

HYDROCHEMICAL CONDITIONS OF AN EXPERIMENTAL AREA IN THE REGION OF THE KISKÖRE RIVER BARRAGE

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Abstract

In the course of the systematic chemical investigations carried out in the experimental area we followed with attention the components that are, in respect of their quantitative and qualitative conditions, in connection with the water biocoenosis, and the direction and degree of their change give us information on the displacement in water quality that may be favourable or unfavourable from human point of view.

Introduction

For the defence of water quality in the Kisköre Reservoir, an area of 4 sq.km extension, covered with a rich vegetation, was inundated with Tisza water. We carried out in that experimental area chemical and biological investigations in 1974 whose aim was to examine the factors having, in all likelihood, an influence on the water quality of the Kisköre Reservoir. Our samples were taken from regions of different plant covering (woods and open water), and we studied how necessary it was to remove woods and brush-woods from the region of the Reservoir.

Material and method

We carried out our investigations in the experimental area from May 28th till December 17th, 1975. Our samples originated from five sampling points (15; 15/1; 15/2; 15/3; 15/4), with a fortnightly recurrence. For the chemical analyses 5 l ladled samples were taken. For examining the dissolved oxygen and free carbon dioxide, special samplers were used.

The chemical investigations were performed on the basis of the Standardized Methods of COMECON for Water Examination, published by VITUKI (1970), and of Felföldy's lecture notes, titled: 1. Biological water qualification (1974).

Results of the investigations

In the course of the hydrochemical investigations we followed with attention the components that, in respect of their quantitative and qualitative conditions, are in connection with the water biocoenosis, the direction and degree of their changes giving us information on the changes in water quality of favourable or unfavourable degree from human point of view.

In my paper I don't want to publish a full series of data, I should only like to draw the attention to the tendency of changes.

The water of the experimental area is slightly basic, pH changed between 7.1 and 8.3. The pH values are higher permanently in the months August and September. Its seasonal change agrees well with the tendency of change in the total algal number (HAMAR 1975).

On the basis of conductivity and the data of the total dissolved material, the water of the experimental-reservoir changed between 313 and $516 \cdot 10^{-6}$ ohm.cm⁻¹ during the year. The conductivity values arose, except for a lesser dilution contemporaneously with the rainy weather in October, what can be brought into connection partly with the dissolution of the mineral substances of the soil, partly with evaporation.

The dissolved oxygen and free carbon dioxide play a considerable part in the assimilation and dissimilation of the autotrophic and heterotrophic water organisms. In the course of studying the oxygen and carbon dioxide circulation we can get a picture of the biological processes taking place in the water areas.

The organic-matter loading of the experimental area is shown well by the oxygen and carbon-dioxide results of our annual investigations series (Fig. 1).

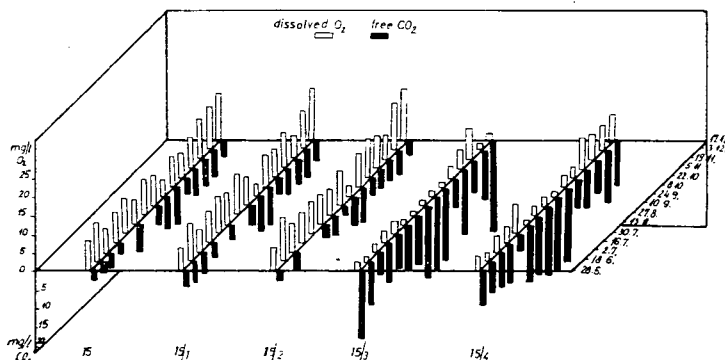


Fig. 1. Formation of the dissolved oxygen and free carbon dioxide content of the experimental area in 1974

The amount of dissolved oxygen varied in the areas of open water and wood in an equally broad interval (at sampling points 15; 15/1; 15/2 between 2.9 and 14.1 mg/l, at sampling points 15/3; 15/4 between 1.5 and 12.0 mg/l) but the values measured in open water were always higher than those measured in wooded areas. In the corresponding periods the dissolved oxygen content of the water in wooded areas is often 5—7 mg/l less than that of an open water.

The different organic-matter load on the various water areas is shown by the oxygen saturation expressed in percentage even more conspicuously. The oxygen saturation was in open-water areas generally between 70—90 per cent, in the water area of a deciduous wood, let alone an exception, it was between 50—60 per cent. In the wooded areas, in the region close to the bottom, we have observed aerobic conditions, as well, from time to time.

The intensive breakdown of the organic matter is well reflected also by the high free carbon-dioxide content of water in the experimental area:

The quantity of free carbon dioxide achieved 10—15 mg/l at sampling points 15/3 and 15/4 in the summer period, and even 20 mg/l in Autumn and Winter. At the open-water sampling points 15; 15/1; 15/2 we have got a little lower values; the quantity of free carbon dioxide was 3—6 mg/l in Summer, nearly 10 mg/l at the end of September and in early October, and in the winter period it was 5—7 mg/l. In open water (15), in the summer period, we could not demonstrate any free carbon dioxide, these periods coincided with the time of phytoplankton maxima (HAMAR 1975). The C. O. D. by the water area and measured with potassium permanganate and potassium dichromate changed considerably during the experimental period. The values of the potassium dichromatic C. O. D. are indicating well the formation of the organic-matter content in the area.

In spite of the values changing strongly after being inundated, the data of the physiognomically different areas became separated well from one another. In August we observed a rising tendency at every sampling point (at sampling point 15/3 measuring 48 mg/l), followed by a general decrease; and then followed a regional equalization in the time of the october rainfall (20—30 mg/l values). In December, however, the open-water and wooded areas considerably separated: the values measured at sampling points 15; 15/1; 15/2 were between 20—26 mg/l, while those measured at sampling points 15/3—15/4 were between 48—51 mg/l.

We have systematically investigated the seasonal dynamics of anions and cations, determining the chemical character of water fundamentally.

From among the anions, only the hydrogen carbonate occurred in a high enough quantity for determining the water type (Fig. 2). Its amount rose about 100 mg/l from the spring inundation till December. We measured 160 mg/l in June, 278 mg/l in December. In the various water areas, too, similar conditions predominated.

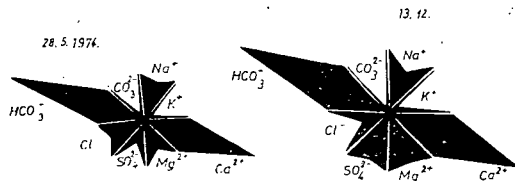


Fig. 2. Initial and end-state of ion-concentration in the experimental area in 1974

The carbonate ion could be demonstrated from the water of the experimental area only on a few occasions and in a very small amount.

The chloride content was comparatively permanent in the experimental period, its mass fluctuated at about 25 mg/l.

In the course of our investigations, the quantity of sulphate rose to 3 to 4 times as much as the initial value was, its seasonal formation showed a peculiar connection with the water temperature, oxygen saturation, and the total iron content.

The change in the sulphate content of the waters is fundamentally determined by the processes taking place in the sediment and the water layer above it.

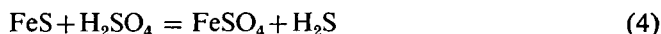
From the vegetable remains of cellulose content of the sediment hydrogen sulphide develops in the course of the activity of the sulphate-reducing bacteria. Is dissolved iron present in the water, then the hydrogen sulphide is transformed into ferrous sulphide and settles (1). At the sediment-surface becoming aerobic the following process takes place:



FeS hydrolyses with water:



Sulphuric acid reacting with the FeS not yet oxidized releases H_2S :



H_2S can get into reaction with the oxygen in water in the course of which elemental sulphure precipitates:



The water becomes opalescent by the precipitating sulphur, then it sinks to the bottom where it may be transformed into sulphuric acid as a result of a slow oxidation. (VÁMOS 1959, VÁMOS *et al.* 1963, 1971, KÖVES—VÁMOS 1959).

The data measured at the sampling point 15/3 of our experimental area agree well with the process outlined above. The decrease in iron content was always observed when the dissolved oxygen content of water was very low in the region near to the surface, and the sediment was very probably anaerobic. The considerable decrease in the quantity of the dissolved iron in July and August can be brought into connection with the formation of ferrous sulphide (1). The improvement of the oxygen conditions is favourable to the dissoluble ferrous sulphate, involving an increase in the iron and sulphate content of water (2). Phenomena 2, 3, and 4 could be observed on two occasions (July 30th, November 19th). Then the water became opalescent owing to the precipitated elemental sulphur granules.

The processes outlined above are drawing the attention to the wooded areas.

In the course of the investigation, the quantity of cations, apart from a few exceptions, increased more and more, probably as a result of the concentration taking place during the evaporation. From the inundation till December, sodium increased 5—7 mg/l, potassium 1.5—4 mg/l, calcium 20—24 mg/l, the change in magnesium content was not considerable.

The water of the experimental area was, let alone a single case, of type calcium-hydrocarbonate.

The Hungarian and foreign literatures attribute the cause of eutrophication to the increase in the nitrogen and phosphorus amount getting into the water. The multipurpose utilization of the future Kisköre Reservoir would be touched on a sore spot by a discontinuous eutrophication after being inundated. Starting from that, one of the most important subject-matters of our investigations was the nitrogen-phosphorus economy.

On the basis of the investigations concerning the nitrogen circulation it may be established that inorganic nitrogen was always present in the water area although some of the forms were from time to time missing. The quantity of the nitrogen of organic bond was the largest at the end of May and August, and in the middle of December, in the meantime we observed larger or smaller decrease.

In the summer period, after the spring phyto- and zooplankton maxima, we observed a decrease in organic and inorganic nitrogen, as a result of the strong expansion of the water macrovegetation. The nitrogen accumulation of the wooded areas was two to three times as much as that observed in open water.

In the course of studying the phosphorus forms, we have met with an obvious difference between the model-accumulating open-water area (15; 15/1; 15/2) and the wooded area (15/3; 15/4) (Fig. 3).

The seasonal formation of the single phosphorus forms was of similar course but their quantity in the wooded area was, as a rule, considerably larger than in open water.

According to literary data (ORR, I. R. 1968, SAWYER, 1966, FELFÖLDY—B. TÓTH 1970), the intensive production of waters is already facilitated by more than 30 mg/cc.m total phosphorus. In the experimental area we have often measured even 5 to 20 times as much as that value but no mass algal production has developed for a longer time. The cause of that cannot be discovered unequivocally by means of

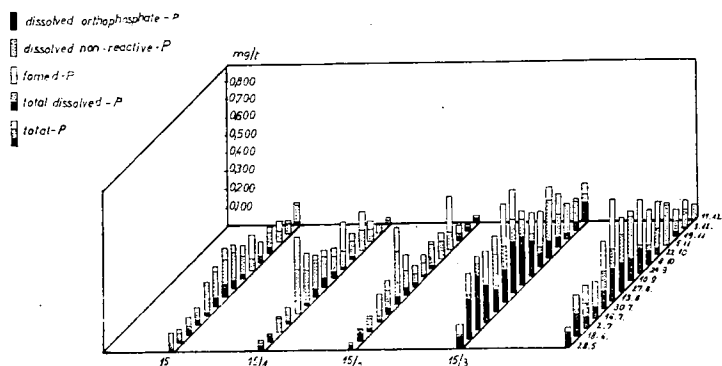


Fig. 3. Formation of the phosphorus forms in the experimental area in 1974

the investigations but it appears from the total data that, apart from the expansion of macrovegetation and the deprival of nutritive material by it, some kind of inhibition may have taken part, as well, because but a minimum part of the available nutritive material was consumed.

The results obtained in the course of investigating the physiognomically different water areas (with woods and open water) unequivocally draw our attention to that the presence of the shrubs and woods (the mass of vegetable organic matter) left in the Reservoir exert an unfavourable effect on the formation of water quality in the experimental area.

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