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Nature Conservation Oriented Algal Biodiversity Monitoring Investigations in the Main Arm and Some Dead Arms of the River Tisza II. Phytoplankton

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Summary: The species composition and to a certain extent the individual number of the phytoplankton in the studied dead arms in the floodplain of the River Tisza is basically determined by the most important water supply, the river itself, which enters the dead arms during floods. After floods, when the connection between the main arm and the dead arms discontinued, the phytoplankton of the dead arms "remember?" its origin but then gradually changes and start to resemble the algae flora of lentic waters also developing several unique characters.

The algal flora of nearly all investigated dead arms had a nature conservation value primarily because of their diversity, or the presence of several rare algae. From among the investigated dead arms, Kacsa-tó, Marót-zugi-holt-Tisza and Oláh-zugi-holt-Tisza showed less obvious natural values partly due to neighbouring villages partly due to human use (mainly intensive angling). Human impacts are the least pronounced at the Remete-zugi-Holt-Tisza, which has important natural values.

It should be stressed, however, that the valuable algae flora of one or another site can only be maintained by the protection of the habitat (dead arm) and its watershed.

In the case of less valuable dead arms (e.g. the eastern part of the Kacsa-tó, Oláh-zugi-holt-Tisza) it might mean the acceptance of the present situation with some improvement (e.g. controlling the number of angles around the dead arm). In other cases direct human use should be stopped and dead arm reconstruction is to be made to help the development of semi-natural conditions, e.g. at the Remete-zugi-holt-Tisza.

Zusammenfassung: Im Rahmen des Ungarischen Nationalen Biodiversität Monitor Programmes haben wir 1996 mit der Untersuchung des Phytoplanktons in einigen toten Armen der Theiss angefangen. 2000 und 2001 wurden die Arbeiten auf dem Probeentnahmegebiet des Pilot-Projektes fortgeführt. An den toten Armen

– den toten Arm „Remete-zugi" ausgenommen – wird die anglerische Tätigkeit ziemlich intensiv ausgeübt. Das Ziel dieser Untersuchungen war der Biodiversität-Monitor naturschützlichen Zweckens. Während der Untersuchungen wurden die biologische Vielfalt des Phytoplanktons, das Vorkommen mancher seltener Arten und die Wasserqualität der toten Armen geprüft.

Die Artenzusammensetzung des Phytoplanktons, in gewisser Hinsicht auch dessen quantitative Verhältnisse werden in den untersuchten toten Armen vor allem durch die Algenfora der Theiss beeinflusst, die bei Hochwasserführung die toten Arme mit Wasser auffüllt und sie zugleich durchwäscht. Nach der Überschwemmungen, wenn die Theiss in das ursprüngliche Bett bereits zurückgezogen und jegliche Verbindung zwischen ihr und den toten Armen abgebrochen ist, ist der Fliessgewässerursprung an dem Phytoplankton eine Weile noch zu bemerken. Langsam aber beginnt das Phytoplankton sich zu verändern und wird mehr und mehr der Phytoplanktonflora der seichten, periodischen, stehenden Kleingewässer ähnlich und zeigt etliche unikale Charakterzüge.

Key words: nature conservation, biodiversity monitoring, phytoplankton, River Tisza

Introduction

In 1996 algological investigations started as part of the Hungarian National Biodiversity Monitoring Programme (TÖRÖK ed. 1997) in some dead arms within the Pilot Project area and continued in 2000-2001. With the exception of the Remete-zugi-holt-Tisza all the sites are intensively utilised for angling. Precipitation is their main water supply but greater floods of the River Tisza also reach the investigated sites. During long, rainless periods their water level drops considerably and they can nearly dry out. These characteristics basically determine the water quality and phytoplankton species composition of these dead arms.

The present study was a nature conservation oriented biodiversity monitoring aiming to describe the biological diversity of the phytoplankton, the presence of rare species and the water quality of the dead arms.

Material and Methods

Sampling sites with a map are characterised and data are given in the first part of this article (ÁCS et al. in this volume). Due to low water level or deep mud covering earth roads after floods samples could not be collected from each site in every sampling period. For comparison with the River Tisza samples were also taken from its streamline at Balsa (559 river km), where it is the nearest to the dead arms.

The phytoplankton samples were taken with a modified Meyer-flask close below the water surface and fixed with Lugol-iodin solution. The abundance was determined by the Utermöhl method with an OPTON Invertoscop D, counting 400 algal individual. To determine the Centrales species, a part of samples was treated by H_2O_2, three times washed with distilled water and examined by transmission electron microscopy (see in detail KISS 1986). The chlorophyll-a content was extracted with hot methanol and measured with spectrophotometry FELFÖLDY (1976). To calculate the trophic level of the water OECD standard was used (e,g, > 75 μg/l chlorophyll-a = hypertrophic level, OECD 1982).

Results and Discussion

Species composition of the phytoplankton

Chlorophyta was the most species-rich group along the Balsa section of the River Tisza in all three occasions. The diatom flora was also diverse mainly due to the presence of Centrales species. The number of Cyanobacteria, Chrysophyceae and Euglenophyta species was low or they could not even be found during counting (Figure 1.)

The species composition of the phytoplankton in the eastern and western parts of Kacsa-tó was similar in October 2000 and in June, 2001 though some differences can be noted. In autumn e.g. the species number of Cyanobacteria was lower in the eastern part, where the Euglenophyta species number was lower in summer. Species numbers were 25-30% smaller in autumn than in June. *Catena viridis* Chod. (Chlorophyceae) is a rare species worth mentioning from here together with the rich Euglenophyta flora (14 species) of the dead arm. In October 2001 greater spatial differences were recorded than before. Chlorophyceae made approximately half the phytoplankton species list (45% and 55%), respectively) but in the eastern part Chrysophyceae was the second most species rich group (20%) followed by a more or less equal number of Bacillariophyceae, Cryptophyta-Dinophyta, and Euglenophyta while in the west Bacillariophyceae was second (20%) followed by Chrysophyceae and a more or less equal number of Cryptophyta-Dinophyta, and Euglenophyta. These species number and composition differences can be explained by the intensive use of the eastern part of the dead arm for angling. *Trachelomonas zorensis* Lefévre, (Euglenophyta) *Catena viridis, Juranyiella javorkae* (Hortob.) Hortob, *Quadricoccus laevis* Fott (Chlorophyceae) are mentioned as rare species in this dead arm. In October 2001 *Euglena viridis* Ehrbg. and *Trachelomonas zorensis* bloom was recorded in the eastern part of the dead arm.

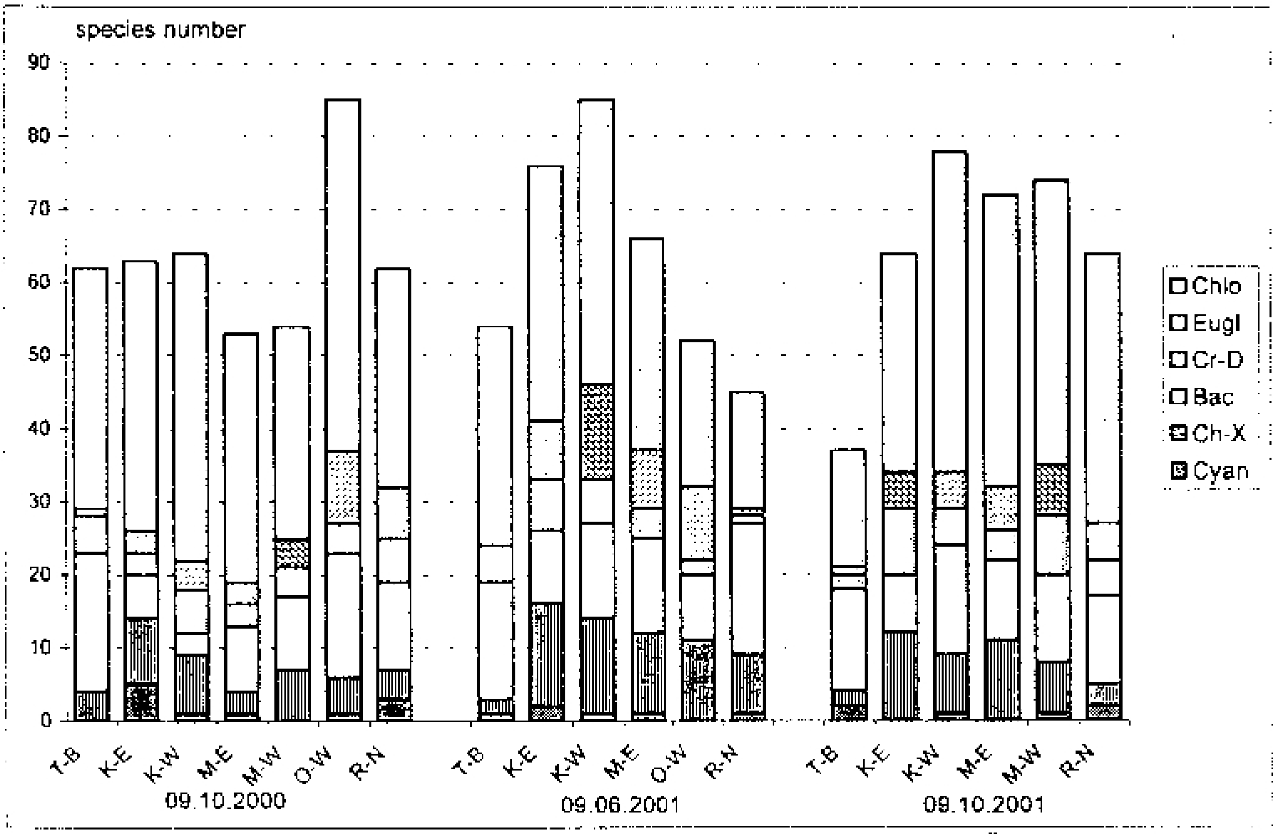

Figure 1. Species number of the main phytoplankton groups in the River Tisza and its dead arms (T-B = main arm of River Tisza at Balsa, dead arms: K-W = Kacsa-tó west, K-E = Kacsa-tó east, R-N = Remete-zugi-holt-Tisza north, M-W = Marót-zugi-holt-Tisza west, M-E = Marót-zugi-holt-Tisza east, O-W = Oláh-zugi-holt-Tisza west – Chlo – Chlorophyta, Eugl – Euglenophyta, Cr-D – Cryptophyta, Dinophyta, Bac – Bacillariophyceae, Ch-X – Chrysophyceae, Xanthophyceae, Cyan – Cyanobacteria).

In October 2000 Chlorophyceae species were the most numerous (nearly 70% of the total) in the eastern part of the Marót-zugi-holt-Tisza and also in the western part even if it was more moderate there. In June 2001 they were also diverse in the eastern part even if their ratio remained below 50%. Chrysophyceae, Bacillariophyceae and Euglenophyta species number was also high then. In October, 2001 there was a pronounced difference between the composition of the main phytoplankton groups between the eastern and the western parts but the general pattern was very similar to that of the Kacsa-tó as the relative abundance of the groups was nearly identical at the two sites. The comparison of the autumn samples revealed that the ratio of Chlorophyceae was smaller (60%) in October, 2001 than in October, 2000 in the eastern part of the Maròt-zugi-holt-Tisza while it was nearly the same in the west. The ratio of other groups was also quite stable, especially in the west. *Trachelomonas zorensis*, (Euglenophyta), *Coelastrum cambricum* Arch., *Lagerheimia hindakii* Hegew et Schmidt, and *Stichococcus contortus* (Chodat) Hindák (Chlorophyceae) should be mentioned as rare species present in this dead arm.

A high phytoplankton species number (85) was recorded in the Oláh-zugi-holt-Tisza in October, 2000. Chlorophyceae was the most numerous but besides Bacillariophyceae, more than 10% of the species also belonged to Euglenophyta. This ratio was even higher in June, 2001 together with Chlorophyceae and Chrysophyceae (appr. 20%). The dead arm was especially rich in silicoflagellata species (4 *Mallomonas*, 2 *Paraphysomonas*, 2 *Spiniferomonas, 1 Synura*). Due to low water level, samples could only be collected from the algal bloom caused by *Euglena viridis* and *Trachelomonas zorensis* in October 2001.

The phytoplankton of the Remete-zugi-holt-Tisza differed concerning both its species composition and individual number from that of other dead arms. In October, 2000 nearly half the species belonged to Chlorophyta. Bacillariophyceae, Cryptophyta and Euglenophyta made another 40% with a more or less equal distribution, while Cyanobacteria, Chrysophyceae had a 5% presence each. In June, 2001 Chlorophyceae and Bacillariophyceae was responsible for 35-35% of the species, Chrysophyceae for 20% while only a low number of species were present from the other groups. In October 2001 the species composition of main taxonomical groups was practically identical with what had been detected a year before. 55% Chlorophyta, 20% Bacillariophyceae, 8% Cryptophyta-Dinophyta, 8% Euglenophyta and 4-5% Cyanobacteria and Chrysophyceae-Xanthophyceae were found. *Rhodomonas lens* Pascher et Ruttner (Cryptophyta), *Trachelomonas zorensis* (Euglenophyta) and *Quadricoccus laevis* (Chlorophyceae) were present as rare species in this dead arm. The October 2001 algal bloom was caused *Trachelomonas zorensis*.

Quantitative relations of phytoplankton

Chlorophyll-a content showed a diverse pattern between the investigated sites and also within the studied dead arms. In autumn, when the water level of the dead arms was low and nutrient concentrations increased there was more phytoplankton in the dead arms that in the River Tisza (Figure 2.)

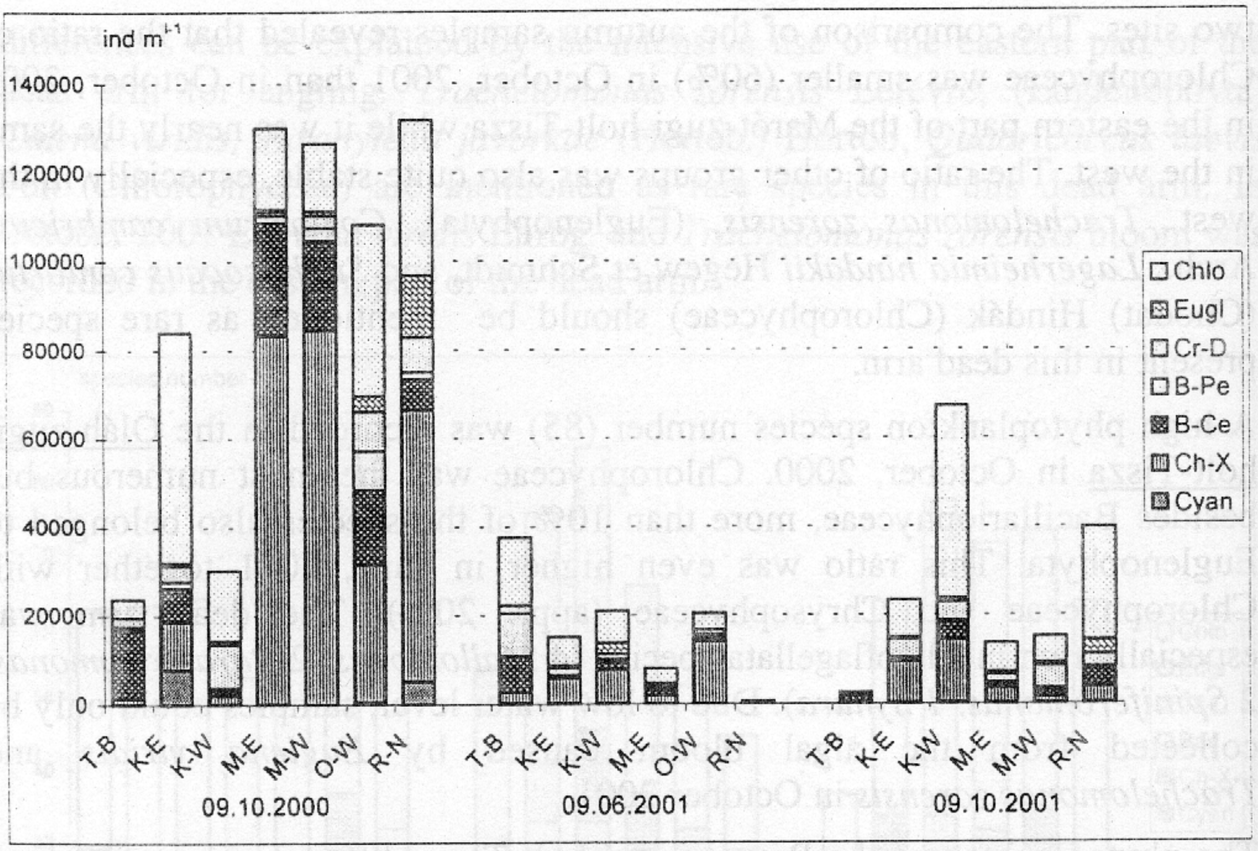

Figure 2. Abundance of the main phytoplankton groups in the River Tisza and its dead arms (abbreviation of sampling sites on Fig 1, Chlo – Chlorophyta, Eugl – Euglenophyta, Cr-D – Cryptophyta, Dinophyta, B-Pe – Bacillariophyceae, Pennales, B-Ce – Bacillariophyceae, Centrales, Ch-X – Chrysophyceae, Xanthophyceae, Cyan - Cyanobacteria).

In the River Tisza at Balsa centric diatoms predominated in October 2000 and 2001, while in June 2001 the individual number of Centrales, Pennales and Chlorococcales species was nearly the same. A high number of teratological diatoms was detected in October, 2000, which decreased by June, 2001 and disappeared by October, 2001. The increase of teratological diatoms was probably in connection with the heavy metal and cyanide pollution of the River Tisza in 2000 (Kiss et al. 2002). It is well known from the literature that heavy metal pollution increases the frequency of frustule deformities in diatoms. No such diatoms were found in October 2001.

The eastern and western part of Kacsa-tó was considerably different. In October, 2000 nearly three times more phytoplankton was found in the east, while in 2001 the individual number was higher in the western part. In October, 2000 several thousands of individuals were caunted for *Snowella* sp. (Cyanobacteria) *Chroomonas acuta* Uterm. (Cryptophyta) *Catena viridis*, *Crucigenia tetrapedia* (Kirch.) W. et G.S. West, *Kirchneriella contorta* (Schmidle) Bohl, *K. obesa* (W. West) Schmidle, *Scenedesmus ecornis* (Ehrbg.) Chod. (Chlorophyceae). In the eastern part of the dead arm a potentially toxic Chrysophyceae species (*Chrysochromulina parva* Lackey) was present in high numbers (4453 ind/ml^{-1}).

In October, 2001 Chlorophyceae, than Chrysophyceae, Cryptophyta, in the western part Centrales species were present in the highest number. *Chrysococcus biporus* Skuja, *C. rufescens* Klebs., *Dinobryon divergens* Imhof (Chrysophyceae), *Stephanodiscus minutulus* (Kütz.) Cleve et Möller (Centrales), *Chroomonas acuta, Cryptomonas ovata* Ehr.. (Cryptophyta), *Chlamydonephris pomiformis* (Pasch.) Ettl, *Crucigenia tetrapedia, Dictyosphaerium pulchellum* Wood, *Kirchneriella contorta, K. obesa, Koliella longiseta* (Kirchner) Hindák, *Monoraphidium contortum* (Thur.) Kom. et Legn. (Chlorophyceae) were reached more than 1000 ind ml^{-1}.

In October, 2000 a small species, Chrysophyceae (*Chrysococcus rufescens* 80000 ind ml^{-1}), and *Aulacoseira distans* (Ehrbg.) Sim. (Bacillariophyceae- 20 000 ind ml^{-1}) was present in extremely high numbers in the Marót-zugi-holt-Tisza. Besides, abundance of the following species was over 1000 ind ml^{-1}: *Nitzschia acicularis* (Kütz.) W.M. Smith – Bacillariophyceae, *Cryptomonas ovata* – Cryptophyta, *Crucigenia tetrapedia, Diplochloris lunata* (Fott) Fott, *Koliella longiseta* and *Monoraphidium contortum* - Chlorophyta. Phytoplankton abundance was low in June, 2001, only 10% of the October, 2000 value. In October, 2001 there were nearly eight times less phytoplankton in the dead arm than in October 2000 and the ratio of main groups also changed, e.g. there was relatively less Chrysophyceae and Bacillariophyceae. Several hundreds or more than 1000 ind ml^{-1} was reached by *Dinobryon bavaricum* Imhof, *D. crenulatum* W. et G.S. West, *D. divergens* (Chrysophyceae), *Aulacoseira distans, Stephanodiscus minutulus, Fragilaria tenera* (W.Smith) Lange-Bertalot (Bacillariophyceae), *Chroomonas acuta, Cryptomonas marsonii* Skuja, *C. ovata* (Cryptophyta), *Trachelomonas volvocina* Ehrbg., *T. zorensis* (Euglenophyta). *Chlamydomonas globosa* Snow., *C. reinhardtii* Dang., *Crucigenia tetrapedia, Monoraphidium arcuatum* (Kors.) Hind., *M. contortum, Scenedesmus acuminatus* (Lagh.) Chod., *S. ecornis, S. intermedius* Chod., *Tetraedron minimum* (A.Br.) Hansg. (Chlorophyceae). The silicoflagellata flora of the dead arm was also diverse, the transmission electromicroscopic study detected the following species: *Chrysospherella brevispina* Kors., *Mallomonas alpina* Pasch. et Ruttner, *M. caudata* Ivanov & Krieger, *Spiniferomonas cornuta* Balonow, *S. bourrelly* Takahashi, *Synura* c.f. *echinulata* Kors., *S. petersenii* Kors., *S. uvella* Ehrbg.

High phytoplankton abundance was measured in the Oláh-zugi-holt-Tisza in October, 2000. The number of Chrysophyceae, Bacillariophyceae and Chlorophyceae cells was nearly the same. The abundant species were *Chrysococcus rufescens* (29500 ind ml^{-1}), *Cyclotella pseudostelligera* Hustedt (7185 ind ml^{-1}), *Stephanodiscus delicatus* Genkal (3640 ind ml^{-1}). *Thalassiosira pseudonana* Hasle et Heimdal (3020 ind ml^{-1}), *Nitzschia acicularis* (5938 ind ml^{-1}), *Chroomonas acuta* (2227 ind ml^{-1}), *Rhodomonas lacustris* Pash. et Rutt. (5938 ind ml^{-1}), *Crucigenia tetrapedia* (2969 ind ml^{-1}), *Diplochloris lunata* (3340 ind ml^{-1}), *Kirchneriella contorta* (2041 ind ml^{-1}), *K. obesa* (2598 ind ml^{-1}), *Monoraphidium contortum* (5567 ind ml^{-1}), *Scenedesmus ecornis* (2041 ind ml^{-1}), *Siderocelis ornata* (Fott) Fott (2041 ind ml^{-1}).

In June, 2001 the abundance of phytoplankton was lower and only three Chrysophyceae species had several thousand cells in a millilitre (*Chrsococcus rufescens, Dinobryon divergens, D. sociale* Ehrbg.). The silicoflagellata flora of the dead arm was diverse, the following species were detected by transmission electromicroscope: *Mallomonas alpina, M. caudata,* 2 *Paraphysomonas* sp., *Spiniferomonas cornuta, S. trioralis, Synura petersenii.*

In October, 2000 from the investigated dead arms the highest phytoplankton individual number was recorded in the Remete-zugi-holt-Tisza. In June, 2001, however, the phytoplankton abundance was the lowest at this site. In October, 2000 nearly every second individual belonged to Chrysophyceae, mainly (58.637 ind ml-1) to the potentially toxic *Chrysochromulina parva*. From other algal groups *Cyclotella pseudostelligera* (2015 ind ml^{-1}), *Chroomonas acuta* (4082 ind ml^{-1}), *Rhodomonas lacustris* (2598 ind ml^{-1}), *Euglena viridis* (2598 ind ml^{-1}), *Chlamydomonas reinhadtii* (3526 ind ml^{-1}). *Chlamydonephris pomiformis* (6309 ind ml^{-1}), *Kirchneriella aperta* Teil. (2227 ind ml^{-1}), *K. contorta* (4825 ind ml^{-1}), *K. obesa* (3711 ind ml^{-1}), *Monoraphidium contortum* (3155 ind ml^{-1}) and *Scenedesmus costato-granulatus* (2598 ind ml^{-1}) were present in a higher number than 2000 ind ml^{-1}. The probable causes of the high abundance were the extremely low water depth and the high nutrient availability in the water. No predominant species were found in June. In October 2001 the phytoplankton abundance was more than there times lower than a year before. More than 60% of the individuals belonged to Chlorophyceae. Species reaching or exceeding several hundred or a thousand ind. ml^{-1} were *Chrysococcus rufescens* (Chrysophyceae), *Cyclotella atomus, C. pseudostelligera, Stephanodiscus hantzschii, S. invisitatus, S. minutulus* (Bacillariophyceae), *Chroomonas* *acuta*, *C. coerulea*, *Cryptomonas ovata* (Cryptophyta), *Trachelomonas volvocina* (Euglenophyta), *Chlamydomonas reinhardtii*, *Chlamydonephris pomiformis*, *Crucigenia tetrapedia*, *Diplochloris lunata*, *Kirchneriella aperta*, *K. contorta*, *K. lunaris*, *K. obesa*, *Monoraphidium contortum*, *Nephrochlamys subsolitaria*, *Scenedesmus ecornis*.

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