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DIURNAL WATER-CHEMICAL INVESTIGATIONS IN AN EXPERIMENTAL AREA AT THE KISKÖRE WATER BARRAGE

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Abstract

The difference between the water surfaces of various organic-matter load and shading is unequivocally shown by the results of the diurnal water-chemical investigations. The data of the 3-hourly surface-water-layer investigation may be brought into connection with the activity of living organisms (migration in the parts of the day, metabolism, etc.).

Introduction

In order to forecast the conditions of water-quality in the Kisköre Reservoir to be created at the Tisza, as well as to study the effect of the dry-land remains on the water-ecosystem, we have performed hydro-ecological investigations in an experimental area surrounded by a 3 sq. km circular dam. The amount of the dry-land vegetation remaining in the inundated area were determined by means of monolith-investigations (B. TÓTH—VÉGVÁRI 1976). The processes taking place were followed with systematic water-chemical analyses (B. TÓTH 1976), as well as with bacteriological, algological (HAMAR 1976) and zoo-plankton investigations (BANCSI 1976).

For giving a more reliable characterization of the water-spaces of different physiognomies, we felt it necessary to complete the measurings of the annual investigation-series, carried out with a weekly, resp. fortnightly frequency, also with investigations in the parts of the day. In the course of the work, diurnal plankton investigations — bacterio-, phyto-, and zooplankton-studies (HAMAR—BANCSI 1976), as well as water-chemical determinations were carried out, with special regard to tracing the quantitative changes in the dissolved oxygen and free carbon dioxide, as well as nitrogen and phosphorus forms.

Materials and Methods

To the diurnal investigation, in 1974, four sampling sites were designated (A,B,C,D) along an imaginary line drawn between two standard sampling sites (15 and 15/4) (Fig. 1). Sampling sites "A" (A/1 surface, A/2 middle, A/3 close to the bottom) were above a Tisza deadarm filled up strongly. Trapa natans L. and Nymphaea alba L. occurred by threads at the surface of the 3.5 m deep water.

Sampling sites "B" (B/1 surface, B/2 middle, B/3 close to the bottom) were designated in the middle of the oozing canal. In the 4 m deep water, in the vicinity of the sampling site, there were no floriferous plants.

Sampling points "C" were in the lopped willowy (C/1 surface, C/2 close to the bottom). The surface of the 1,5 m deep water was covered with *Spirodela polyrrhiza* (L.) SCHLEID *Lemna minor* L.

The submerged vegetation consisted of the rather thinly scattered stand of *Utricularia vulgaris* L. *Lemna trisulca* L.

The shallow water (50 cm) of sampling site "D" was covered with the network of the dense texture of *Utricularia vulgaris* L. and its surface was covered with *Lemna minor* L. & *Spirodela polyrrhiza* (L).

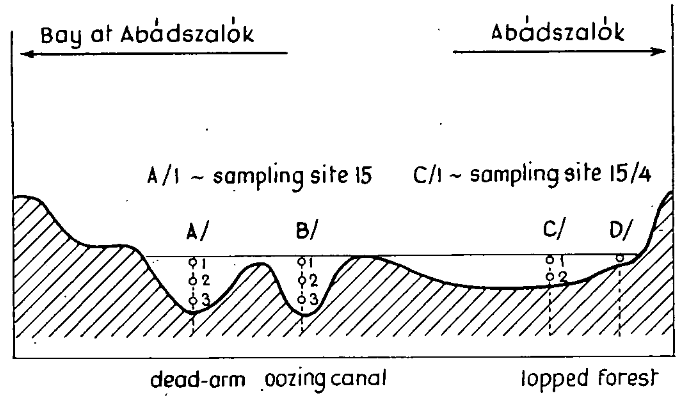

Fig. 1. Schematic cross-section of the area investigated, with the sampling sites marked out in 1974.

The investigations were carried out on *July 11—12, September 17,* and *November 13—14, 1974.* The results of the three measuring series are shown through the data of the investigations on September 17.

In the time of the investigations (September 17), the air temperature was 15,4—27,0 °C, water temperature at the surface changed between 17,0 and 21,0 °C. The strength of the N-NE wind was 0—3 °B. During the day, sunshine was only moderated in the small hours of the morning and late in the afternoon by a few cumuli.

On *August 5, 1975,* we investigated the O_2-CO_2 circulation of two areas of different physiognomies. One of these was the area designated with C_1 — C_2, studied already in the earlier years, as well, where the lopped forest was exploited from during the Winter. The other was designated in the area of the experimental district covered with a foliage-leaved forest (sampling site 15/4). In the course of the investigation we wanted to study the connection between lumbering and the oxygen-carbon dioxide circulation.

Similarly in 1975, we studied the connection between the bed-formation of the experimental area and the dissolved oxygen-content of water, in the cross section of direction N-S.

The samples taken 3-hourly, were elaborated for pH—O_2—CO_2—HCO_3 on the site immediately, for the other components in 6 to 12 hours. Determinations were performed on the basis of COMECON 1970 and L.Felföldy's work (1974).

Results

The summary of the chemical and biological investigations in the experimental area in 1974 is giving a detailed information on the direction of the changes ensued, the difference between beginning and end-state (B. TÓTH 1976). The migration of organisms according to the parts of the day was confirmed by the diurnal plankton investigations on September 17, 1974 (HAMAR—BANCSI 1976).

From the chemical characteristics, the value of conductivity changed between 353 μS and 422 μS; higher values were measured at noontime. The maximum value of the difference between water temperatures at night and in the daytime was 4 °C.

Thus the phenomenon can only be explained partially by an increase in ion-mobility. The increase in concentration of the major cations and anions would already advance a more acceptable argument, but in the time of conductivity maxima the total amount of "all the cations" and "all the anions" was smaller than in other times. (By major cations and anions we mean: Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, CO_3^{2-}, HCO_3^{1-}, Cl^{-}, SO_4^{2-}). Given this knowledge, the cause of differences is to be looked for in other peculiarities of the natural waters. It is proved experimentally that at measuring conductivity, every cation and anion being in a dissolved state in the electrolyte get a part in the conduction. In case of the natural waters, however, it seems to me that it can be connected with the individual density, metabolic intensity of the planktonical living world, as well. That is to say, not only the solubility conditions (pH, temperature, solubility series, etc.) may be the determinants.

We have got an interesting picture from the change in two cations, mangenese and iron, as compared to the total bacterial number. The maxima at the total bacterial number were between 06^{00} and 18^{00} h. (HAMAR—BANCSI 1976). At 6 h the total manganese content was at the limit of demonstrability and at 18^{00} h, taking no notice of the result of the first measuring, we measured the maximum. On the other hand, the maximum of the total iron content was at 18^{00} h. — It is to be mentioned as a matter of curiosity that the minimum of the individual density of the zoo-plankton fell to the same time (HAMAR—BANCSI 1976).

The pH values changed between 7,1 and 8,0. Between the values measured at the same time, in the same place but in different depths was hardly any difference. But between the pH values taken in different places of the section investigated, even if at the same time, we have observed even a difference of 0,5. The highest values were measured at sampling points B_1—B_2—B_3. The values of the dissolved oxygen content were also higher in these places. The changes according to the parts of the day in pH values could not be interpreted unambiguously in the course of the investigation.

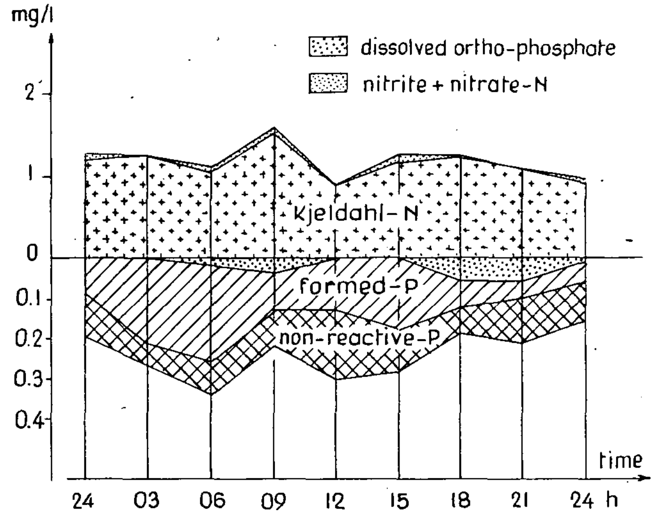

Fig. 2. Change in the puality of the nitrogen and phosphorus forms in the surface layer of open water, on September 17, 1974.

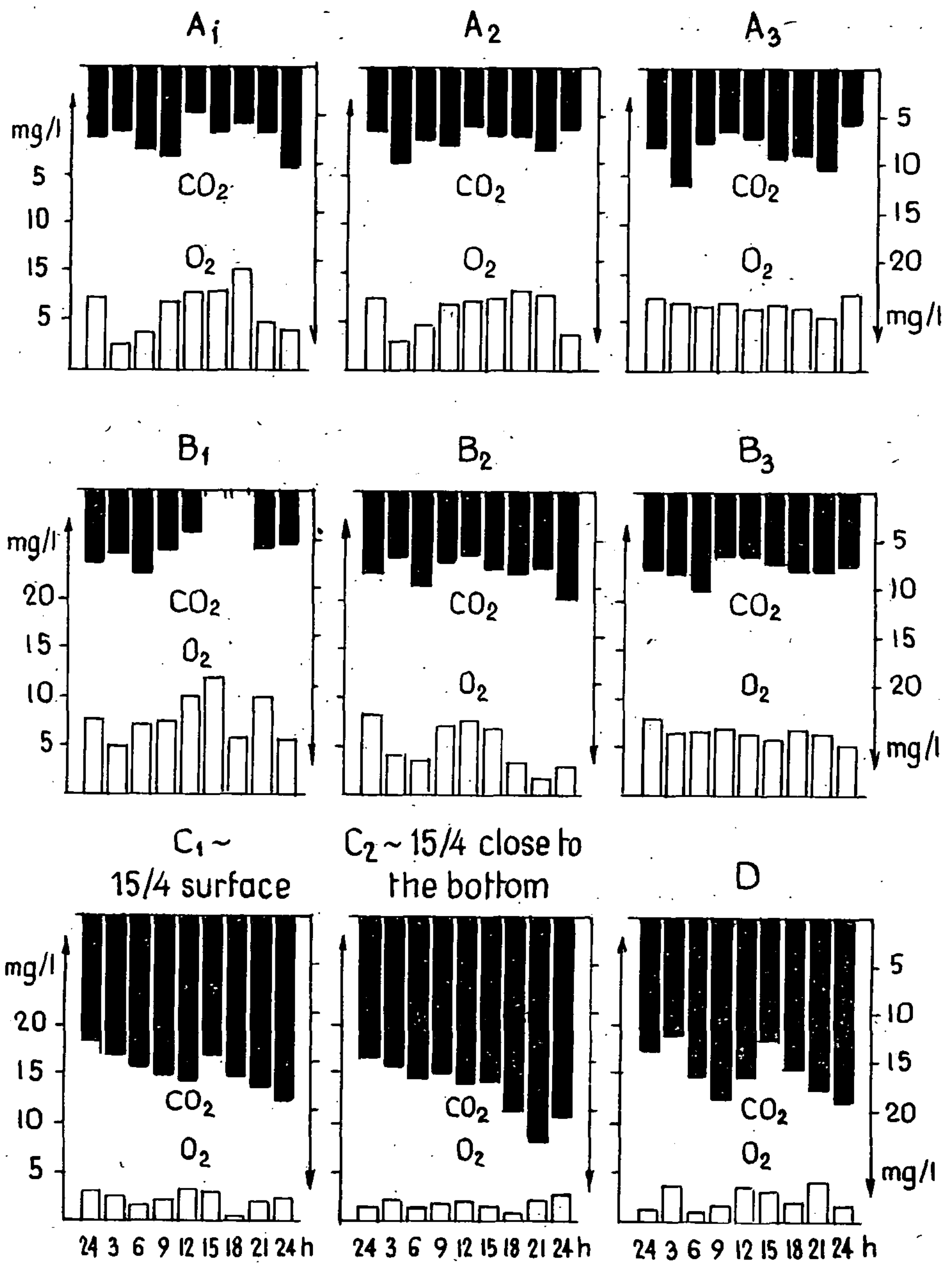

Fig. 3. Change in the puality of the dissolved O_2 and free carbon dioxine, according to the part of the day, on September 17, 1974.

From the vegetable nutriments the various forms of phosphorus and nitrogen were investigated (Fig. 2). Comparing the data with the results of the phyto- and zooplanktons, we have not found any unequivocal connection, although the minimum of the dissolved ortho-phosphate quantity coincided at 15^{00} h with the maximum of the total algal number. The beginning of the decrease in the formed phosphorus agrees with the time of the minimum of the zooplankton density.

Surveying the values of the dissolved O_2 and free carbon dioxide contents as measured on September 17, 1974 (Fig. 3), the difference between the open-water areas (A_1—A_2—A_3; B_1—B_2—B_3) and those overgrown with forest (C_1—C_2—D) is striking.

In the surface- and central layers of the open water the change in the oxygen content is averagely loaded by organic matter. This is characteristic of the waters with good food-supply. The minum of the oxygen content was measured between 03^{00} and 06^{00} h. The oxygen supply of the water layer close to the bottom is good but the daily rhythm observed in the surface- and medium water layers has not manifested itself there. The fluctuation of the free CO_2 content according to the part of the day is the most dynamical in the water layer close to the surface, in the deeper-lying places it is of smaller proportion.

Of the area overgrown with forest in the course of the whole day a low oxygen content (max. 4,6 mg/l) and a high carbon dioxide content (max. 23 mg/l) were

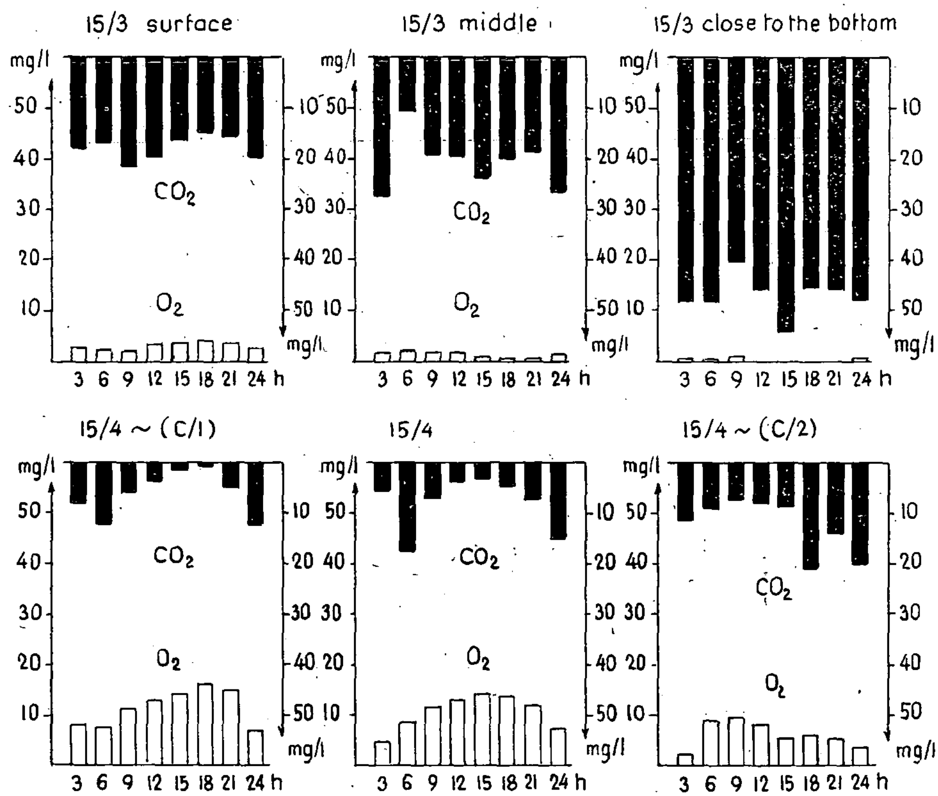

Fig. 4. Change in the puality of the dissolved O_2 and free O_2, according to the part of the day on August 5. 1975.

characteristic. The daily rhythm does not appear in the customary form because of overshadowing by trees.

On *August 5, 1975,* the influence of lumbering on the O_2—CO_2 circulation was investigated. In the district of sampling site 15/4, from nearly 2 ha area, trees were cut in the course of the last winter. The results of investigations (Fig. 4) both in the place overgrown by forest (sampling site 15/3 and in the cleared area (sampling site 15/4) are unequivocal.

In the surface samples of sampling site 15/3, oxygen was found on any occasions in the course of the day. The highest value (4 mg/l-) was measured at 18^{00} h. In the medium layer of water the oxygen content was lower than 1,5 mg/l already the whole day. In the water layer close to the bottom there was no oxygen on four occasions.

The change in the dissolved O_2 content was followed by the change in the carbon dioxide amount in the vicinity of the water surface reversely.

The increase in the amount of the dissolved oxygen was connected with a decrease in the carbon dioxide content. In the deeper layer of water where the quantity of carbon dioxide is considerably more than at the surface, the daily rhythm could not be measured. The high carbon dioxide content of the water close to the bottom (45 mg/l on average) can be brought into connection with the decomposition of the organic sediment of large quantity.

The oxygen—carbon dioxide data of sampling site 15/4 may be compared with the values measured under open-water conditions (A_1—A_2 ; B_1—B_2) in earlier years. The maximum of the oxygen content was measured between 15^{00} and 18^{00} h

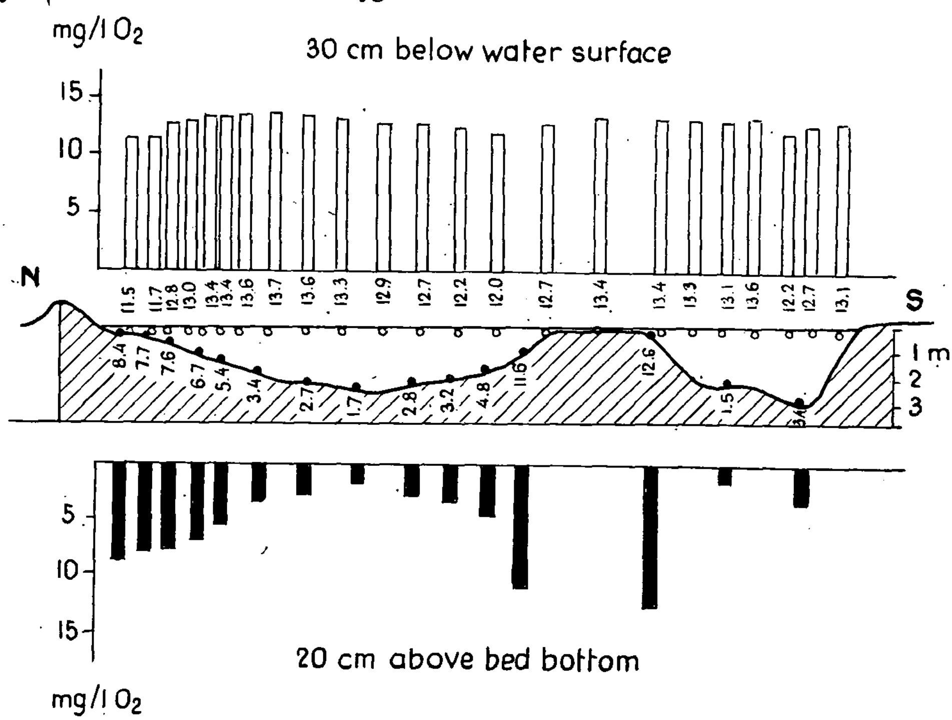

Fig. 5. Formation of the quality of the dissolved oxigen in the cross-section of the experimental area, on August 5. 1975.

Table 1. *Formation of the dissolved oxygen and free carbon dioxide contents in the experimental area*

	Open-water area September 17, 1974		Area overgrown with forest September 14, 1974		Logged land August 5, 1975	
	dissolved O_2 mg/l	free CO_2 mg/l	dissolved O_2 mg/l	free CO_2 mg/l	dissolved O_2 mg/l	free O_2 mg/l
Sampling time (h)	surface (A/1)		surface (A/2)		surface (C/1)	
24^{00}	7,32	7,51	3,02	13,45	—	—
03^{00}	2,39	6,99	2,47	14,84	8,25	8,29
06^{00}	3,74	8,91	1,39	16,15	7,03	12.2
09^{00}	6,69	9,53	1,75	17,28	11,50	6,18
12^{00}	8,12	5,19	3,43	17,46	11,92	4,78
15^{00}	8,08	6,78	3,02	15,68	12,47	2,47
18^{00}	10,51	6,18	0,48	16,91	15,07	1,07
21^{00}	4,70	7,03	2,07	18,00	14,75	5,15
24^{00}	4,14	10,43	2,47	19,28	7,89	12,90
Sampling time (h)	middle (A/2)				middle (A/2)	
24^{00}	7,32	6,81	+	—	—	—
03^{00}	3,02	10,56	—	—	4,14	5,39
06^{00}	4,62	8,03	—	—	8,12	18,00
09^{00}	7,00	8,51	—	—	11,77	7,08
12^{00}	7,40	6,15	—	—	13,26	4,96
15^{00}	7,56	7,21	—	—	14,45	4,18
18^{00}	8,36	7,28	—	—	14,22	4,92
21^{00}	7,88	8,52	—	—	13,75	7,88
24^{00}	3,98	6,50	—	—	7,83	16,59
Sampling time (h)	close to the bottom (A/3)		close to the bottom (C/2)		close to the bottom (C/2)	
24^{00}	7,28	8,29	1,27	14,77	—	—
03^{00}	6,93	12,22	1,83	15,72	2,39	11,77
06^{00}	6,77	7,86	1,27	16,59	8,28	9,65
09^{00}	7,08	6,43	1,43	21,30	9,36	7,67
12^{00}	6,61	7,40	1,75	17,27	7,08	7,90
15^{00}	7,00	9,65	1,35	16,49	5,73	8,92
18^{00}	6,45	9,18	0,48	20,18	6,87	21,39
21^{00}	5,41	10,67	2,07	23,47	5,41	14,77
24^{00}	7,96	5,82	2,47	20,84	3,02	20,18

(17 mg/l), its minimum in the small hours of the morning. The difference observed in the oxygen content of the water layer close to the bottom, which could not be explained by the "change according to the part of the day", was in connection with the stirring effect of the early morning wind. In the place of the forest logged the oxygen supply is good, taking into cosideration the whole waterbody (it is considerably better than at sampling site 15/3).

The carbon dioxide content is the smallest close to the surface. The dynamics of changes is the most obvious here. In the medium water layer and in that close to the bottom its quantity is more. But even the highest values don't approach those observed at the previous sampling site.

On the basis of data of the measurings carried out at the same time (on August 5, 1975) in different places (sampling sites 15/3 and 15/4), the difference between the O_2—CO_2 traffics of the area overgrown with forest and that under open water at the time of the investigation is striking (cf. Fig. 4).

The difference observed between the data of the investigations carried out in the same area (in 1974: C/1 and C/2, in 1975: 15/4 at surface and 15/4 close to the bottom) but at different times (on September 17, 1974 and August 5, 1975) can also be brought into connection, just as above, with exploiting the trees (cf. Table 1). In 1974, the high free carbon dioxide content, the little oxygen, and the weak daily rhythm was characteristic. In 1975, after the trees being cut, a low free CO_2 content (considerably lower than in 1974), a high (considerably higher than in 1974) dissolved oxygen content, and a characteristic daily rhythm could be observed.

The change following tree-felling is of favourable direction in respect of the human water-utilization: There developed a situation similar to the conditions observed in the open-water area existing already in the earlier years (cf. Table 1).

The oxygen supply of the open-water area was investigated at a cross section, on August 5, 1975 (Fig. 5). In the water layer close to the surface, the oxygen content was 11 to 14 mg/l. The lower values were measured in the shadow of the shrubs being at the northern fringe. Close to the bottom, the quantity of oxygen was changing together with the depth of water. The high values were measured at the shallow sites, the lower ones in the deeper parts.

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