

RESULTS OF THE PRELIMINARY INVESTIGATIONS ON THE ALGACOMMUNITIES IN THE BACKWATER OF THE TISZA AT ALPÁR

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Abstract

Authors briefly review the results of their studies carried out in the backwater between 1976 and 1980. With these studies, they determined the biological water quality of the backwater. At the same time, they also detected the seasonal changes characteristic to the zone, on the basis of the composition of the alga-communities. In the studied years the tendency of changes was similar, in some cases, however, the effect of the changes in weather (flood, milder Spring, and colder Winter, resp.) resulted slight shifts.

In 1982 authors started a more detailed study at the Alpár backwater, in the frame of which they invariably examined the phytoplankton composition to species level. For the demonstration of the seasonal changes regarding the algacommunities the Czekanowski similarity index was used. Authors also studied the phytoplankton diversity of the water area by applying the Shannon-index.

The chlorophyll-a and pheophytin-a concentrations were determined from the monthly taken samples. The state of aliment supply at the water area by determining the phosphorus forms was followed with attention. Eventually, authors performed the most essential chemical studies, confined to the oxygen circulation and ionic dynamism.

Introduction

The determination of the incursive biological water quality of the surface waters in Hungary can be traced back since 1974, when the practical book "Biological water qualification" written by Dr. LAJOS FELFÖLDY was published. Since then the hydrobiologists working in the various parts of the country carry on their activities with uniform methodics. Their results in this concern have been published since 1977 (VÍZKELETI—LENTI 1977, 1979; BARTALIS 1978, 1981; DOBLER—SCHMIDT 1979). The studies on the algal vegetation of the backwater became known from the paper of I. KISS published in 1978. Information could be gained about the temporal changes of the phytoplankton stands — also in rivers — from the works of SCHMIDT—VÖRÖS (1981), BARTALIS (1978), VÍZKELETY (1977), UHERKOVICH (1968, 1969, 1971), HORTOBÁGYI (1941, 1942), KISS (1979a), DOBLER—KOVÁCS (1982), KISS K.T. (1974), Hydrobiological studies (Publishing House of the Czechoslovakian Academy of Sciences, 1973). The seasonal changes of the backwater's phytoplankton stand have been illustrated on dendrogram with the cluster-analysis (UPGMA) method following the determination of the Czekanowski similarity index (1909), and diversity has been calculated (VÖRÖS—NÉMETH 1981, HAJDU, 1977, 1979). The anaerobic process taking place in the water area of the backwater is known from the works of FELFÖLDY (1981) and VÁMOS (1972).

Materials and Methods

The studies carried out from 1976 to 1980 at the Alpár backwater were suitable for the biological water qualification of the water area. The water samples required for the studies were taken monthly from 1976 even to this day, drawn from open water — 20 cm below the surface — at the border of the village Tiszaalpár, above the mouth of the channel at Alpár—Nyárlőrinc.

To determine the biological water quality the following studies were carried out:

1. measuring of the water's specific conductivity,
 2. counting of total number of algae on membrane filter, and to species level, resp., on agar by dropping aliquot amounts,
 3. determination of chlorophyll-a and pheophytin-a concentrations,
 4. saprobiological analysis according to the method of Pantle-Buck.
- The chemical studies were also accomplished on the basis of the guide-book "Biological water qualification" by Dr. LAJOS FELFÖLDY. The results obtained between the period 1976—1980 are summarized on Table 1.

Results

- a) The inorganic chemical basis of the backwater's water area was measured by conductivity. The average values showed that in 1976—1977 and in 1980 the water area was alpha-oligohalobic, concentrated fresh water. On the effect of rushing in Tisza water in the years 1977 and 1979 dilution was experienced to such extent that in 1978 and 1979 the halobity changed to beta-oligohalobic, fresh water of medium quality.
- b) To determine the planktonic trophity of the backwater measurements were made referring to the chlorophyll-a concentration and the number of algae in one litre of water was counted. Comparing these results the water area proved to be eutrophic, highly productive.
- c) The degree of pollution was characterized by the annual averages constituted from the Pantle-Buck saprobity index. The studied area of the backwater proved to be b-mesosaprobe, somewhat polluted.

The 5-years studies were suitable for detecting seasonal changes on the basis of the total algal count, the composition of chlorophyll-a and the algal communities.

The tendency of changes was similar in the studied years, in some cases, however, the effect of changes in weather (flood, colder Spring, Winter) caused slighter shifts. The months of Winter and early Spring, resp., could be characterized by medium total algae number (1—3 mill. i/l) and low chlorophyll-a concentration (1—10 mg/m³). The only exception was experienced in January, 1980, when from the water sample taken from under ice, 57 mill. individual numbers were counted per litre, and the chlorophyll-a concentration was found to be 95 mg/m³. The thick ice-sheet without snow blanket prevented the stirring up of the precipitate, thus besides favourable light conditions the algal community of high individual number could be established.

The dominancy of the Chrysophyceae class (*Ch. biporus* and *Ch. rufescens*) was more striking in January and February. Nevertheless, in January, 1977, several species of the *Synura uella* and the *Mallomonas* genus; and in March, April of 1978 the *Dinobryon bavaricum* characterized the water area.

At Spring the species representing the Chrysophyceae class gradually became repressed and parallel to this the species and individual numbers of diatom increased. The proportion of diatom reached 70—80% in May, June. These samples can be characterized by the *N. acicularis*, *N. subtilis*, *St. hantzschii* and a few *Cyclotella* species. In March, 1979, the mass appearance of *Asterionella formosa* was also detectable (SCHMIDT, VÖRÖS 1981).

Simultaneously with the dominancy of diatom the total algae number increased

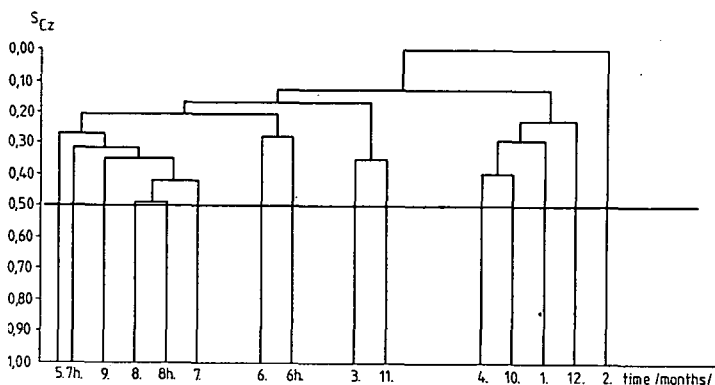


Fig. 1. Dendrogram of phytoplankton.

to 20–22 mill. i/l, and the chlorophyll-a concentration also surpassed the value of 20–30 mg/m³.

The decrease in algal individual number in the early Summer months, and later the increase of these values by the beginning of Autumn — Autumn could be explained by the characteristic phytoplankton — macrophyta relationship characteristic to the backwater.

At the beginning of Summer the total algal count per litre ranged around 2–4 million, maximum 10 million i/l. Then 20 million were found again per litre by September–October. With the change in total algal number, there was also a change in the chlorophyll-a concentration. In the samples taken in the Summer months the proportion of green algae was higher, from which several species characterized the plankton by prominently high individual number. In whole, the Summer plankton association was in general characterized by balanced conditions, by the more uniform appearance of every alga group — counted by us.

In September–October the diatoms were those which were dominating again (*Melosira* gr., *St. hantzschii*, *Synedra acus*, *N. acicularis*).

In November–December the light conditions became unfavourable, the temperature decreased, therefore the decrease in number of algae was also a natural consequence. In this period, again the species of the Chrysophyta strain dominated in the water area.

In 1982, as one of the tasks of the Committee of Tisza Research, a more detailed study was started at the aforementioned water area of the Alpár backwater.

1. Accordingly, the phytoplankton composition was invariably studied (to species level), given in i/l.
2. The chlorophyll-a and pheophytin-a concentrations were determined from each sample.
3. The aliment supply was also followed with attention by determining the phosphorus forms.
4. Finally, the necessary chemical studies were also performed, presenting a basis for the hydrobiologist (oxygen circulation and ionic dynamism; VÍZKELETI 1977, KIS K.T. 1974).

1. Following analysis of the alga-communities the Czekanowski similarity index was calculated (CZEKANOWSKI 1909). From the received index values, with the help of cluster analysis — using the average chain procedure (UPGMA) from the

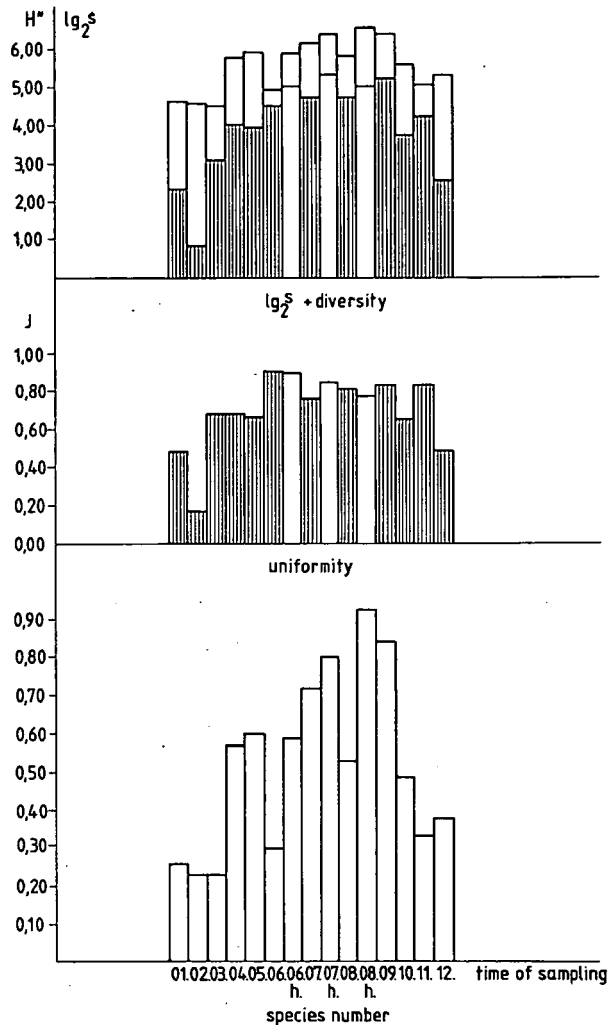


Fig. 2. Changes in time of the diversity (H'') and uniformity of phytoplankton.

agglomerative hierarchy methods — dendrogram was prepared (Fig. 1). On the basis of the dendrogram the followings were established: the seasonal changes assumed so far became more concrete.

The linkages took place below the value of 0,50, for which the explanation could be given that the water area is not so balanced from the viewpoint of the alternation of the plankton communities. (Here we refer to flood, duck-pond, swimming, which by all means influence the long-lasting staying together of the alga-communities).

Four groups could be differentiated; which are the following three, since the 6—6h and the 3—11 are directly connected to each other, thus these can be comprehended as one core. Analysing further the dendrogram, besides the inherence of the 7.—8.—8h.—9th months, we can find the 6.—6h and 3.—11th months; and the 4.—10.—1—12th months appear as separate core.

The seasonal changes are detectable from the dendrogram, for the Summer months differentiate from the early Spring and late Autumn months, but the Spring — Autumn — Winter months form separate cores. It also becomes striking immediately that the algae association of the water sample taken in the second month, i.e. February, completely differs from that taken in the rest of the months of the year. This was caused by the fact that at that time the water area was dominated by a *Synura* species in an amount of 130 million, and this species did not manifest itself in such an *i/l* value neither earlier, nor later. Now we should like to examine which organisms are responsible for the associations and to what ratio?

In the 3—11th and 4—10th months the *Chrysococcus biporus* in 17,2% and 23,9%, resp., the *Cryptomonas erosa* in 17,8% and 4,4%, resp., the *Chroomonas acuta* in 17,8% and 5,4% were responsible for the associations (BARTALIS 1981). The ratio of the two latter organisms decreased with the rise in water temperature and the increase in the number of sunny hours. In the associations of the Summer months, the *Cyclotella glomerata*, *C. striata*, *Trachelomonas volvocinopsis* and *Ankistrodesmus angustus* played role in the first place, that is, those organisms which favour the balanced, warmer weather on the basis of the observations so far. *Chrysococcus* species dominated in the Winter samples, too. Months distinguished by the "h" letter are also observable on the dendrogram. This means that in that particular month, namely in the 6th, 7th and 8th, samples were also taken near reed-grass associa-

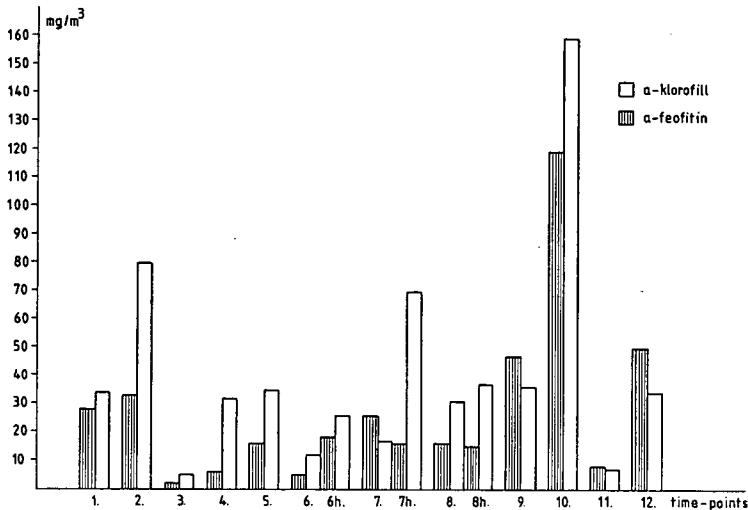


Fig. 3. Changes of chlorophyll-a and pheophytin-a concentrations.

ions. These water areas differed from the open water plankton associations of the otheronths due to the *Cosmarium*, *Closterium*, *Staurastrum* and *Micrasterias* species (VIZKELETY 1979). Apart from the mentioned similarity index: values, the diversity was also studied, thus the variety of the plankton associations. Diversity is the characteristic feature of biocenosis. During the course of our studies searched for an answer to the question, how does the species number and individual number change in the water, considering an optimal condition? It should be mentioned that the optimal condition can only be determined approximately, nevertheless, the principle known in ecology is definitely of help (SEBESTYÉN 1963)-

- I. the more varied the essential conditions of a biotop, the higher the species number of the biocenosis;
- II. the more the essential conditions of a biotop shift from the normal and the optimum of most of the organisms, the poorer the biocenosis in species and the higher the appearance of individual numbers of the various members;
- III. the more continuous the development of the millieu conditions of a habitation, the longer the period of similar environmental circumstances, the richer the biocenosis in species, the more settled and constant the biocenosis.

From the diversity indexes, we used the Shannon index, which gives the richness in species and the uniformity in a single number when characterizing the association (HAJDU 1977). Its "H" value varies between 0, as minimum and $\lg_2 S$ as maximum, and J between 0 and 1.

From the diversity diagram (Fig. 2) the differentiation of the February month mentioned at the discussion of the dendrograms is striking. In this month the growing space varied from the optimum, thus the *Symura* increasing to 130 million i/l raised the number of individuals, but the species number decreased, therefore the values of diversity and the related uniformity are low. The values of diversity gradually increased by the end of the Summer months, which was also followed by the uniformity of the species, then there was a decrease and in December close to similar value to that found in January was observed, and at the same time the change in species number also followed this tendency. It should be mentioned of the samples taken from the reed-grass associations that in the studied period higher species number was found than in the open water, which was also proved by the value around 5 of the diversity indexes.

2. (Fig. 3). The chlorophyll-a measurings were carried out with routine nature, using them only as informational data, because rapid information was gained on the expectable algal number in the water area. Two maximums were measured from the open water, in February and in October. The highest total algal number counted in the year belonged to these values (130 million and 27 million i/l).

3. As already mentioned, the studies performed in 1982 also included the examination of the aliment supply at the water area. This was endeavoured to be followed by the determination of the phosphorus forms (Fig. 4). From January till April there was a gradual increase in the $\text{PO}_4\text{-P}$ concentration of the water area, and with this also in the total phosphorus mg/m^3 amount. In May the available phosphorus suddenly decreased, due to the revival of the macrophytons. Till October the PO_4P amount of the samples taken from the open water and near the macrophytons remained unchanged, becoming stable around the concentration of 10 mg/m^3 , therefore the macrophyton patches developing in the water area kept the available nutriment at low level. From July to October the majority of the concentration of the total phosphorus got into the water, thus it developed from the organic debris. During the course of the studies the determination of the sestonic inorganic phosphorus was also accomplished. The results proved that this phosphorus form has no significance in the viewpoint of aliment supply.

4. Finally, we should like to report on a few points of interest after reviewing the chemical studies.

As a test, the Ca^{++} ion mg/l concentrations of the yearly samples were also compared with cluster analysis (Fig. 5). Studying the dendrogram it becomes striking immediately that the 7—8—9th months belong together tightly, and in all three months, in the water type determined on the basis of the cation amounts, Na^+ and Mg^{++} ions occurred, therefore the Ca^{++} ionic source became exhausted in

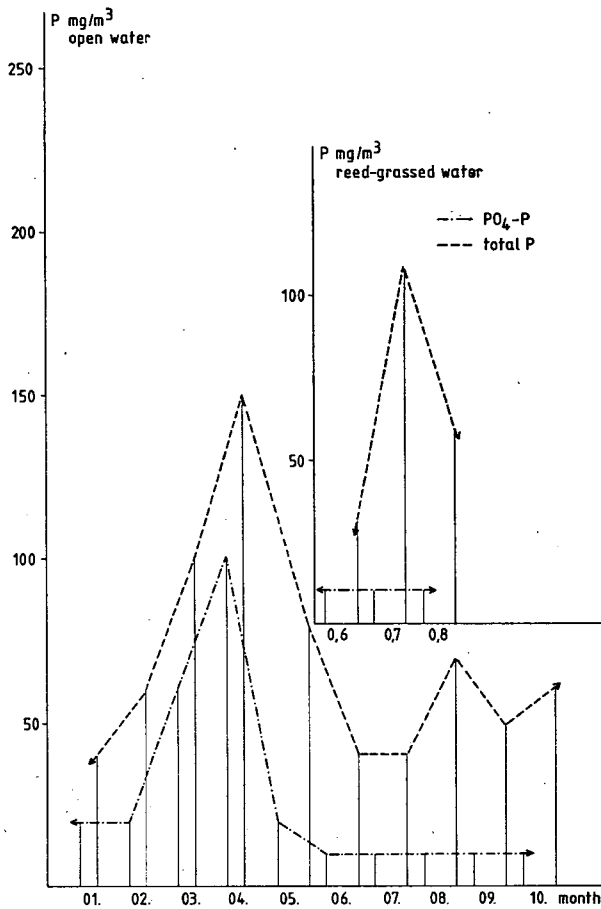


Fig. 4. Changes of phosphorus forms in open and reed-grassed water.

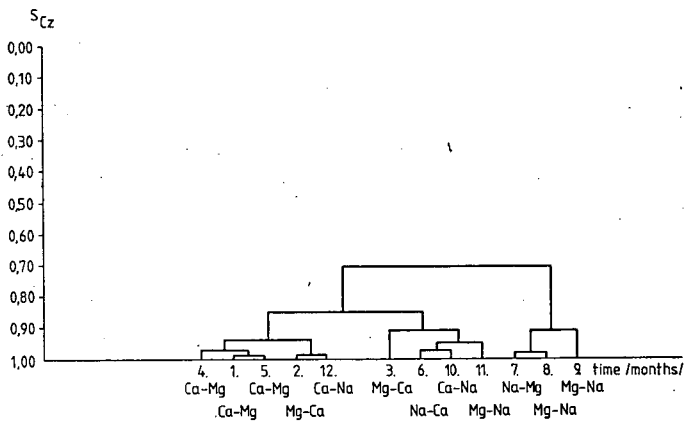


Fig. 5. Dendrogram of Ca⁺⁺ ion.

these months. In the 7—8—9th months the temperature of the water was the highest and the temperature of the air also indicated canicular days (Kiss, K. T. 1974). The followings could be reported on the oxygen household: the water's dissolved oxygen content decreased from the average 11,2 mg/l to 3,9 mg/l in August. This alteration was also accompanied by the decrease and increase, resp., of other components. Namely, by September, i.e. by the following month, the water's SO_4 -ionic concentration decreased from the average 24,5 mg/l to 1,9 mg/l, at the same time, the highest dissolved iron mg/l value was measured. Reviewing the related literature, the following process took place: the dissolved oxygen minimum in August brought about anaerobic conditions in the deeper layer. This was proved by the sudden increase (0,28 mg/l) in the dissolved form of iron. Sulphate reduction was concluded from the sulphate ion decrease, which is not only due to the function of sulphate reductive bacteria, but also to the methane developing during the course of cellulose decomposition, and the reaction of sulphate ions. In this latter case CaCO_3 precipitation should be counted upon, therefore an explanation was found also to the minimal values of the Ca^{++} ions measured at that time (FELFÖLDY 1981).

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Az Alpári holtág alगतársulásainak elővizsgálati eredményei

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Kivonat

A szerzők dolgozatukban röviden összefoglalják a holtágon 1976—1980 között végzett vizsgálatok eredményeit. Ezekkel a vizsgálatokkal megállapították a holtág biológiai vízminőségét. Ugyanakkor az algaegyüttesek összetétele alapján az égvőre jellemző szezonális változásokat is megfigyelték. A változás tendenciája a vizsgált években hasonló volt, esetenként azonban az időjárás változásának hatása (árvíz, hűvösebb tavasz, illetve hidegebb tél) kisebb eltéréseket eredményezett.

1982-ben részletesebb vizsgálatot kezdtek az Alpári holtágon, amelynek keretében változatlanul vizsgálták a fitoplankton összetételét, faji szintig. Az algaegyüttesek szezonális változásának bemutatásához a Czekanowski hasonlósági indexet használták. A szerzők vizsgálták még a víztér fitoplankton diverzitását is a Shannon-féle index felhasználásával.

A havi gyakorisággal vett mintákból meghatározták az a-klorofill és az a-feofitin koncentrációkat. Figyelemmel kísérték a víztér tápanyagellátottságát a foszfor formák meghatározásával. Végül elvégezték a legszükségesebb kémiai vizsgálatokat, amelyek az oxigénforgalom és az ion dinamizmusra korlátozódtak.

Результаты предварительных анализов сообществ водорослей в мёртвом русле Алпари

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Резюме

Авторы работы кратко обобщают результаты исследований, проведенных в мёртвом русле Алпари в 1976—1980 гг. На основе этих исследований было определено биологическое качество воды мёртвого русла. В то же время на основании состава сообществ водорослей наблюдались и характерные для данного климатического пояса сезонные изменения. Тенденция этих изменений в течение исследуемого периода была в общем подобна, однако в некоторых случаях под влиянием погодных изменений (наводнение, более холодная весна, или более суровая зима) наблюдались некоторые отклонения.

В 1982 году в воде мёртвого русла Алпари были начаты более подробные исследования, в ходе которых неизменно продолжали анализ состава фитопланктонов (на уровне видов). Для показа сезонных изменений в сообществах водорослей применяли сравнительный индекс Чекановского. Авторы исследовали также дивергенцию фитопланктонов с использованием индекса Шаннона.

В пробах, которые брались каждый месяц, определяли также концентрацию хлорофилла-а и феофитина-а. Велись наблюдения по определению степени обеспеченности воды питательными веществами с помощью определения форм фосфора. Наконец, были проведены также и наиболее необходимые химические анализы, которые ограничивались определением оборота кислорода и динамики ионов

Preliminarni rezultati istraživanja algi u mrtvaji Alpár

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Abstrakt

Autori su sumirali rezultate istraživanja za period 1976—1980. u odnosu na kvalitet vode mrtvaje. Pored zajednica algi pratili su i karakteristične sezonske promene za to podneblje. U ispitivanom periodu promene su bile ujednačene, mada su periodične promene vremenskih prilika (vodostaj, hladnije proleće, odnosno zima) rezultirale izvesnim odstupanjima.

Detaljnija istraživanja fitoplanktonskih zajednica do nivoa vrsta vršena su od 1982. godine. Analiza zajednica algi vršena je Čekanovskim indeksom sličnosti, dok je diverzitet određivan Shannon-ovim indeksom.

Mesečne probe su poslužile za određivanje koncentracije hlorofola- a i feofitina-a. Foforne forme su poslužile za određivanje sadržaja hranljivih materija. Takođe je izvršena i hemijska analiza u odnosu na promet kiseonika i dinamiku sadržaja jona.