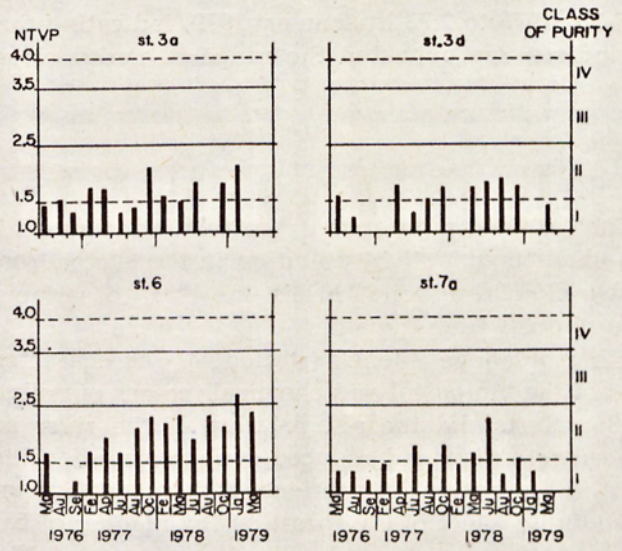

Fig. 6. Changes in water purity of the reservoir and artificial lake (stations: 3a, 3d, 7a) and the pond (station: 6) in the period 1976—1979. NTVP — numerical taxonomic value of pollution

The waters of the reservoir and artificial lake were relatively pure and corresponded to NTVP = 1.73 for the Kozłowa Góra reservoir and to 1.57 for Lake Chechło-Nakło. The Świerklaniec park pond was characterized by water of purity class II with an NTVP value of 2.04 (fig. 4).

Seasonal changes in the purity of the River Brynica waters showed a periodical deterioration of its quality, especially in the spring and summer at stations 1, 2, and 4. The water at station 5, however, was always characterized by strong pollution, except for two sampling dates, i.e. February and June 1977, and corresponded to purity class III (fig. 5).

In the dam reservoir at Kozłowa Góra at stations 3a and 3d seasonal changes in the purity of the water were somewhat differentiated. At the right west bank in the upper part of the reservoir slightly more advanced eutrophication was found, this being less pronounced at the left east bank in the lower part of the water body. In the period of investigation the NTVP value showed that the water was sometimes very pure and could be classified in class I. This condition was noted in 1976 and 1977 (fig. 6).

On most dates of sampling in Lake Chechło-Nakło the NTVP values varied between purity classes I and II. Only in June 1978 did the water quality deteriorate, with an NTVP quality of 2.30 (fig. 6).

In the pond of the Świerklaniec park the water purity corresponded to class I only in September 1976, this showing its poor quality as compared with the reservoir at Kozłowa Góra and Lake Chechło-Nakło. A progressive eutrophication of the water from year to year was observed here, which was evidenced by a gradual increase in the NTVP value from 1.60 in May 1976 to 2.73 in January 1979, indicating that the values of pollution indices approximated the range of purity class III (fig. 6).

5. Discussion

The obtained results suggest that the relatively pure River Brynica undergoes gradual though slight pollution in the sector from its springs to the Kozłowa Góra reservoir. This is due both to surface run-off and the immission of dusts from the air.

The river sector above Zdenek (station 1) was characterized by the lowest values of the biological and chemical indices of pollution (Bombówna 1985). Certainly, the afforestation of the river banks in this sector increased retension and reduced surface run-off, which is known to be decisive in the content of nutrients and bacteria in surface waters. A similar favourable effect of the forest on the number of bacteria in the water of a forest stream was found by Starzecka and Trela (1982). A periodical increase in the number of bacterial microflora at station 1 may be associated with natural changes, e.g., the decay of vascular plants in the autumn or the more abundant spring rains observed in April 1977

and May 1978 which caused the inflow of greater amounts of the organic substrate and nutrients which favoured the development of bacteria. The results of Vaccaro (1969) and Williams and Gray (1970) showed that bacteria have the ability to react rapidly to a sudden increase in concentration of the substrate in the environment. The above-mentioned authors observed that during a few days bacteria completely decomposed glucose and amino acids added to the substrate at concentrations higher by 1—2 orders of magnitude than the level of these substances in their natural life environment.

The effect of surface run-off was more pronounced in the middle course of the River Brynica, at station 2 in the backwaters of the Kozłowa Góra reservoir, where the run-off from fields and meadows and municipal sewage from the village of Niezdara penetrated to the river. The total number of heterotrophic bacteria per 1 ml of water was slightly (1.3 times on the average) higher there than at station 1. Significant differences were noted in the different groups of bacteria. A 19-fold increase in the number of proteolytic bacteria indicated that protein substances which underwent bacterial hydrolysis were fed to the river. An average 4—5-fold increase in the number of ammonifying and denitrifying bacteria suggested a growing content of amino acids and nitrates which underwent, respectively, desamination and reduction. The activity of microorganisms expressed by larger or smaller numbers of the different populations may indicate the kind of substrates occurring in or introduced into the water with wastes and surface run-off (Pasternak, Starzecka 1979).

Bacteriological results and the concentrations of mineral forms of nitrogen ($N—NO_3$, $N—NO_2$, $N—NH_4$), which were higher in the water at station 2 than at station 1 (Bombówna 1985), clearly demonstrated the agricultural utilization of the river basin, while higher concentrations of chlorides, phosphates, and organic matter showed that the eutrophication was brought about by the inflow of domestic wastes from the villages of Brynica and Niezdara. However, an increase in NTVP by 0.5 between stations 1 and 2 showed that in the period of the investigation surface run-off was not a threat in this sector of the Brynica and that the river waters were still relatively pure.

The quality of the water did not improve at station 4 below the dam, in spite of the passage of the river through the reservoir. This suggested an additional source of pollution, which was undoubtedly due to the run-off not only from fields and meadows but from a ditch receiving water from a circumference canal of the Kozłowa Góra reservoir, and also the run-off from the park at Świerklaniec. A similar situation in this sector was found by Paluch et al. (1956a) in their bacteriological study of the Kozłowa Góra reservoir.

The greatest number of the investigated groups of bacteria and a pe-

riodical rise in the content of ammonia nitrogen (2.92 mg dm^{-3}), phosphates (1.10 mg dm^{-3}), and chlorides (30.50 mg dm^{-3}) found by Bombówna (1985) at station 5 demonstrated the detrimental effect of run-off from the surrounding areas. Also the value NTVP = 2.73 confirmed that the river was strongly polluted in this sector. Probably, the total effect of surface run-off and particles of organic matter, nutrients, and planktonic bacteria brought down from the upper sectors of the river, was manifested here. As is known, the rate of transport of surface run-off, depending upon the quantity of water discharge, plays a significant role in the rate of substrate utilization by bacteria and thus in the synthesis of their biomass and multiplication of their number (Starzecka, Trela 1982). Hence, at station 5 the water discharge, smaller on the average by 0.5 m^3 s^{-1} than that of to the investigated upper sectors of the River Brynica, occasioned the longer period in which the interaction of biotic and abiotic factors formed the unfavourable pattern of changes.

The dam reservoir at Kozłowa Góra in the course of the River Brynica was characterized by considerable variation of the water level. Differences between the highest and the lowest level occur over 360 hectares, i.e. on $^2/_3$ of the area of the reservoir (Otto 1957). Owing to undulation, the organic matter stored in the bottom sediments is moved to higher levels of the water, thus contributing to its eutrophication. The results obtained in the present study show the fairly good water quality, corresponding to class II and sometimes even to class I of purity. Nevertheless, over a 20 year period an increasing value of pollution indices was observed in the river. From May 1976 to May 1979 the total number of heterotrophic bacteria varied from a few hundred to several thousand cells in 1 ml of water in the surface layer (at a depth of 30 cm), while in the years 1952—1954 it was smaller by 1—2 orders of magnitude (Paluch, Dobrzański 1956, Paluch et al. 1956a, b, Otto 1957). The periodically occurring stronger eutrophication of the water in the reservoir was distinctly manifested in the pattern of development of ammonifying bacteria. An increased number of ammonifiers was found in the spring and in the autumn-winter period. Apart from natural processes associated with seasonality, the intensified processes of ammonification in October could be caused by the inflow of organic nitrogen compounds with surface run-off after heavy rainfall (112 mm) in the preceding periods, i.e. in September of both 1977 and 1978. In winter and spring the metabolic activity of ammonifiers expressed by growing numbers of cells in the water, suggested a regularity connected with the stratification of the distribution and density of bacteria in the reservoir under ice (Szulkowska-Wojaszek 1973). In the spring this could also be due to organic suspensions flowing into the reservoir just under the ice from the littoral zone, and to the release of organic substances accumulated during the winter from the melting ice.

An alternate quantitative predomination of the populations of ammonifying and proteolytic bacteria was also observed in the reservoir. In periods when greater numbers of ammonifiers occurred, the proteolytic bacteria became less numerous. It may be, as shown by Neumark and Citri, quoted by Sokatch (1969), that the evolution of proteolytic enzymes could be inhibited by the high level of amino acid concentration in the environment. Attention should also be paid to the periodical slight but existing difference in the more advanced eutrophication of the right bank of the reservoir than of the left one. This could be the result of dusts carried in by the locally prevailing western winds and of the direction of waves which probably move the sediments from the left to the right bank of the reservoir.

The Świerklaniec park pond was characterized by a large content of nutrients, especially phosphates (Bombówna 1985) and by frequent algal blooms (Bucka 1985). The numbers of microflora of all investigated groups markedly exceeded those in the reservoir at Kozłowa Góra and in Lake Chechło-Nakło, showing that the eutrophication of the pond water was much more advanced. This can be explained by the inflow of pollution from the land environment. The mean value of NVTP = 2.04 calculated for the whole investigated period, classified the water of the pond in purity class II, i.e., as relatively pure water. Nevertheless, a distinctly progressing eutrophication was observed from year to year, bringing about an increase in pollution and reducing the purity of the water to class III in January 1979 (NTVP = 2.70). Among other factors, this could be the result of poorer light conditions and a greater accumulation of organic components which were extracellularly released by algae and favoured the development of bacteria (Fogg, Nalewajko 1963, 1964, Fogg et al. 1965 quoted by Chróst 1978).

Lake Chechło-Nakło has no outflow; it lies in a sandy area and shows the lowest fertility. The water was characterized by a low concentration of mineral nitrogen compounds and a small content of organic matter (Bombówna 1985). The value of NTVP varied around classes I and II of purity, confirming the favourable phenomena of self-purification of the water here.

6. Polish summary

Ekologia niektórych wód w leśno-rolniczej zlewni rzeki Brynicy w pobliżu Górnośląskiego Okręgu Przemysłowego

5. Charakterystyka bakteriologiczna wód

W latach 1976—1979 przeprowadzono badania wody rzeki Brynicy, zbiornika zaporowego Kozłowa Góra, sztucznego jeziora Chechło-Nakło i stawu parkowego w Świerklańcu (ryc. 1).

W próbach wody pobieranych na 8 stanowiskach (tabela I) oznaczono zmiany ilościowe ogólnej grupy bakterii heterotroficznych, proteolitycznych, amonifikacyjnych, rozkładających substancje białkowe z wydzieleniem H_2S i denitryfikacyjnych. Stan czystości wody badanych obiektów określono liczbową wartością taksonomiczną zanieczyszczenia — LWTZ.

Na odcinku śródleśnym Brynicy (st. 1), w cofce zbiornika Kozłowa Góra (st. 2) i tuż poniżej wypływu Brynicy ze zbiornika (st. 4) ogólna liczba bakterii heterotroficznych była podobna i przeważnie kształtowała się w granicach 10^3—10^4 komórek ml^{-1} wody (ryc. 2 A—A_2). Wyraźnie większą liczebność heterotrofów, rzędu 10^4—10^5 komórek ml^{-1} i to w całym okresie badawczym, odnotowano na odcinku Brynicy, w odległości 1,5 km (st. 5) poniżej zapory zbiornika (ryc. 2 A_3). Wśród oznaczanych grup bakterii najliczniej reprezentowane były amonifikatory. Na niektórych stanowiskach liczebność ich okresowo osiągała rząd 10^6 komórek ml^{-1} wody (ryc. 2 C—C_3).

W zbiorniku Kozłowa Góra ogólna liczba heterotrofów w całym okresie badawczym była dość wyrównana i wahała się w granicach od kilkuset do kilku tysięcy komórek w 1 ml wody.

W stawie parkowym zarówno liczebność bakterii w wodzie, jak i okresowe jej wahania były większe. Z roku na rok obserwowano tendencję wzrostu liczebności mikroflory bakteryjnej (ryc. 3 A_2, B_2, C_2, D_2, E_2).

W sztucznym jeziorze Chechło-Nakło rozwój poszczególnych grup bakterii był podobny do obserwowanego w zbiorniku Kozłowa Góra i w stawie parkowym (ryc. 2 A_3, B_3, D_3, E_3). Wyjątek stanowiły bakterie amonifikacyjne, których średnia liczba za cały okres badawczy była tutaj 40-krotnie mniejsza (ryc. 3 C_3).

Opierając się na LWTZ, wyliczoną z danych odnoszących się do całego okresu badawczego, wodę Brynicy w obrębie stanowisk 1, 2 i 4 oraz wodę zbiornika i jeziora (st. 3a, 3d, 6, 7a) zakwalifikowano do II klasy czystości, tj. wód względnie czystych (ryc. 4). Najgorszą jakość wody, w III klasie czystości (z wyjątkiem lutego i czerwca 1977 r.), stwierdzono na odcinku Brynicy (st. 5), w odległości 1,5 km poniżej zapory zbiornika Kozłowa Góra (ryc. 4, 5).

Woda jeziora Chechło-Nakło (st. 7a) charakteryzowała się najniższymi wartościami biologicznych i chemicznych wskaźników zanieczyszczenia. Niejednokrotnie wartości tych wskaźników ulegały znacznemu obniżeniu do I klasy czystości, potwierdzając zachodzące w zbiorniku pozytywne zjawiska samooczyszczania się wody (ryc. 6). Podobnie w zbiorniku Kozłowa Góra (st. 3a, 3d) jakość wody okresowo odpowiadała I klasie czystości (ryc. 6).

W stawie parkowym (st. 6) wartości LWTZ w całym okresie badawczym były zbliżone do danych uzyskanych dla górnego i środkowego (st. 1, 2) badanego odcinka Brynicy. Jednak od maja 1976 r. w stawie obserwowano stopniowe pogarszanie się jakości wody i wzrost wartości wskaźników zanieczyszczenia, których zakresy w styczniu 1979 r. mieściły się już w III klasie czystości (ryc. 6).

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