HYDROBIOLOGICAL INSTITUTE
ACADEMY OF SCIENCES OF THE CZECH REPUBLIC
ČESKÉ BUDĚJOVICE

45th ANNUAL REPORT

For the Year 2004

ISSN 0232 - 0533

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CONTENTS

Academy of Sciences of the Czech Republic
Hydrobiological Institute
Na Sádkách 7
370 05 České Budějovice
Czech Republic

telephone (++420) 385310262
fax (++420) 385310248
e-mail hbu@hbu.cas.cz
http://www.hbu.cas.cz

The staff and field of work

Scientific staff:

Department of plankton and fish ecology:

Doc. RNDr. J. Kubečka, CSc. (Head)	Fish population dynamics and scientific sonar techniques
Prof. RNDr. Z. Brandl, CSc.	Ecology of predatory Cyclopidae, predatory food relations
Ing. J. Frouzová	Hydroacoustics and fish behaviour
Mgr. E. Hohausová, Ph.D.	Fish ecology and behaviour
Doc. RNDr. J. Hrbáček, DrSc. (Scientific Consultant)	Limnology of artificial water bodies, zooplankton, especially *Daphnia*
RNDr. K. Kubečková-Kaštovská, Ph.D.	Phytoplankton analyses, morphological variability of cyanobacteria (genera *Anabaena, Aphanizomenon*)
RNDr. J. Komárková, CSc.	Plankton primary production, phytoplankton analyses, taxonomy of algae
RNDr. J. Macháček, CSc.	Fish–zooplankton interactions, ecology of *Daphnia*
Doc. RNDr. J. Matěna, CSc.	Feeding biology of fish, ecology of chironomids
RNDr. J. Seďa, CSc.	Zooplankton, especially seasonal dynamics of Cladocera and fish–zooplankton interactions
RNDr. P. Znachor, Ph.D.	Phytoplankton, autoradiography, microphotography, cyanobacterial bloom ecology

Department of aquatic microbial ecology:

Prof. RNDr. K. Šimek, CSc. (Head)	Aquatic microbiology, bacteria–protozoa interactions, bacterial community composition
Ing. M. Macek, CSc. (11 months UNAM México, Campus Iztacala)	Protozoa–bacteria interactions, freshwater ciliates, biological waste water treatment
RNDr. J. Nedoma, CSc.	Microbial biochemistry, image analysis
RNDr. V. Straškrábová, DrSc.	Self-purification (BOD), aquatic bacteriology, interactions with phyto- and zooplankton
RNDr. J. Vrba, CSc.	Aquatic microbiology, extracellular enzyme activity

Department of hydrochemistry and ecosystem modelling:

Doc. Ing. J. Hejzlar, CSc. (Head)	Reservoir limnology and eutrophication
RNDr. J. Borovec, Ph.D.	Reservoir limnology, chemistry of sediments
RNDr. V. Jankovská, CSc. (from July)	Pollen analysis
Doc. Ing. J. Kopáček, Ph.D.	Analytical chemistry, soil–water interactions

Ing. P. Porcal, Ph.D. (from September until October)	Aquatic dissolved organic matter
Ing. M. Růžička, CSc. (until December)	Mathematical modelling of reservoirs
Doc. Ing. H. Šantrůčková, CSc. (from July)	Soil biochemistry
Ing. L. Vejvodová (from October until December)	Soil and water chemistry
Ing. J. Veselý, DrSc. (from May)	Palaeolimnological studies

Technical staff:

J. Bučková	Cleaner
A. Charvátová	Cleaner
A. Fiktusová	Chemical analyses
Ing. V. Hejzlarová	Chemical analyses
V. Jirák	Building maintenance, electric installations
Ing. J. Kroupová	Chemical analyses
M. Kupková	Phytoplankton analyses
V. Lavičková	Documentator
Ing. R. Malá	Bacteriological analyses, cultivation of microbes
Ing. P. Mautschka	Construction of laboratory and field electronic equipment, maintenance of computer nets
Mgr. K. Murtinger	Analytical chemistry
Z. Prachař	Field assistance, zooplankton analyses
S. Smrčková, DiS.	Bacteriological analyses, data processing
D. Šrámková	Secretary, accountant
M. Štojdlová	Biochemical analyses, image analysis
M. Vožechová	Microscopy, laboratory analyses
MUDr. J. Zemanová	Zooplankton analyses and culture maintenance

Ph.D. students:

Mgr. M. Brzáková (until December)	Phosphorus turnover and sedimentation
RNDr. M. Čech	Fish behaviour in the open water
Mgr. V. Draštík	Fish behaviour and community structure
Mgr. M. Hladík (until October)	Fish migrations

Mgr. K. Horňák	Bacterioplankton community composition and activity
Ing. J. Jarošík (from March)	Mathematical modelling of reservoirs
Mgr. J. Jezbera	Protozoan–bacterial interactions
Mgr. J. Jezberová (from February)	Identification of cyanobacterial picoplankton
Mgr. J. Kaňa (from September)	Water and soil chemistry
Ing. R. Kyrian (until August)	Soil and water chemistry
Mgr. R. Litvín (from March)	Mathematical models
Mgr. J. Peterka	Fish foraging
RNDr. M. Prchalová (until September)	Fish behaviour
Mgr. A. Štrojsová	Extracellular phosphatases of phytoplankton
Mgr. J. Turek	Hydrology and water chemistry
Mgr. M. Vašek	Fish feeding and distribution

Student help:

T. Jůza, Bc.	Fry trawl fishing
K. Kolářová, Bc. (from June until September)	Zooplankton
M. Kratochvíl, Bc. (from August)	Pelagic fish larvae
M. Marešová, Bc.	Water and sediment analysis
M. Říha, Bc. (from September)	Efficiency of beach seining
M. Tušer, Bc. (from September)	Acoustic methods

Civil service:

J. Jarošík
(until February)

J. Kaňa
(until August)

1. INTRODUCTION

The basic staff of the institute has remained unchanged in 2004. Regular long-term monitoring with some special investigations has continued in the Slapy and Římov reservoirs, and so has the research on lakes in the Bohemian Forest and in the Slovakian and Polish High Tatra Mts. Field research has been supplemented by focused laboratory experiments.

The Institutional Research Project „Biotic interactions in the pelagic zone of lenitic ecosystems, reservoirs and lakes of different trophy after reduction of emissions in post-communist Europe" was finished and an evaluation of the achievements of the HBI during the last five year period (1999–2003) took place in 2004. The HBI was classified as one of the best institutes in the AS CR, as "Ia" on a "Ia to Ic" scale. At the same time the new Institutional Research Plan "Structure, functioning and development of aquatic ecosystems", proposed for the years 2005–2010 was approved.

The "Support Programme for targeted research in the AS CR" will continue in the HBI through another project "Limnological basis of sustainable management of reservoirs", approved for the period 2005–2009.

HBI is responsible for one site in the global LTER (long-term ecological research) and GTOS (global terrestrial observing system) networks – "Reservoirs in the Vltava River Watershed". The site is registered in the database of TEMS (Terrestrial Ecosystem Monitoring Site) on the website: www.fao.org/gtos/tems.

Close cooperation of the HBI with the Faculty of Biological Sciences, University of South Bohemia, has continued under similar conditions as in preceding years. Institute members have also been actively engaged supervising students' theses, lecturing and training students at other Faculties (Agriculture and Pedagogical) of the University of South Bohemia and at other Universitites (Charles University, Prague, Institute of Chemical Technology, Prague). 1 Master's thesis and 7 Bachelor's theses supervised by staff members were completed in 2004 (see list at the end of chapter). Most staff members work part-time for the University of South Bohemia and vice-versa. Students are active in the HBI as student helpers and part-time staff members (see list of staff).

Frequently, scientists from abroad have stayed at the institute to evaluate the results of joint projects, prepare publications and plan future cooperation: G.I. Orderud, O. Foss (Norwegian Institute for Urban and Regional Research, Oslo, Norway); A.N. Butorin, A.I. Kopylov (Institute for Biology of Inland Waters, Russian Academy of Sciences, Borok, Russia); V. Novotny (North Eastern University, Bolton, Massachussets, USA) – invited lecture at the regular Memorial of M. Straškraba; L. Nasseli-Flores (University of Palermo, Italy) – referee of the Institutional Research Plan; F. Van Wambeke (Laboratoire de Microbiologie Marine CNRS, Marseille, France); G. Addico (University of Hull, UK); E. Rejmánková (University of California, Davis, USA); S. Ventura (CNR – Centro Studio dei Microorganismi Autotrofi, Firenze, Italy); J. Dolan, M. Weinbauer (Station Zoologique, Villefranche-Sur-Mer, France); X. Cao (Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan, China); G. Hocking (Murdoch University, Perth, Australia) – invited lecture for the Czech Limnological Society; T. Posch, M. Salcher (University of Innsbruck, Austria); F. Dierberg (Environmental Department, Rockledge, Florida, USA).

HBI members took part in congresses and conferences abroad (see below) and visited foreign institutions to carry out and evaluate joint experiments and prepare projects: V. Straškrábová, J. Nedoma, J. Borovec (4th Annual Conference of CONTINENT, Krakow, Poland); J. Hejzlar (Technical University Dresden, Germany, invited lecture); J. Seďa (University of Frankfurt, Germany); J. Straškrábová, J. Jezbera (Lake Baikal, Russia, field work on CONTINENT); J. Kopáček (Innsbruck, Austria, EUROLIMPACS workshop); J.

Kubečka (Neusiedlersee, Austria, preparation of joint experiments); K. Šimek (Station Zoologique, Villefranche-Sur-Mer, France, joint project BARRANDE); J. Hejzlar (Carmona, Spain, EUROHARP workshop); J. Kubečka (University of Helsinki, Finland, referee of a Ph.D. thesis); J. Vrba, A. Štrojsová (Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan, China, project KONTAKT); J. Komárková (Finnish Environmnetal Institute, Lammi, Finland); P. Znachor (Bergen, Norway, Conference of Toxic Cyanobacteria); J. Kubečka (University of Vienna, Austria, DFG AQUASHIFT); J. Nedoma (Lab. de Microbiologie Marine CNRS, Marseille, France, preparation of a new project); J. Vrba (Manaus, Brazil, ILTER Annual Meeting); J. Hejzlar (Silkeborg, Denmark, EUROHARP workshop); J. Frouzová (Delft, The Netherlands, Conference of Underwater Acoustics); J. Komárková (Utrecht, The Netherlands, INTECOL Conference); J. Kubečka, J. Fouzová, E. Hohausová, Z. Prachař (Neusiedlersee, Austria, fish assessment); V. Straškrábová, J. Kopáček, J. Macháček, J. Vrba, K. Horňák, J. Jezbera, J. Jezberová, M. Prchalová (Lahti, Finland, SIL Congress); M. Prchalová, J. Peterka, E. Hohausová, M. Čech, M. Hladík (Silkeborg, Denmark, Conference of Behavior and Ecology of Freshwater Fish); A. Štrojsová, J. Nedoma, K. Šimek (Cancun, Mexico, International Symposium on Microbial Ecology); J. Komárková (Luxembourg, Symposium of the Internat. Assoc. of Cyanophyte Research); J. Kubečka, Z. Prachař (Enonkoski, Finland, pelagic trawling methods); J. Kopáček, J. Vrba (Germany, sampling of Lake Rachelsee); J. Kopáček, J. Kaňa, P. Porcal, J. Turek (Slovakia, Poland, sampling of High Tatra lakes); J. Jezberová, A. Šrojsová, M. Macek (Pallanza, Italy, Freshwater Microbial Ecology workshop); M. Tušer (Vigo, Spain, ICES Conference); J. Kubečka (Slovakia, Gabčíkovo Water Work, evaluation of further cooperation); J. Nedoma (Nice, France, Mediterranean Sea, expedition within the project DYNAPROC 2); J. Jezbera, K. Šimek, K. Horňák (CMIMA Barcelona, Spain, project BASICS); J. Vrba (Halle, Potsdam, Germany, ALTERNET meetings); V. Straškrábová (Borok, Russia, International Conference); V. Straškrábová (Vienna, Austria, ALTERNET workshop); J. Hejzlar (Ronde, Denmark, ALTERNET workshop); V. Straškrábová (Helsinki, Finland, ALTERNET workshop committee); J. Vrba, K. Šimek (University of Innsbruck, Austria, project KONTAKT); P. Znachor (Poland, analysis of samples); J. Jezberová (CNR Firenze, Italy, project KONTAKT); K. Šimek (Mondsee, Austria, invited lecture); J. Matěna (Technical University Zvolen, Slovakia, referee of Ph.D. theses); J. Frouzová (Norway, expedition on the research wessel G.O. Sars).

PROJECTS

Institutional project, Academy of Sciences of CR

1999–2004 Z6017912 Biotic interactions in the pelagic zone of lenitic ecosystems, reservoirs and lakes of different trophy after reduction of emissions in post-communistic Europe –Hydrobiological Institute AS CR.

Priority Research Programs of the Academy of Sciences of CR

2001–2004 K3046108 The effect of climatic and anthropogenic factors upon the living and non-living environment

2001–2004 K6005114 Biodiversity and function of ecological structures

Program Support of Targeted Research in the Academy of Sciences of CR

2000–2004 S6017004 Management of water quality in reservoirs

Projects sponsored by the Grant Agency of the Academy of Sciences of CR

2002–2004 A6017201 Pelagic niche of riverine fish in Czech reservoirs – J. Matěna

2002–2005 A6017202 Detection, localisation and quantification of extracellular enzymatic activities on cellular and population level in natural lake seston – J. Vrba

2003–2005 A6017301 Dynamics of morphology and growth of *Daphnia* as a response to spatio-temporal heterogeneity of environmental conditions – J. Macháček

2003–2005 A6005308 Relations between the phenotypic and ultrastructural characters of heterocytous cyanobacteria – J. Komárková (coordinated by Institute of Botany AS CR)

2003–2006 A3017301 Modelling of processes in the system "atmosphere–catchment–reservoir" and their impacts to surface water quality – J. Hejzlar

Projects sponsored by the Grant Agency of CR

2002–2004 206/02/0520 Tributary zone as a key factor for fish stock development in reservoirs – J. Kubečka

2002–2004 206/02/0003 Top-down and bottom-up factors controlling bacterial community composition and dynamics in different parts of a meso-eutrophic canyon-shaped reservoir – K. Šimek

2003–2005 103/03/0469 Simulation of processes with impacts to water quality in reservior systems – J. Hejzlar (coordinated by Institute of Hydrodynamics AS CR)

2003–2005 206/03/1583 Nutrient cycling in the nitrogen-saturated mountain forest ecosystem: History, present, and future of water, soil, and Norway spruce forest status – J. Kopáček (cooperation with the Faculty of Biological Sciences, University of South Bohemia, České Budějovice; Czech Geological Survey, Prague; Faculty of Forestry, Czech University of Agriculture, Prague; Institute of Landscape Ecology AS CR, České Budějovice; and Institute of Botany AS CR, Brno)

2003–2005 206/03/1537 Mechanisms of coexistence of *Daphnia* species and clones in a stratified reservoir with planktivorous fish predation – J. Macháček

2003–2005 206/03/1491 Light-limited phytoplankton in a deep canyon-shaped reservoir: strategy of survival in the period of winter mixing – J. Hrbáček (coordinated by the Faculty of Science, Charles University, Prague)

2003–2005 206/03/P024 Relationship between molecular and morphological characteristics of planktic and benthic cyanobacteria – K. Kaštovská

2004–2006 206/04/0190 Local genetic differentiation of *Daphnia* in deep canyon-shaped dam reservoirs – J. Seďa (ccoperation with the Faculty of Science, Charles University, Prague)

2004–2006 206/04/P092 Large scale survey of plant biomass and plant cover by echosounding – E. Hohausová

International projects

2003–2004 Single-cell analysis of aquatic bacterioplankton: comparing methods and transferring expertise (bilateral project AS CR – CSIC Spain); awarded to K. Šimek and J. Gasol, CMIMA, Barcelona, Spain

2004–2005 Sources of mortality in *Synechococcus*, a common planktonic, autotrophic prokaryote (bilateral project Barrande, AS CR – CNRS France); awarded to K. Šimek and J. Dolan, CNRS-UPMC, Villefranche-sur-mer, France

2003–2005 The role of bacteria in carbon cycling in reservoirs and long-term changes in biotic interactions (bilateral project AS CR – RAS Russia); V. Straškrábová and A.I. Kopylov, Institute for Inland Waters Russian Academy of Sciences, Borok, Russia

Project sponsored by the Ministry of education, youth and sports CR

2003–2004 ME 617 (KONTAKT / Sino-Czech Scientific and Technological Cooperation, 36–20) The role of extracellular enzymes in the processes of eutrophication in lakes – J. Vrba

European Communities R&D Program 5th framework

2001–2004 EUROHARP Towards European harmonized procedures for quantification of nutrient losses from diffuse sources – J. Hejzlar (coordinated by NIVA, Oslo, Norway)

2002–2004 CONTINENT High resolution record in the Lake Baikal: A key-site for Eurasian teleconnection to the North Atlantic Ocean and monsoonal system – V. Straškrábová (coordinated by GeoForschungsZentrum Potsdam, Germany)

European Communities R&D Program 6th framework

2004–2009 ALTER-Net A Long-Term Biodiversity, Ecosystem and Awareness Research Network – V. Straškrábová (coordinated by Centre for Ecology and Hydrology NERC, Lancaster, UK)

2004–2009 EURO-LIMPACS Integrated Project to Evaluate the Impacts of Global Change on European Freshwater Ecosystems – J. Kopáček (coordinated by University College, London)

CONSULTANCIES

2004 Fish stock assessment of the Želivka water supply reservoir – J. Kubečka, Vltava River Autority.

2004 Impacts of surface water level decrease on water quality in the Nýrsko reservoir – J. Hejzlar, Vltava River Autority.

GUEST SEMINARS HELD IN HBI

Dr. A. I. Kopylov, A. N. Butorin (Institute for Biology of Inland Waters, Russian Academy of Sciences, Borok, Russia): Research profile of IBIW. May 27, 2004.

Prof. V. Novotny (Northeastern University, Boston, USA): Assessment of watershed vulnerability – a tool for watershed management. June 24, 2004. Memorial of M. Straškraba (organized together with the Faculty of Biological Sciences, University of South Bohemia).

Prof. Graeme Hocking (Murdoch University, Perth, Western Australia): Modelling in Limnology – Why and How? August 24, 2004.

PRESENTATIONS OF HBI MEMBERS AT INTERNATIONAL CONFERENCES

Behaviour and ecology of freshwater fish: Linking ecology and individual behaviour, Silkeborg, Denmark – M. Čech, J. Kubečka, M. Kratochvíl, V. Draštík, J. Matěna: Diel vertical migrations and ontogenetic changes of bathypelagic layer of European perch fry, *Perca fluviatilis* L.; M. Hladík, J. Kubečka: Fish migrations in a temperate reservoir; M. Vašek, J. Kubečka, J. Matěna: Spatial variation in diet of juvenile fish within a canyon-shaped reservoir; M. Kratochvíl, J. Peterka, J. Kubečka, J. Matěna, M. Čech, J. Seďa, J. Macháček, I. Vaníčková, V. Draštík: Survival strategies of three sympatric ecological groups of larval and juvenile percids (poster); M. Prchalová, J. Kubečka, M. Čech: Fish behaviour on the spawning grounds of cyprinids; J. Peterka, J. Matěna: Behavioral factors affecting feeding efficiency in juvenile perch and roach (poster); E. Hohausová, R.J.

Lavoy, M.S. Allen: Dispersal of fish between source and seasonal habitats: a human influence.

XXIX SIL Congress, Lahti, Finland – K. Horňák, J. Jezbera, M. Mašín, J. Nedoma, K. Šimek: Impacts of resource availability and predation on the community composition and proportion of active bacteria in a canyon-shaped reservoir (poster – 3rd price in students'competition); F.E. Dierberg, J. Potts, K. Kaštovská: Alternation in the suspended algal abundance, distribution, and diversity within a stormwater treatment area in South Florida, USA; J. Kopáček, J. Hejzlar, J. Nedoma, J. Vrba: Natural inactivation of phosphorus by aluminium and its impact on in-lake phosphorus cycling; M. Prchalová, J. Kubečka, M. Hladík, M. Vašek, J. Peterka, M. Čech, V. Draštík, E. Hohausová, J. Frouzová: Fish habitat preferences in a complex reservoir system; J. Vrba, A. Štrojsová, M. Štrojsová, J. Nedoma: Enzyme labeled fluorescence (ELF): a new tool for detecting enzymes in discrete planktonic organisms and particular populations; V. Straškrabová, J. Nedoma, J. Borovec, J. Jezbera, M. Macek, A. Štrojsová: Size fractionated primary production and microbial loop in the euphotic zone of Lake Baikal; G. Rosiles, G. Vilaclara, J. Carmona, M. Macek: Picocyanobacteria in the maar lake Alchichica, México; J. Jezberová (Lodeová): Responses of picocyanobacteria to protozoan grazing (poster); J. Macháček: *In situ* dynamics of morphology and life history traits of *Daphnia galeata*: spatio-temporal pattern.

7th Intecol International Wetland conference, Utrecht, The Netherlands – J. Komárová, E. Rejmánková, V. Vymazal: Changes in species diversity of cyanobacterial mats in marshes of Belize and the Florida North Everglades following nutrient enrichment; E. Rejmánková, J. Komárková, K. Epps: Phosphorus, nitrogen and salinity as determinants of structural and functional changes in cyanobacterial mats: mesocosm experiment; D. Sirová, J. Vrba, E. Rejmánková: Extracellular enzyme activities in benthic cyanobacterial mats: comparison between nutrient enriched and control plots in marshes of northern Belize.

16th Symposium of the International Association for Cyanophyte Research, Luxembourg, Luxembourg – J. Komárková , C.L. Sant´Anna, M.A. Mugnai: The *Microcystis* genus is monophyletic according to 16S rRNA gene sequencing, however fixed monotypes do exist; J. Komárek, S. Ventura, S. Turicchia, J. Komárková, C. Mascalchi, E. Rejmánková: Cyanobacterial diversity in alkaline marshes of northern Belize (Central America); J. Komárková, E. Rejmánková: Changes in diversity of cyanobacterial mats impacted by nutrients and salinity increase: a mesocosm experiment in Belize (poster); P. Rajaniemi, L. Hoffmann, R. Willame, J. Komárek, P. Hrouzek, K. Kaštovská, K. Sivonen: Phylogenetic and morphological evaluation of selected planktic nostocalean cyanobacteria: taxonomic consequences; E. Zapomělová, K. Kaštovská, P. Hrouzek, M. Šabacká, M. Stibal, L. Caisová: Morphological variability of eight cyanobacterial strains as a response to varied temperature, light intensity and media; J. Jezberová (Lodeová): Colonial formation of picoplanktic cyanobacteria (poster).

6th International Conference of Toxic Cyanobacteria, Bergen, Norway – P. Znachor, T. Jurczak, J. Komárková, J. Mankiewicz, J. Lodeová, E. Zapomělová, K. Kaštovská: Cyanobacterial bloom species composition and microcystin concentrations in Czech reservoirs.

10th International Symposium on Microbial Ecology, **ISME-10, Cancun**, **Mexico** – K. Šimek, K. Horňák, M. Mašín, J. Jezbera, J. Nedoma, J. Gasol, M. Schauer: Members of a small subcluster of Beta-Proteobacteria sensitively respond to top-down and bottom-up manipulations with bacterioplankton in a freshwater reservoir; A. Štrojsová, J. Nedoma, J. Vrba: Hydrolysis of organic phosphorus by cyanobacterial and algal enzymes: a direct visualization and quantification of extracellular phosphatase activity; J. Nedoma, J. Vrba:

Measurement of extracellular phosphatase activity in freshwater bacteria at the single-cell level using ELF97 phosphate and image analysis; M. Macek, D. Peštová, G. Rosiles-González, M.E. Martínez-Pérez, G. Vilaclara-Fatjó, J. Carmona-Jiménez: Protozooplankton and their activity in a deep monomictic athalassohaline lake in a semi-desert area; D. Peštová, M.E. Martínez-Pérez, M. Macek: Peritrichs dominate temporarily the ciliate assemblage activity in high altitude tropical lakes; N. Murueta-Figueroa, M. Macek, J. Carmona-Jiménez: Picophytoplankton, protozooplankton and their feeding activity in a tropical Valle de Bravo Reservoir.

Workshop of the ALTER-Net WP RA3, Halle, Germany – J. Vrba: Acidification and eutrophication as drivers for biodiversity of freshwater ecosystems.

12th International Symposium on River and Lake Environments, Wuhan, China – X. Cao, A. Štrojsová, P. Znachor, E. Zapomělová, G. Liu, J. Vrba, Y.Y. Zhou: Detection of extracellular phosphatases in natural spring phytoplankton of a shallow eutrophic lake (Donghu, China).

XXIInd Conference of Danubian Countries on the Hydrological Forecasting and Hydrological Bases of Water Management, Brno, Czech Republic – J. Borovec, J. Hejzlar, M. Brzáková, J. Jan: Sediments as a dynamic pool of phosphorus in a stratified reservoir; J. Hejzlar, J. Jarošík, J. Borovec, M. Růžička: Modelling of hydrodynamics and water quality in a dimictic reservoir – Jordán reservoir (Czech Republic); J. Turek, J. Hejzlar, J. Žaloudík: Transport of phosphorus in the river network of a highland basin with mixed land use.

Primary production of the Water Ecosystems, International Conference, Borok, Russia – V. Straškrabová, J. Nedoma, K. Šimek, J. Vrba: Coupling between pelagic bacteria and phytoplankton primary production and exudation.

Workshop on Freshwater Microbial Ecology: Comparison of methods for measuring activity and interactions among microorganisms, Pallanza, Italy – J. Jezberová: Influence of physical-chemical conditions and protozoan presence on the growth and shape of the rod-like picoplanktic cyanobacteria; M. Macek: Protozooplankton feeding activity (FLB) and autotrophic picoplankton distribution (APP numbers vs. chlorophyll a) in water column of a monomictic maar-crater lake Alchichica (Mexico); A. Štrojsová, J. Vrba, J. Nedoma, M. Štrojsová: Extracellular enzymes in particular planktonic populations. Investigation using enzyme labelled fluorescence (ELF).

STUDENTS' THESES (finished in 2004)

K. Marhanová (BA): A structure of pelagic microbial assemblages in reservoir – a comparison of an identification of isolated strains with the FISH method, Faculty of Biological Sciences USB; supervised by V. Straškrábová

M. Marešová (BA): An influence of photochemical transformation of organic matter on concentrations of dissolved reactive phosphorus in the main surface tributary of Plešné Lake, Faculty of Biological Sciences USB; supervised by J. Kopáček

M. Říha (BA): The efficiency of shore seine for sampling of fish in reservoirs, Faculty of Biological science USB; supervised by J. Kubečka

M. Tušer (BA): Near-bottom blind zone during acoustic surveys of fish in reservoirs, Faculty of Biological science USB; supervised by J. Kubečka

I. Vaníčková (BA): Seasonal and diurnal stratification of zooplankton in reservoirs Slapy and Římov, Faculty of Biological Sciences; supervised by J. Seďa

J. Jan (BA): Factors effecting phosphorus release of sediments in Jordán reservoir, Faculty of Biological Sciences; supervised by J. Borovec

J. Mudruňková (BA): Foam formation at the Upper Vltava River 2002–2003, Faculty of Biological Sciences; supervised by J. Hejzlar

M. Štrojsová (MS): A new method for detecting digestive enzymes of planktonic rotifers and their seasonal dynamics in the Římov reservoir as related to their food, Faculty of Biological Sciences USB; supervised by J. Vrba

REPORT ON FINANCES

INCOME

balance from preceding year	1 620.00
support by Academy of Sciences including Priority research programmes	19 986.90
grants from Grant Agency AS CR	1 684.00
grants from Grant Agency CR	4 609.00
other domestic grants	145.00
foreign grants	2 432.20
consultancies	541.20
Total	**31 018.30**

EXPENSES

salaries	10 876.90
health + social insurance + social funds	3 896.20
other obligatory insurance of persons and property	226.60
student and civil service helpers	71.90
energy	656.90
gasoline	251.00
maintenance of buildings	267.00
maintenance of cars and equipment	241.00
postage, telephone, internet	193.40
books, journals	620.30
travelling and conference fees	1 635.80
computing, software	190.90
consumables and small equipment	3 646.30
others	707.40
submergeable light mater	114.60
flow cytometer	4 040.00
other durable equipment	57.20
Total	**27 693.40**

BALANCE (a fund for equipment) **3 324.90 thous. CZK**

2. RESERVOIRS

2.1 Dissolved and dispersed substances in reservoir water (Slapy and Římov)

Annual and summer mean concentrations of chemical constituents dissolved and dispersed in the surface layers of the Slapy and Římov reservoirs (Table 1) were obtained by J. Hejzlar and J. Kopáček. Samples were taken from 0.1 to 0.4 m depth at the deepest points of the reservoirs, pre-filtered through a 200-µm polyamide sieve to remove large zooplankton, stored in the dark at 4°C, and analysed within 48 h after sampling. Dissolved constituents were analysed in samples filtered through a glass fibre filter with 0.4 µm nominal pore size. Abbreviations in Table 1 are: TON, total organic nitrogen; DON, dissolved organic nitrogen; TN total nitrogen; TP, total phosphorus; TDP, total dissolved phosphorus; COD, chemical oxygen demand; DOC and POC, dissolved and particulate organic carbon, respectively. Summer means: April to September.

Table 1: Mean values of main chemical constituents dissolved and dispersed in the waters of Slapy reservoir and Římov reservoir in 2004.

VARIABLES	UNIT	MEAN VALUES			
		Slapy		Římov	
		Annual	**Summer**	Annual	Summer
NO_3–N	µg l^{-1}	2685	3162	1565	1380
NO_2–N	µg l^{-1}	24	39	11	16
NH_4–N	µg l^{-1}	33	48	75	60
TON	µg l^{-1}	663	732	549	585
DON	µg l^{-1}	579	599	494	517
TN	µg l^{-1}	3405	3981	2200	2041
TP	µg l^{-1}	44.0	30.4	27.3	20.6
TDP	µg l^{-1}	32.6	24.9	19.5	13.6
COD	mg l^{-1}	21.2	21.9	18.2	19.0
DOC	mg l^{-1}	6.33	6.54	5.08	5.38
POC	mg l^{-1}	0.63	1.03	0.48	0.49
Ca^{2+}	mg l^{-1}	22.1	22.5	12.4	11.5
Mg^{2+}	mg l^{-1}	6.2	6.4	3.0	2.85
Na^{+}	mg l^{-1}	11.5	11.4	6.6	5.6
K^{+}	mg l^{-1}	3.9	3.8	2.2	2.0
SO_4^{2-}	mg l^{-1}	32.4	33.8	18.7	18.5
Cl^{-}	mg l^{-1}	15.0	15.9	6.3	5.0
Alkalinity (Gran)	meq l^{-1}	0.82	0.74	0.45	0.41
Conductivity at 25°C	µS cm^{-1}	243	246	138	127

2.2 Microbial characteristics, chlorophyll and zooplankton biomass of the reservoirs Slapy and Římov

Annual and summer mean concentrations of bacteria, protozoans, microzooplankton, BOD_5 (total and after separating algae by filtration) as well as chlorophyll concentrations in the reservoirs and inflows to Římov reservoir, and mesozooplankton biomass in the reservoirs, based on data by Z. Brandl, J. Komárková, M. Macek, R. Malá, Z. Prachař, J. Seďa, K. Šimek, S. Smrčková, M. Štojdlová, V. Straškrábová, M. Štrojsová and M. Vožechová are shown in Table 2.

Table 2: Mean values of microbial characteristics, zooplankton, chlorophyll and BOD in the Slapy and Římov reservoirs and inflows. "Summer": April to September. Sites: S–Slapy and R–Římov reservoirs, C–Černá and M–Malše rivers – inflows to Římov reservoir.

SITE	VARIABLE	LAYER	UNIT	MEAN VALUE	
				Annual	Summer
S	BOD_5	0 m	mg l^{-1} O_2	[illegible]	2.13
	BOD_5 filtered	0 m	mg l^{-1} O_2	–	1.53
	bacteria DAPI	0 m	10^6 ml^{-1}	2.76	3.83
	bact. beef-pept. agar	0 m	CFU ml^{-1}	210	180
	het. nanoflagellates	0 m	10^3 ml^{-1}	1.27	1.75
	ciliates	0–3 m	per ml	[illegible]	1.86
	chlorophyll *a*				
	[illegible]	[illegible]	mg m^{-3}	6.21	11.74
	>40μm	0–3 m	mg m^{-3}	3.77	6.92
	zooplankton biomass, protein N				
	Cladocera herbiv.	0–41m	mg m^{-2}	[illegible]	159.5
	Copepoda	0–41m	mg m^{-2}	69.0	119.0
	total zooplankton	0–41m	mg m^{-2}	165.4	278.4
R	BOD_5	0 m	mg l^{-1} O_2	1.79	1.63
	BOD_5 filtered	0 m	mg l^{-1} O_2	–	1.21
	bacteria DAPI	0 m	10^6 ml^{-1}	2.66	3.55
	bact. beef-pept. agar	0 m	CFU ml^{-1}	630	190
	bact. yeast ext. agar	0 m	10^3 CFU ml^{-1}	2.9	3.5
	het. nanoflagellates	0 m	10^3 ml^{-1}	0.59	0.31
	ciliates	0 m	per ml	4.21	2.88
	rotifers	0–4 m	per ml	0.260	0.377
	chlorophyll *a*				
	[illegible]	0–3 m	mg m^{-3}	7.05	10.85
	>40μm	0–3 m	mg m^{-3}	3.71	6.00
	zooplankton biomass, protein N				
	Cladocera herbiv.	0–40 m	mg m^{-2}	111.6	143.3
	Copepoda	0–40 m	mg m^{-2}	50.2	69.2
	total zooplankton	0–40 m	mg m^{-2}	214.2	213.3
C	BOD_5	0 m	mg l^{-1} O_2	1.48	1.48
	chlorophyll *a*	0 m	mg m^{-3}	2.42	2.77
M	BOD_5	0 m	mg l^{-1} O_2	2.62	3.21
	chlorophyll *a*	0 m	mg m^{-3}	2.42	2.47

2.3 Metabolic activity of major bacterial groups in the Římov reservoir

K. Horňák, J. Jezbera, J. Nedoma, and K. Šimek examined changes in the phylogenetic structure and metabolic activity of major bacterial groups in the Římov reservoir under different levels of grazing pressure (top-down control) and resource availability (bottom-up control). The experiment was conducted in the canyon-shaped Římov reservoir during the clear-water phase (19–23 May 2003). Water sample collected at the dam and middle part of the reservoir was size-fractionated into <0.8 µm, <5 µm fractions, and incubated in duplicates in dialysis bags, glass bottles, and glass bottles enriched with phosphate in the dam and middle area of the reservoir. The goal of the study was to determine the metabolic activity of bacteria and the impacts of resource availability and predators on bacterial activity.

K. Horňák analysed the phylogenetic composition of the bacterial assemblage by means of the catalysed reporter deposition-fluorescence in situ hybridisation (CARD-FISH) method with HRP-labelled oligonucleotide probes for major phylogenetic groups of bacteria present in the Římov reservoir – beta-Proteobacteria (BET), R-BT (a subcluster of BET), gamma-Proteobacteria (GAM), and Cytophaga-Flavobacterium (CF). CARD-FISH technique was combined with microautoradiography to determine the taxonomic affiliation of bacteria and the number of cells taking up the amino acid leucine (Leu).

All the groups of bacteria examined in the study (BET, R-BT, GAM, CF) assimilated Leu. However, the groups showed a different proportion of metabolically active cells. BET were the dominant Leu-active bacteria of the bacterial assemblage. Interestingly, BET consisted almost entirely of the specific R-BT cluster, which achieved the highest level of Leu-uptake within the whole assemblage. The R-BT cluster showed the highest proportion of cells taking up leucine, thus forming the most active part of the assemblage, especially in treatments with enhanced grazing pressure. Considering the relative abundances, the CF group comprised the third most important group and GAM was the least important overall. On the other hand, GAM belonged to the highly active part of the community and showed a marked increase in substrate uptake, especially in treatments with added phosphorus. In general, uptake of Leu by CF was low, but increased mainly in the phosphorus-enriched treatments.

2.4 Top-down and bottom-up factors controlling bacterial community composition and dynamics in different parts of a eutrophic canyon-shaped reservoir

Final report summarizing the most important findings and published outputs of the GACR 206/02/0003 grant awarded to K. Šimek.

K. Šimek, J. Nedoma, J. Hejzlar, J. Vrba, V. Straškrabová, M. Macek and Ph.D. students M. Mašín, J. Jezbera, and K. Horňák collaborated on this project during the period 2002–2004.

The aim of the project was to study the impacts of principal factors shaping bacterioplankton community composition (BCC) and dynamics, i.e. bottom-up control, predation and viral lysis, in different parts of the canyon-shaped Římov reservoir with a marked longitudinal gradient of the limiting nutrients and organic substrate availability. To top-down-manipulate bacterioplankton populations, water samples were size-fractionated, yielding thus different levels of bacterivory. To manipulate bottom-up controlling factors, the same size fractions of plankton samples were incubated *in situ* in dialysis bags at different parts of the reservoir with distinct levels of nutrient limitation. To design experiments combining both types of the above manipulation approaches, we explored the knowledge gained during specific studies of longitudinal gradients in microbiological and chemical parameters in the reservoir (see [4–6] below).

In the following text the most important findings and outputs of the project are listed:

(i) Having analyzed a large series of experiments we proposed a model explaining changes in BCC as a response to sudden changes in the balance between bacterial growth and protist-induced mortality rates (see [1] for details).

(ii) A direct analysis of protozoan food vacuole contents by means of fluorescence in situ hybridization (FISH) indicated marked differences in food selectivity of protists on different bacterial species that specifically contribute to the fast shifts in BCC (see [9] for details). Moreover, in two manipulation experiments we found diatom-attached choanoflagellates of the genus *Salpingoeca* in high abundance that allowed us to conduct a detailed study of the ecological role and feeding rates of this important pelagic bacterivore in the reservoir [7].

(iii) Enhanced protistan bacterivory and phosphorus availability apparently stimulated viral production and virus-induced mortality of bacteria [2, 3, 8].

(iv) Members of a small subcluster of Beta-proteobacteria were detected to be of fundamental importance for overall bacterioplankton dynamics and production in the reservoir since they have a high nucleic acid content and large growth potential enabling them to respond very rapidly to different experimental manipulations [10].

(v) New methodical approaches (i.e., flow cytometry, microautoradiography combined with FISH), allowing studying specific aspects of relationships between bacterial community structure and function, were successfully introduced within the scope of the project.

Ten most important papers published in impacted journals with the support of the 206/02/0003 grant:

[1] Šimek, K., Nedoma, J., Pernthaler, J., Posch, T. Dolan, J.R. 2002: Altering the balance between bacterial production and protistan bacterivory triggers shifts in freshwater bacterial community composition. Antonie van Leeuwenhoek 81: 453–463.

[2] Šimek, K., Horňák, K., Mašín, M., Christaki, U., Nedoma, J., Weinbauer, M.G., Dolan, J.R. 2003: Comparing the effects of resource enrichment and grazing on a bacterioplankton community of a meso-eutrophic reservoir. Aquat. Microb. Ecol. 31: 123–135.

[3] Weinbauer, M.G., Šimek, K., Christaki, U., Nedoma, J. 2003: Comparing the effects of resource enrichment and grazing on viral production in a meso-eutrophic reservoir. Aquat. Microb. Ecol. 31: 137–144.

[4] Brzáková, M., Hejzlar, J., Nedoma, J. 2003: Phosphorus uptake by suspended and settling seston in a stratified reservoir. Hydrobiologia 504: 39–49.

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[6] Jezbera, J., Nedoma, J., Šimek, K. 2003: Longitudinal changes in protistan bacterivory and bacterial production in two differently loaded canyon-shaped reservoirs. Hydrobiologia 504: 115–130.

[7] Šimek, K., Jezbera, J., Vrba, J., Seďa, J. 2004: Role of diatom-attached choanoflagellates of the genus *Salpingoeca* as pelagic bacterivores. Aquat. Microb. Ecol. 36: 257–269.

[8] Horňák, K., Mašín, M., Jezbera, J., Bettarel, Y., Nedoma, J., Sime-Ngando, T., Šimek, K. 2005: Effects of decreased resource availability, protozoan grazing and viral impact on a structure of bacterioplankton assemblage in a canyon-shaped reservoir. FEMS Microb. Ecol. 52: 315–327.

[9] Jezbera, J., Horňák, K., Šimek, K. 2005: Food selection by bacterivorous protists: insight from the analysis of the food vacuole content by means of Fluorescence In Situ Hybridization. FEMS Microb. Ecol. 52: 351–363.

[10] Šimek, K., Horňák, K., Jezbera, J., Mašín, M., Nedoma, J., Gasol, J.M., Schauer, M. 2005: Influence of top-down and bottom-up manipulations on the R-BT065 subcluster of β-proteobacteria, an abundant group in bacterioplankton of a freshwater reservoir. Appl. Environ. Microbiol. 71: 2381–2390.

2.5 Transparency, pH and cyanobacterial density in the last five years in the Slapy reservoir

J. Hrbáček has summarised his data on the parameters above, measured at a standard sampling site near the Živohošť bridge. Fig. 1 shows that transparency (from June onwards) in the two years prior to the great flood (which occured in August 2002) was usually lower than in the two years after the flood. Comparison of these results with transparency data from 1988–2004 shows that after the flood transparency has reverted to the higher values of former years.

A similar picture emerges upon analysis of the values of pH (Fig. 2). Two years before the flood the pH had been considerably higher in the second half of summer, especially before the mixing of the reservoir.

Fig. 3 shows that the highest pH values measured in individual years gradually increased from 1988 to 2000. Since 1993, even the lowest observed pH values slightly increased. In 2003 and 2004, after the flood, the highest (late summer) observed pH values decreased towards values found in the preceding decade.

The upper part of Fig. 3 indicates a similar long-term progression for cyanobacteria. The density of cyanobacterial flakes was estimated from observing a water sample taken from the surface (flake density) and from the colour of surface layers in the reservoir (viewed from above – from the bridge) The following scale was used: 100 – very dense layers of cyanobacterial flakes near the surface, wide cyanobacterial blue stripes on the surface of stones on the shore; 50 – dense flakes, homogenous green colouring of the water surface, no coloured stripes on stones; 5 – individual flakes, no sign of green colour of the water surface.

The reasons for the observed changes in pH might be the following: before 1960, when the upstream Orlík reservoir was impounded, the Slapy reservoir had been filled by sediments carried by the stream of the Vltava river. The sediments decomposed and lowered pH values. After the Orlík impoundment this sediment inflow ceased. After 40 years, the big flood in 2002 once again brought a large amount of sediments which again has released CO_2 during their decomposition and thus contributed to a lowering of pH values.

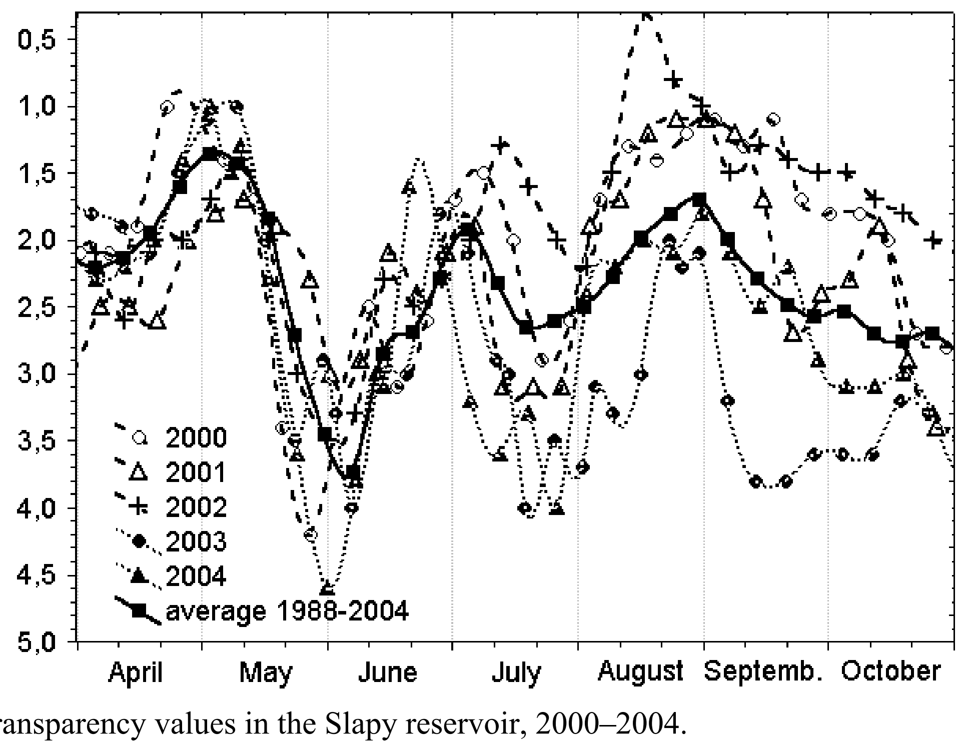

Fig. 1: Transparency values in the Slapy reservoir, 2000–2004.

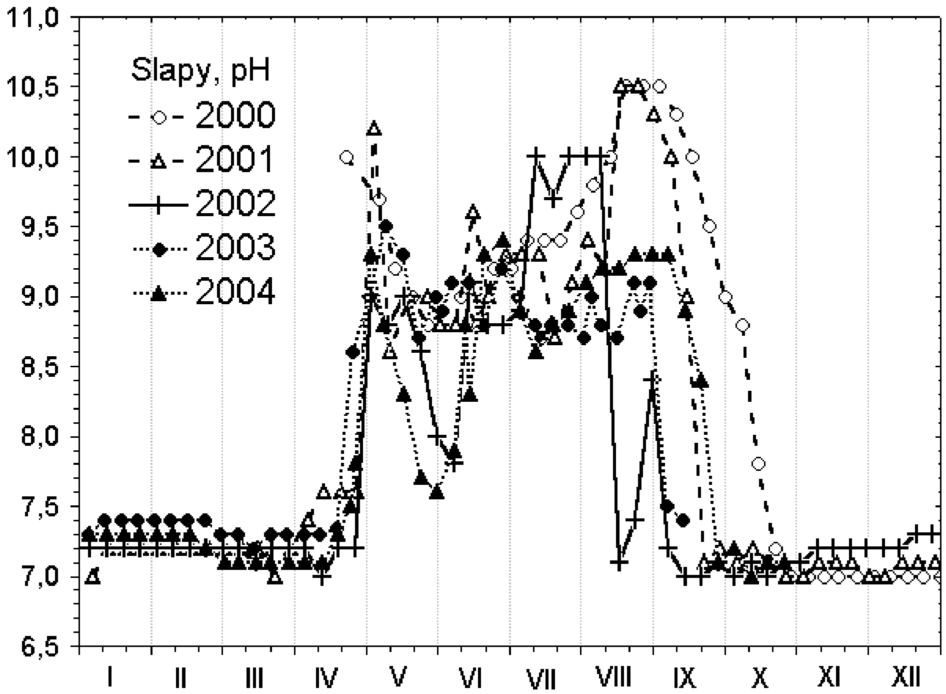

Fig. 2: pH values in the Slapy reservoir, 2000–2004.

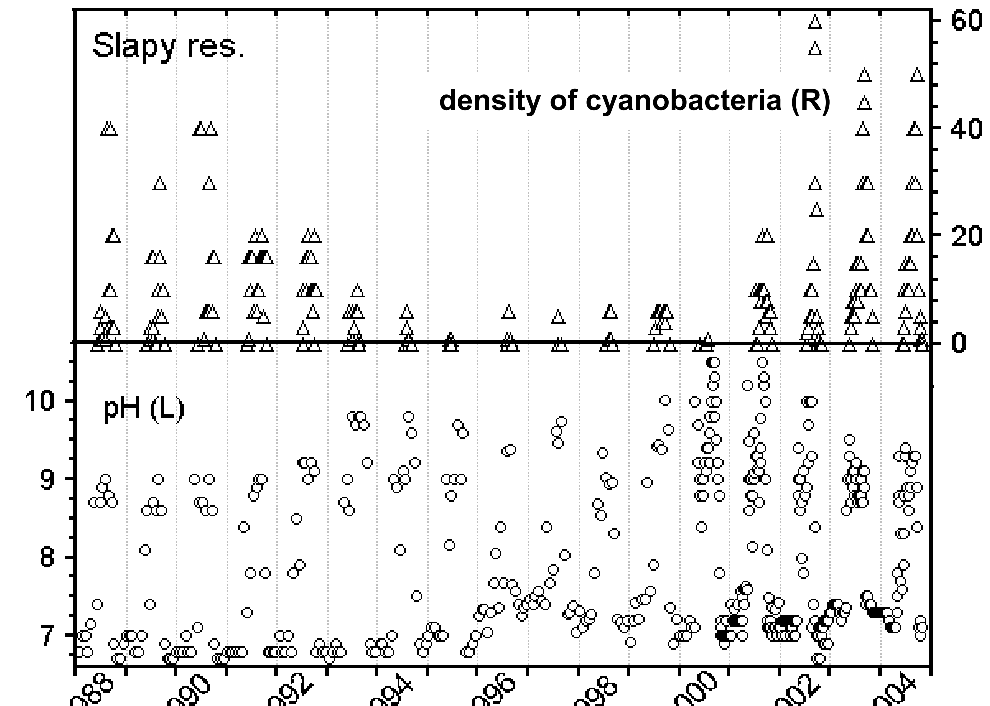

Fig. 3: Long-term changes in pH (surface) and cyanobacterial flakes density in the Slapy reservoir.

2.6 Reservoir ageing and coherent changes in *Daphnia* phenotypic and genotypic characteristics

J. Seďa, A. Petrusek (Charles University, Prague) and K. Schwenk (J.W. Goethe University, Frankfurt am Main) examined the long-term changes of *Daphnia* morphology in the Římov reservoir using the new method of geometric morphometrics. The method is principally different from traditional morphometrics where only discrete distances (length, width...) are measured. Geometric morphometrics captures the geometry of the studied structure and makes possible the retrieval of the original shape from data matrices. We tried to answer the classic question about long-term changes in *Daphnia* sizes as well as the novel question about long-term changes in *Daphnia* shapes. This was confronted with available data on *Daphnia* genetics. This study was carried out during the 3-month stay of J. Seďa at the J.W. Goethe University in Frankfurt.

We made use of the huge collection of zooplankton samples which have accumulated in Hydrobiological Institute as part of its long-term sampling programme. The zooplankton had usually been sampled in three-week intervals which yielded 17 samples per year. In this study of *Daphnia* characteristics just seven years were chosen to describe the pattern of long-term changes during a 24-year period (1979, 1980, 1982, 1985, 1996, 2000, and 2002). This selection was influenced by the long-term dynamics of fish populations and by the availability of genetic data for species discrimination of *Daphnia*. Each year was characterized by three samples; spring sample (sampled between May 29 and June 12), summer sample (sampled between July 31 and August 14), and winter sample (sampled between January 26 and February 5 of the subsequent year).

Forty randomly chosen adult *Daphnia* per one sample were photographed by digital camera. We measured four size characteristics; total body length, head length, carapace length and spine length. The *Daphnia* outline was determined by 70–80 co-ordinate points using the tpsDIG32 programme (Morphometrics, Stony Brook). The spine was not included in the outline of the *Daphnia* body (the spine begins at the beginning of the straight outline). The co-ordinate points were subjected to an elliptic Fourier transformation using the programme EFAwin (Institute of Mathematics, Pushchino). Normalized coeficients (33 coeficients derived from 9 harmonics) were arranged as column vectors for principal component analysis. The analyses of *Daphnia* shape in this study were processed as size and orientation independent.

Resulting summary:

1) The long-term proces of reservoir ageing was linked with a succession of *Daphnia* species as well as with a succession of *Daphnia* morphology.
2) The occurrence of *D. galeata* × *cucullata* hybrids seems to be a common phenomenon. The lowest indication of the occurrence of hybrids was found during first two years of existence.
3) The highest variability of phenotypes of *D. galeata* was found in the spring sample of 1979 when the pioneering population was occupying the newly created environment.
4) As expected, the lowest variability of *Daphnia* phenotypes was found for winter populations.
5) The long-term changes of morphology of *D. galeata* are correlated with time, i.e. the increasing time distance between compared populations of *D. galeata* is increasing the dissimilarity of *Daphnia* shape.
6) Long-term changes in *Daphnia* size were closely linked with changes in *Daphnia* shape, probably indicating an allometric relationship, where similar size categories of *Daphnia* have a higher similarity of body shape.

2.7 Fish stock composition in the Římov reservoir in 2004

The fish stock of the Římov reservoir was monitored traditionally by night seining. Open water and benthic habitats were also studied by split-beam echosounder, gillnets, pelagic trawl and purse seine. The inshore area was fished quantitatively according to Kubečka and Böhm (1991, J. Fish Biol., 38: 935–950) Field work was carried out by J. Kubečka, J. Peterka, M. Čech, J. Frouzová, E. Hohausová, Z. Prachař, M. Vašek, V. Draštík, M. Kratochvíl, T. Jůza, M. Tušer, H. Balk, G. Haraldson, L. Piálek and O. Jarolím. Analysis of the catch was done by M. Říha and J. Kubečka. The composition of the catch is given in Table 3.

Sampling was carried out during one week in mid-August, using seine nets 50 and 150 m long. An area of over 1.6 hectares of the inshore region was fished. The estimate of inshore fish biomass was slightly lower compared with previous years with a total biomass of about 87 kg ha^{-1} (the value is very similar to 2002 results). There was no significant change in fish stock compared to the previous years. Common bream and roach remained the most important fish species in the reservoir, representing the bulk of both numbers and biomass. The results show that only very few traces of the extreme 2002 flood were found in the ichthyofauna two years later and confirm the remarkable stability of the cyprinid-dominated fish stock of the reservoir.

Table 3: Composition of the fish stock of the Římov reservoir in 2004 according to night shore seining estimate.

Common name	Latin name	Abundance ind ha^{-1}	Biomass kg ha^{-1}	% Abundance	% Biomass
Perch	*Perca fluviatilis*	271.71	2.98	11.52	3.46
Roach	*Rutilus rutilus*	871.78	20.35	36.97	23.67
Bream	*Abramis brama*	645.14	48.42	27.36	56.32
Chub	*Leuciscus cephalus*	0.84	0.08	0.04	0.09
Pike	*Esox lucius*	6.71	3.01	0.28	3.50
Asp	*Aspius aspius*	25.68	1.96	1.09	2.28
Dace	*Leuciscus leuciscus*	28.11	0.34	1.19	0.40
Bleak	*Alburnus alburnus*	31.35	0.90	1.33	1.05
Ruffe	*Gymnocephalus cernuus*	304.83	1.43	12.93	1.66
Pikeperch	*Stizostedion lucioperca*	160.47	2.42	6.80	2.82
Hybrid	*Abramis × Rutilus*	9.87	0.68	0.42	0.79
Carp	*Cyprinus carpio*	0.84	3.21	0.04	3.73
Eel	*Anguilla anguilla*	0.84	0.20	0.04	0.23
	Total	2358.16	85.98	100.00	100.00

2.8 The tributary zone as a key factor for fish stock development in reservoirs

Supported by a grant from the Grant Agency of the Czech Republic during 2001–2004, principal investigator: Jan Kubečka, investigators: M. Vašek, M. Hladík, V. Draštík, J. Peterka, M. Prchalová, J. Frouzová, M. Čech, E. Hohausová, Z. Prachař, M. Kratochvíl, T. Jůza, M. Tušer, L. Piálek and O. Jarolím, M. Říha, P. Štafa, L. Pokorný.

The tributary zone of reservoirs has been found to be extremely important for fish stock formation. It harbours 3–5 times more fish than the lacustrine zone during the vegetation season (see [1] below). The tributary zone tends to have the highest species diversity and the strongest food competition, which causes slower growth of fish. Even in the tributary zone, the fish production is dependent mostly on zooplankton [2]. The importance of the tributary zone increases further during the spawning period when 10–20% of the adult fish biomass migrates there [3]. Some species come from the whole reservoir (bleak, asp, roach, white bream, hybrid of roach and bream), while others (bream, perch, zander, pike) migrate only from the upper part of the reservoir. Some species of the former group are completely dependent on spawning in the tributary and all their fry migrate passively through the tributary zone back to the reservoir [4]. The fish stock of the reservoir influences the fish stock of the river via the tributary zone mainly by the huge input of eggs of reservoir fish.

Central European reservoirs with natural-regime tributaries tend to reach a stage of cyrpinid-dominated fish fauna, which is very stable under these conditions [Kubečka, J., 1993: Succession of fish communities of Central and East European reservoirs. In: Comparative Reservoir Limnology and Water Quality Management. (Straškraba, M., Tundisi, J.S., Duncan, A., Eds.), Kluwer, Dodrecht, 153–168.]. The stability was confirmed during the catastrophic flooding of 2002 [5]. Missing or cascade-degraded tributary zones lead to a fish stock with a higher proportion of percid or salmonid fish [6]. The quantity of fish in such reservoirs is much lower than in the reservoirs with natural tributary zone. Stocking of fish by anglers can compensate the effect of a reservoir cascade in some cases [7]. In 2004 we investigated the fish stock of four cascade reservoirs, Kamýk, Slapy, Štěchovice and Vraný (Vltava Cascade). Most of the results of this extensive study are still being processed but it is already evident that, unlike natural tributary zones, the tributary zones in cascade reservoirs have the poorest fish stock both quantitatively and qualitatively. Instead, fish tend to inhabit the lacustrine parts where the influence of the degraded tributary diminishes. The tributary zone is the key area for fish life, fish surveys, exploitation and management.

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[2] Vašek, M., Kubečka, J., Seďa, J. 2003: Cyprinid predation on zooplankton along the longitudinal profile of a canyon-shaped reservoir. Archiv für Hydrobiologie, 156: 535–550.

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2.9 Diet and distribution of 0+ fish within the Římov reservoir in late summer

M. Vašek studied the distribution and diet of young-of-the-year (0+) fish in the deep, canyon-shaped Římov reservoir characterised by a pronounced longitudinal trophic gradient. Samples of 0+ fish were obtained in August 1999. Inshore fish were collected by seining whereas offshore fish were sampled by trawling. The total catch of inshore 0+ fish per unit of effort was highest in the tributary part of the reservoir and declined gradually downstream toward the dam area. The highest total offshore catch of 0+ fish was obtained at the uppermost-located trawling site within the reservoir. Such results indicate that the upper part of the reservoir can be an important nursery area for fish populations. Further, species-specific differences in the spatial distribution of 0+ fish were found. In offshore areas, roach (*Rutilus rutilus*) strongly dominated the catches of 0+ fish taken from the surface layer (0–3 m depth) whereas perch (*Perca fluviatilis*) usually dominated the catches of 0+ fish taken from the deeper stratum (4–7 m depth). Cyprinids, mainly roach, constituted a substantial part of the inshore 0+ fish assemblage in the tributary, more eutrophic area of the Římov reservoir. At more downstream sites, inshore 0+ fish assemblages were overwhelmingly dominated by perch. The succession from dominance of perch to roach with increasing ecosystem productivity has been well documented in the literature by comparing fish community structure among lakes of different trophic status – the present results suggest that reciprocal changes in the dominance of perch and roach may also occur along a productivity gradient within a system.

Both inshore and offshore sampled 0+ fish of the three most abundant species (perch, roach and bream *Abramis brama*) fed mainly on planktonic crustaceans. The diet of perch was generally dominated both by planktonic cladocerans (*Daphnia*, *Leptodora*, *Diaphanosoma*) and copepods (Cyclopidae, *Eudiaptomus*) while the diet of roach consisted chiefly of planktonic cladocerans (mainly *Daphnia* and *Leptodora*) and copepods were not an important food component. Cyclopoid copepods constituted significant proportions in perch diets especially at the upper end of the reservoir, where the abundance of such prey was by far the highest. Concerning the diet of bream, species which were caught in larger numbers only in the upper reservoir part, planktonic cladocerans (*Daphnia*, *Leptodora*) usually predominated in the guts of offshore sampled individuals whereas benthic cladocerans (Chydoridae) comprised the majority in guts of inshore sampled specimens. Apparently, inshore 0+ bream foraged close to or in the bottom sediment, since their major prey, chydorids, were practically absent in littoral zooplankton taken concurrently with fish.

Diel observation of stomach fullness of 0+ perch revealed that perch foraged intensively at daytime and dusk, and fed very little or not at all during late night and before dawn. Decreasing stomach fullness of inshore 0+ perch was found from the dam to the tributary area within the reservoir. Daily consumption rates of inshore 0+ perch in the Římov reservoir during August were estimated to be 33.4, 17.3 and 14.5% of body wet weight for fish collected at the dam, middle and tributary areas, respectively. Moreover, inshore 0+ perch were of smaller size at the tributary area than at the more downstream areas. Intense competition for food within the fish assemblage at the tributary area is a likely explanation for the smaller size and lower consumption rate of 0+ perch in this part of the Římov reservoir. Besides competition, less favourable visual conditions in the more eutrophic and therefore more turbid part of the reservoir might have been another reason for the lower feeding efficiency and consequently slower growth of 0+ perch, which are known as typical visual predators.

2.10 Ontogenetic changes in the bathypelagic layer of perch fry (*Perca fluviatilis* L.) monitored by hydroacoustic methods (Part of the GA AS CR projects no. A 6017201 and Z 6017912).

M. Čech and J. Kubečka monitored the behaviour of young-of-the-year perch, the dominant species in the assemblage of fry in the pelagic zone of the Římov reservoir, during midday in late May, late June, early August and early September using acoustic methods (SIMRAD EY 500 echosounder, elliptical split-beam transducer, Sonar5 postprocessing software). This study complements previous research from the Slapy reservoir (Čech et al. 2005) and focuses on the seasonal and longitudinal aspect (Fig. 4) of the bathypelagic perch fry layer including changes in fish size, abundance, shoaling activity and depth distribution.

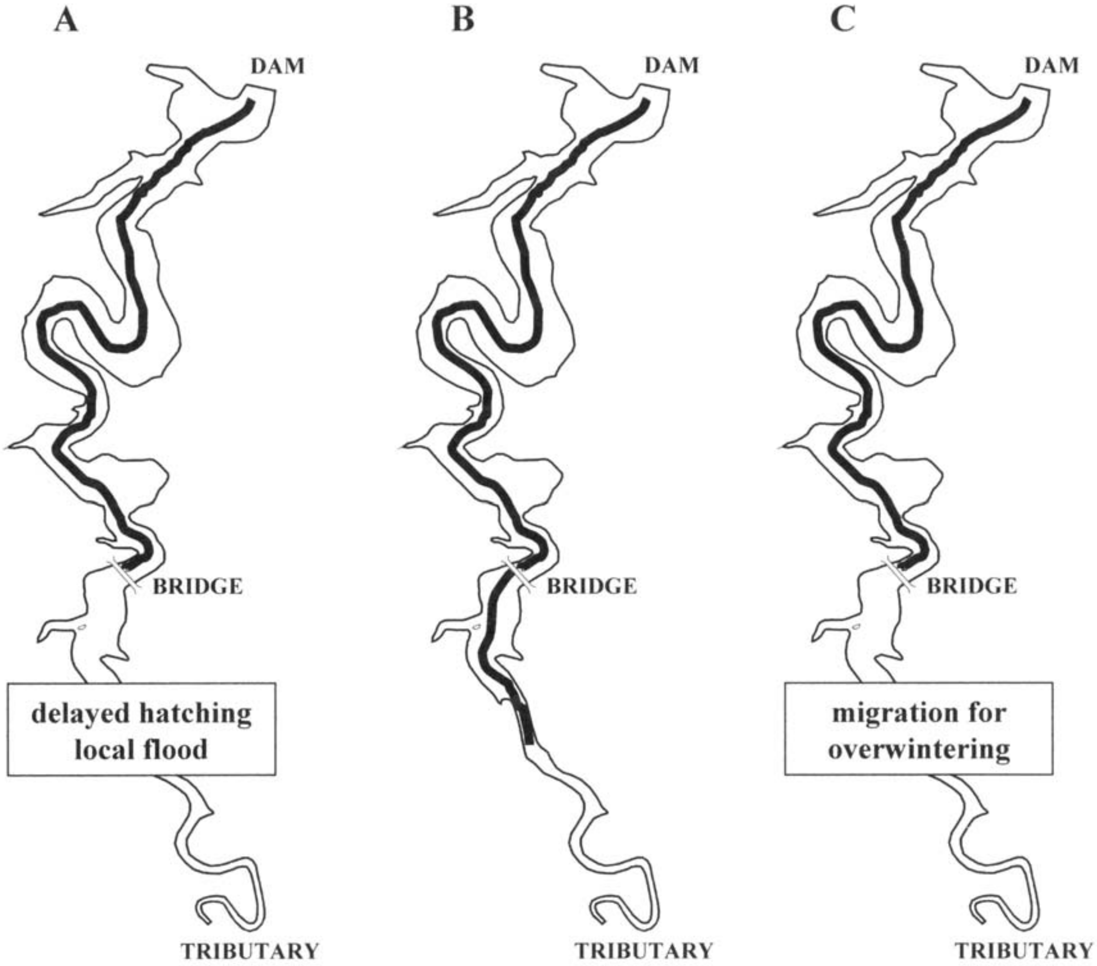


Fig. 4: Spatial extent of the scattering layer of bathypelagic perch fry along the longitudinal profile of the Římov reservoir (bold black line) during the season. A, late May; B, late June and early August C, early September. Notes in rectangles indicate potential reasons for absence of BPF layer in the upper part of the reservoir (from the bridge upstream).

In May, the bathypelagic perch fry (BPF) layer comprised a mass of solitary perch larvae (size peaked at 7.7 mm L_T) at an abundance of over 31000 inds. ha^{-1}. In contrast, in June, the BPF layer consisted almost exclusively of shoaling individuals. A bimodal size distribution peaking at 16.7 mm (stronger peak) and 36.2 mm (weaker peak) was clearly recognized. The abundance of BPF increased up to 166000 inds. ha^{-1}. In August, fish in shoals also prevailed in the BPF layer (size peaked at 50.5 mm) but the abundance had dropped to less than 3000 inds. ha^{-1}. The average length of the BPF shoals was much greater in June (4.6 m) than in August (2.4 m) whereas the average height of the shoals did not differ in June (1.1 m) and August (1.0 m). In September, the BPF layer consisted of both individuals and small groups of fish with sizes peaking again at 50.5 mm. At this time the abundance of BPF had slightly increased to almost 5000 inds. ha^{-1}.

Individual parameters describing the BPF layer, depth of the main layer, abundance of BPF in the main layer and thickness of the whole layer differed significantly among months. The negligible abundance of potential predators below the thermocline, both in June and in August (exclusively adult perch), suggests that the BPF shoals were more likely to be created as a result of a social need rather than as a defense against predators. During similar surveys carried out prior to (mid May) and after this period (early October), the BPF layer was not recorded.

It appears that, despite the fact that the littoral region of the Římov and many other canyon-shaped Czech reservoirs is favored by fry, the littoral comprises a negligible part of the total reservoir volume and definitely has a highly limited carrying capacity. Thus it seems reasonable that a significant part of the perch fry community should utilize the pelagic zone of these reservoirs for a longer period.

The results of the investigation have been submitted as a manuscript to the Biologia, Bratislava.

Čech, M., Kratochvíl, M., Kubečka, J., Draštík, V., Matěna, J. 2005: Diel vertical migrations of bathypelagic perch fry. J. Fish Biol., 66: 685–702.

3. LAKES

3.1 Response of alpine lakes and soils to changes in acid deposition: the MAGIC model applied to the Tatra Mountain region, Slovakia–Poland

J. Kopáček, D. Hardekopf (Charles University, Prague), V. Majer, J. Veselý (Czech Geological Survey, Prague), E. Stuchlík and P. Pšenáková (Charles University, Prague) applied a dynamic, process-based model of surface water acidification, MAGIC (Modelling the Acidification of Groundwater in Catchments) to thirty one alpine lakes in the Tatra Mountains (~50% of all alpine lakes >0.3 ha in the lake district).

The model was calibrated to observed lake chemistry for the period 1980–2002. Surface water and soil chemistry were reconstructed for the 1860–2002 period, based on estimates of historical acid deposition, and forecast to 2020 based on the reductions in sulphur and nitrogen emissions presupposed by the Gothenburg Protocol. In the 1860s, all lakes were buffered by the carbonate system and only ~6% of lakes had an acid neutralising capacity (ANC) of <20 μeq l^{-1}. Lake acidification progressed until the 1980s, at which time 23% of lakes had a depleted carbonate buffering system and 33% of lakes had ANC <20 μeq l^{-1}. Reversal of water chemistry from acidification started in the late 1980s as a response to reduced acid deposition. ANC has increased such that only ~16% of the lake population currently has ANC <20 μeq l^{-1}. The number of low ANC lakes is predicted to decrease to 10% by 2020, but the original carbonate buffering system of these lakes will not be re-established according to the model. The patterns in long-term changes of sulphate and chloride primarily reflected trends in atmospheric deposition and were similar for all lakes. Base cations (BC), ANC, nitrate, and pH, however, were significantly influenced by catchment characteristics. The water chemistry response to changes in strong acid anion (SAA) inputs varied among the lakes. The changes in SAA were compensated for (1) by parallel changes in BC concentrations (~75% of the SAA change) in non-sensitive lakes (high weathering rates and abundant soils with high base saturation), (2) by inverse changes in bicarbonate concentrations (>50% of the SAA change) in sensitive lakes with intermediate weathering rates and sparse soils (low BC exchangeable capacity and elevated terrestrial export of nitrate) and (3) by parallel changes in concentrations of protons and aluminium (each ~20% of the SAA change) in extremely sensitive lakes, with the lowest weathering rates and soil base saturation. The full implementation of the Gothenburg Protocol will not be probably sufficient to allow recovery of the latter group of lakes, which will remain acidified after 2020.

3.2 Sulphur and nitrogen emissions in the Czech Republic and Slovakia from 1850 till 2000

J. Kopáček and J. Veselý (Czech Geological Survey, Prague) reconstructed the emission rates of major acidifying pollutants (SO_2, NO_x, and NH_3) in the area of the Czech Republic and Slovakia (CS) (Kopáček and Veselý, 2005). The respective rates of SO_2, NO_x, and NH_3 anthropogenic emissions in CS were <10, <5, and 33 mmol m^{-2} yr^{-1} in 1850, increased slowly until 1950 and rapidly in the 1950–1980 period, and peaked at ~380, ~180 and ~80 mmol m^{-2} yr^{-1} in the 1980s. The emissions declined markedly after the political and economic changes in 1989 due to (1) restructuring of industry and farming in the early 1990s (~35% decrease in energy production and 50–60% decrease in cattle numbers and fertilisation rate of farmland), (2) sulphur emission controls, (3) changes in fuel supply, and (4) optimisation of combustion regimes at stationary sources of NO_x. The CS emission rates of SO_2, NO_x, and NH_3 were 87%, 51%, and ~44% lower, respectively, in 2000 than in 1985. Emissions of SO_2 declined linearly throughout the 1990s (to 47 mmol m^{-2} yr^{-1} in 2000), while NO_x and NH_3 emissions declined rapidly during 1989–1994 and then slowly to ~85 and ~44 mmol m^{-2} yr^{-1}, respectively, in 2000. Similar declines in SO_2 and NO_x emissions occurred in the entire central European region, while NH_3 emission decreased less over a wider region due predominantly to more stable emission rates of NH_3 in Germany. Emission rates of S and N compounds correlated tightly (P<0.001) with their deposition in the CS region.

Kopáček, J., Veselý, J. 2005: Sulfur and nitrogen emissions in the Czech Republic and Slovakia from 1850 till 2000. Atmospheric Environment, 39: 2179–2188.

3.3 Nutrient cycling in a strongly acidified mesotrophic lake

J. Kopáček, M. Brzáková, J. Hejzlar, J. Nedoma, P. Porcal, and J. Vrba measured and evaluated in-lake cycles of C, N, and P in the strongly acidified Plešné Lake in the Bohemian Forest (Czech Republic).

In contrast to the well known nutrient transformations in circum-neutral lakes, Plešné Lake exhibited significant changes in nutrient cycling due to acidification-derived changes in its chemistry and biology. Due to the absence of fish and strongly reduced zooplankton population, Plešné Lake had a “simplified” food web. The lake tributaries had high concentrations of dissolved organic C (DOC), inorganic N, and total P (TP), resulting in annual averages of 644, 52, and 0.72 µmol l^{-1}, respectively. The mass balance of nutrients was based on the major external inputs (tributaries and atmospheric deposition), internal sources and transformations (primary and bacterial production, biological decomposition of sedimenting seston and sediments), sedimentation, and outputs. External inputs of total organic C (TOC), total N (TN), and TP into Plešné Lake were 7244, 864, and 8.6 mmol m^{-2} yr^{-1}, respectively. Net primary production of particulate C (C_{part}) and extracellularly released DOC were 3205 and 613 mmol m^{-2} yr^{-1}, respectively. Bacterial C_{part} and total inorganic C production were both 1518 mmol m^{-2} yr^{-1}. Of the total internal and external inputs of TOC, TN, and TP, the in-lake processes removed 4551 (50% respiration, 40% sedimentation, and 10% photooxidation), 211 (74% sedimentation and 26% denitrification), and 4.6 (100% sedimentation) mmol m^{-2} yr^{-1}, respectively. Compared to circum-neutral lakes, nutrient cycling differed as follows:

(1) Liberated orthophosphate from sedimenting seston was converted from a liquid to a particulate phase by colloidal Al in the hypolimnion, and deposited. Similar abiotic P immobilisation with Al removed 1.6 mmol m^{-2} yr^{-1} from the whole water column, thus reducing by ~20% the pool of potentially bio-available P and contributing to a severe P limitation of biomass.

(2) The cessation of nitrification due to long-term water acidification has led to an atypical situation with Plešné Lake becoming a net source of ammonium (NH_4^+). NH_4^+ entering the lake from terrestrial and atmospheric sources was assimilated by phytoplankton and transformed to organic nitrogen. After NH_4^+ depletion, nitrate was utilised as an alternative nitrogen source. Organic nitrogen was mineralised and liberated as NH_4^+ from the dead, sedimenting phytoplankton. Because the dissimilation occurred mostly below the productive layer, the liberated NH_4^+ was not re-assimilated and accumulated in the hypolimnion. After lake overturns, this NH_4^+ was exported from the lake (Fig. 5). The acidified productive lakes, with dissimilative production of NH_4^+ exceeding its assimilation may thus become a net NH_4^+ source.

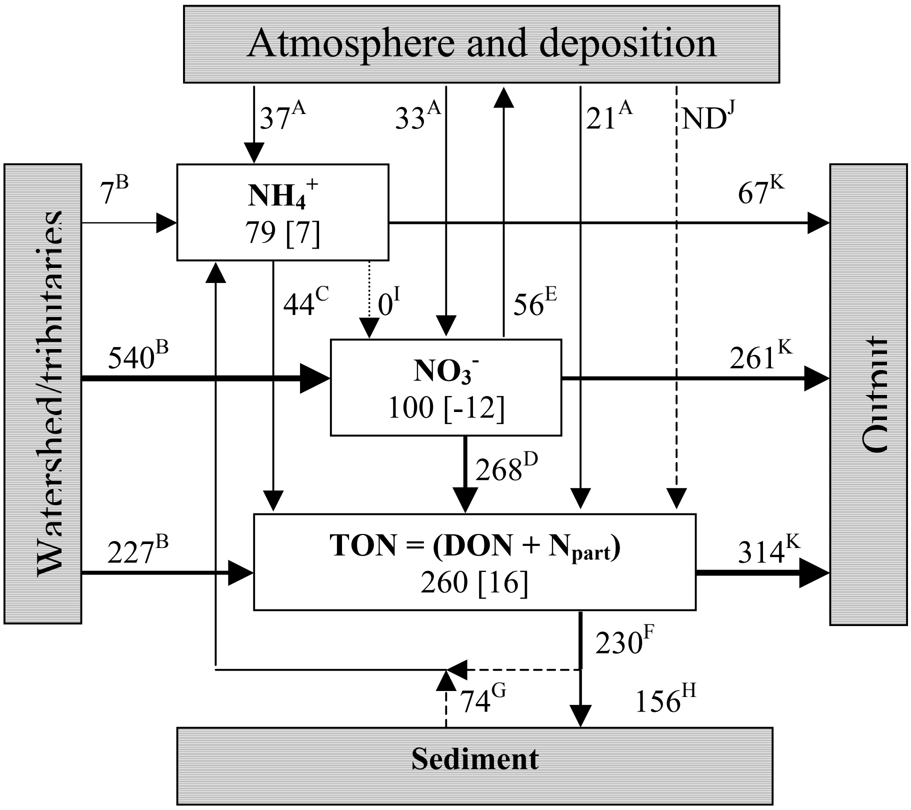


Fig. 5: Major fluxes and transformations of nitrogen forms (NH_4^+; NO_3^-; TON, total organic N; DON, dissolved organic N; and N_{part}, particulate N) in Plešné Lake in the 2001 hydrological year. Arrows represent N fluxes (mmol m^{-2} yr^{-1}). Boxes represent pools of N forms (mmol m^{-2}) with annual changes in their storage in the lake (mmol m^{-2} yr^{-1}) given in brackets. (A) Direct atmospheric input. (B) Input by tributaries. (C) NH_4^+ assimilation by biomass. (D) NO_3^- assimilation by biomass. (E) NO_3^- denitrification in the hypolimnion and sediments. (F) Sedimentation of N_{part}; the sum of sedimentation rate (201) and bacterial production below sediment traps (29). (G) NH_4^+ production by dissimilation of sedimenting seston and sediment. (H) Net N_{part} storage in sediments; the difference between the fluxes (F) and (G). (I) Nitrification of NH_4^+ (was absent). (J) Nitrogen fixation was not determined (ND) and neglected. (K) Output from the lake by outflow. Figure derived from Kopáček et al. (2004).

3.4 Primary production and microbial activity in the euphotic zone of Lake Baikal in 2003 and 2004

A report on project EC (program EESD) EVK2-CT-2000-00057 CONTINENT – High-resolution continental paleoclimate record from Lake Baikal: a key-site for Eurasian teleconnections to the North Atlantic Ocean and monsoonal system. Project coordinator Hedi Oberhänsli, GeoForschungsZentrum, Potsdam, Germany. Czech participation lead by V. Straškrábová. Project started in 2001, HBI was invited to participate in 2003.

The HBI contributed to investigations in the Work Package 2 of the project – Evolution of sediment signals from the water column. The multidisciplinary program involved measurements of photosynthetic pigments, phytoplankton (especially diatoms) and clay minerals in the water column, their seasonal changes, sources, fluxes and transfer to sediment.

Methodological approaches combined (i) evaluation of satellite data, (ii) continuous sediment traps, (iii) analyses of upper sediment layers, (iv) the HBI task – direct measurement of production and destruction processes in the euphotic zone and the estimation of taxonomic phytoplankton composition (done by G. Kobanova from Irkutsk University).

Four expeditions were organized from the HBI to Lake Baikal: late winter measurement under the ice in South Basin, March 2003 (V. Straškrabová, J. Nedoma, J. Borovec), early summer cruise accross the whole lake in July 2003 (V. Straškrabová, J. Borovec), late summer cruise accross the whole lake in August to September 2003 (V. Straškrabová, J. Borovec, J. Nedoma, A. Štrojsová) and late winter measurement under the ice in South Basin, March 2004 (V. Straškrabová, J. Jezbera, V. Kasalický). The work was done in close cooperation and with the help of other CONTINENT partners (especially the July cruise, photosynthetic pigments by S. Fietz, Leibniz Insitute of Freshwater Ecology and Inland Fisheries, Germany) and of the staff of the Research Institute of Biology at the State University of Irkutsk (continuous monitoring and sampling, phytoplankton determination, August–September cruise, infrastructure at the field station Bolshie Koti).

Primary production was measured by the ^{14}C metod in separated fractions: phytoplankton (particles) >3 μm, autotrophic picoplankton (1–3 μm), used by bacteria (0.2–1 μm) and dissolved <0.2 μm. Bacterial production was determined by ^{3}H-thymidine and ^{14}C leucine uptake. Under the ice the euphotic zone was 40 m deep in March 2003 (80 cm ice, no snow) and 30 m deep in March 2004 (40 cm ice, 150 cm snow).

From early winter towards summer, autotrophic picoplankton became the dominant producer and also the proportion of exudated production was considerable. This meant that a major part of the primary production may have been directly used by grazers and by bacteria in the water column and did not contribute much to sedimenting material. Bacterial activity in decomposition is probably directly correlated with primary production as indicated by the coherence of bacterial production and primary production values.

During the summer expeditions, nutrients and their stratification in the water column were measured in all three basins (see Table 4). In early summer there was no temperature stratification with the exception of two sites (Maloe more = shallow site and Posolski = site affected by the Selenga River), and there N limitation may have been possible (according to the Redfield ratio). In late summer, a short period (2 weeks) of temperature stratification occurred in the whole lake and all the sites were N limited with one exception – the site affected by wastes (treated) from the Baikalsk pulp-mill combinate.

Table 4: Ranges of selected chemical data measured during the two summer expeditions (upper 5 m) accross Lake Baikal, all basins.

	DOC mg/l	dissolved P ug/l	inorganic N ug/l	Si mg/l	N/P atomic
Early summer	1.14–1.52	2.5–10.2	2–119	0.52–0.99	0.9–35.6
N limited sites only Maloe more and Posolski					
Late summer	0.84–1.68	2.2–5.1	1–20	0.50–0.96	0.8–14.1
Site at Baikalsk	1.79	–	41	–	72.1
All sites N limited except of Baikalsk					

The other possible limitations of primary production in Lake Baikal were by temperature and by light (either limitation in deep layers or inhibition at the surface).

Part of the project investigations have already been published in a special issue of Global and Planetary Change (Straškrábová et al. 2005).

Straškrábová, V., L.R. Izmest'eva, E.A. Maksimova, S. Fietz, J. Nedoma, J. Borovec, G.I. Kobanova, E.V. Shchetinina, E.V. Pislegina, 2005: Primary production and microbial activity in the euphotic zone of Lake Baikal (Southern Basin) during late winter. Global and Planetary Change, Special issue, 46 (1–4): 57–73.

3.5 Estimation of bacterial extracellular phosphatase activity at the single-cell level using ELF97 phosphate and image analysis.

J. Nedoma has processed images of bacterioplankton, that had been labelled for presence of extracellular phophatases during a 2003 sampling campaign on Čertovo Lake, and kept in the computer "for later processing". Čertovo Lake is an acidified (pH ~4.6) oligotrophic (TP ~5 μg l^{-1}, chlorophyll ~3 μg l^{-1}) mountain lake (altitude 1030 m, area 10.5 ha, max. depth 36 m) in the Bohemian Forest (30°12'E, 49°10'N) in the Czech Republic. The lake plankton is dominated by bacterioplankton of extraordinary morphological variability, long filaments being the most conspicious morphotypes. Čertovo Lake is permanently severly P-deficient due to phosphate–aluminium coprecipitation, which results in the exceptionally high activity of microbial extracellular acid phosphatases (higher by 1–3 orders of magnitude than in most aquatic systems). These features make Čertovo Lake a suitable model system for investigation of the distribution of phosphatase activity among specific types of bacterial cells ("functional diversity" of bacterioplankton). Using ELF97 phosphate, a precipitate-forming fluorogenic artificial substrate, it is possible to label the cells possessing extracellular phosphatases by bright green fluorescence, while the cell identity can be distinguished by their morphology and size. During the last several years, the "ELF group" in HBI, consisting of J. Vrba, J. Nedoma, A. Štrojsová, and M. Štrojsová, has gained considerable experience in using ELF97 for both qualitative and quantitative assessment of extracellular phosphatases in algae and other aquatic organisms using epifluorescent microscopy and image analysis.

To investigate Čertovo Lake bacterioplankton phosphatases, surface samples were taken regularly in 3-week intervals and incubated, within 8 hours after sampling, with ELF97 phosphate for 25–40 minutes. At appropriate time intervals (5–10 min) during the incubations, subsamples were fixed with formaldehyde, counterstained with DAPI, and filtered through polycarbonate filters of 0.2-μm porosity. Images of blue and green fluorescence of filter-retained microorganisms were taken using a fluorescence microscope (Olympus AX-70), a digital camera (DVC-1300), and image analysis software LUCIA G/F 4.8.

Compared to previous work with algae, work with bacteria brought new challenges. First, DAPI and ELF97 emission spectra overlapped. Both ELF97 and DAPI have a common excitation maximum at ~360 nm; DAPI has rather broad emission peak at 400–550 nm, and ELF97 at 480–650 nm. Consequently, using a specific narrow-band DAPI filter-set on a fluorescence microscope (~460 nm), the blue DAPI fluorescence could be observed without any interference from ELF97 fluorescence, whereas the green ELF97 fluorescence was always accompanied by a relatively strong DAPI signal, even when using a specific narrow-band filter-set for ELF97 (~530 nm). To quantify the ELF97 fluorescence, special correction based on the measurement of green/blue fluorescence ratio had to be developed.

Second, long filaments could not be treated as single objects. Instead, the fluorescence had to be measured at random points given by the intercepts between filaments and a grid of test bars laid over the image. The intercepts also served for determination of the total length and biomass of filaments. Average ELF97 fluorescence per μm of filaments or per μgC was then calculated using these data.

Third, we could not easily distinguish between "active" and "inactive" cells, because the ELF97 fluorescence data showed rather a continuum of activities than a clear difference between active and non-active cells. In an attempt to define active cells, cells with a green/blue fluorescence ratio exceeding a certain threshold value were taken as active. The threshold was determined on filters with cells stained with DAPI only as the average + 3SD of their green/blue fluorescence ratio. The percentage of active cells determined this way, however, was not stable over incubation time and did not appear reliable. Therefore, results are given as mean cell-specific activities in bacterial groups defined by morphology and size (see Table 5).

Table 5: Main characteristics and mean cell-specific extracellular acid phosphatase activity (EAcPA) of bacterioplankton morphotypes and size-groups in Čertovo Lake in 2003. Numbers are seasonal averages (ranges in parentheses), n = numbers of sampling dates when EAcPA was detectable in a specified morphotype and size-class.

Morphotype	Size-class	Abundance	Cellular carbon	Mean cell-specific EAcPA	
	length	10^6 cell ml^{-1}	fg cell^{-1}	fmol cell^{-1} h^{-1}	
Cocci & rods	0.3–0.6 µm	0.19 (0.06–0.41)	9.3 (8.5–10.5)	0.22 (0.17–0.28)	n=2
	0.6–1.2 µm	0.08 (0.03–0.14)	18 (15–21)	0.51 (0.42–0.56)	n=3
	1.2–2.5 µm	0.11 (0.07–0.15)	34 (30–40)	2.0 (0.86–5.6)	n=5
	2.5–5 µm	0.09 (0.04–0.17)	56 (39–73)	2.8 (0.35–10.6)	n=6
	5–10 µm	0.07 (0.02–0.15)	75 (52–87)	1.9 (0.51–5.5)	n=6
Curved cells	2.8–10 µm	0.05 (0.005–0.09)	131 (115–163)	21 (7.3–46)	n=5
	diameter	m ml^{-1}	fg µm^{-1}	fmol µm^{-1} h^{-1}	
Filaments	<0.3 µm	6.7 (3.7–10.9)	11	0.10 (0.02–0.24)	n=5
	0.3–0.6 µm	1.3 (0.29–1.8)	22	0.49 (0.05–1.18)	n=6
	>0.6 µm	0.31 (0.05–0.68)	50	0.37 (0.09–0.65)	n=5

The main results can be summarised as follows:

(1) A method for estimation of specific activity of extracellular phosphatases in bacterioplankton groups has been developed. Currently, the bacterioplankton groups have to be defined by their morphology, but the approach is also applicable to phylogenetically defined groups visualised with FISH (assay development in progress). The weak points of the procedure are the labour-intensive manual editing during image processing (to separate small bacteria and filaments) and uncertainty in estimation of the exact conversion factor between fluorescence and amount of ELF97.

(2) A specific, conspicuous, apparently homogeneous, morphotype of curved cells of average length ~5 µm, despite its low total biomass (4% in average), contributed significantly (by 31% in average) to the total bacterioplankton phosphatase activity in Čertovo Lake (Fig. 6). Filaments, although comprising in average 85% of bacterioplankton biomass, contributed only by 45% to the total bacterioplankton activity. Biomass-specific activity of extracellular phosphatases of the main bacterioplankton morphotypes increased in the order: filaments < cocci & rods < curved cells. Average cell specific activities of different morphological groups are given in Table 5.

(3) The biomass-specific activity of bacterioplankton extracellular phosphatases was generally highest in the spring and decreased gradually during summer. These changes could result from seasonal changes in phosphorus status of the lake and from subsequent regulation

of enzyme expression by bacteria; however, more data have to be collected to support this hypothesis.

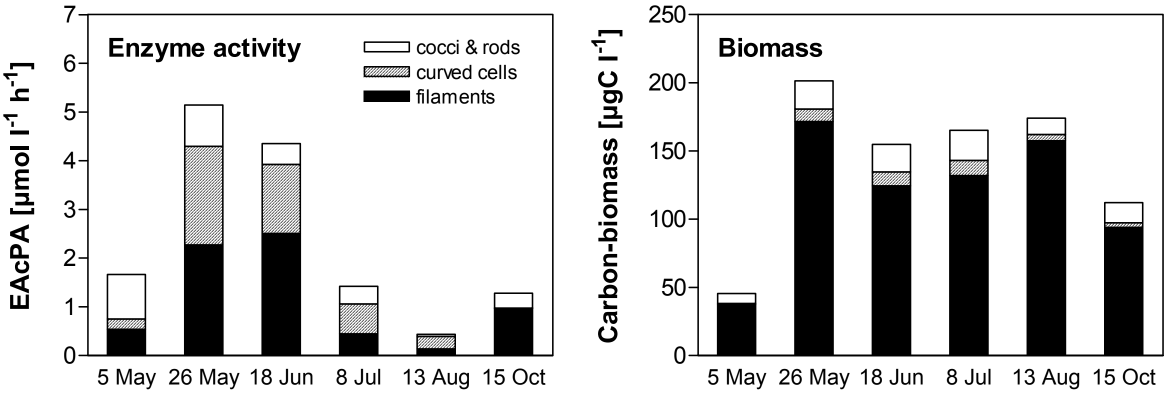


Fig.6: A comparison of contributions of the main bacterioplankton morphotypes to total bacterial extracellular acid phosphatase activity (EAcPA) and to total bacterial carbon biomass in Čertovo Lake in 2003.

3.6 Protozooplankton APP-feeding in a deep monomictic saline lake in a semi-desert area

M. Macek continued work on his projects at Universidad Nacional Autónoma de México *campus* Iztacala, Laboratory of Tropical Limnology (head – Javier Alcocer Durand) dealing with the study of maar-crater lakes in the State of Puebla, Mexico. He was joined by D. Peštová (Ph.D. student of the Masaryk University, Brno – 10 month stay tutored by M. Macek) and by K. Šimek and J. Nedoma (one month stay). The protozoan assemblage feeding activity on picophytoplankton was studied in lake Alchichica with special emphasis on the role of peritrichs. Epifluorescence methods based on chlorophyll autofluorescence and DAPI staining were employed to count autotrophic picoplankton (APP) and ciliates, respectively. Identification of ciliates was performed using the Quantitative Protargol Staining; feeding activity was estimated by means of the Fluorescently Labelled Particles (FLP) method.

Peritrichs were the most important ciliate groups since the end of the stratification period (October), throughout the turnover and during the period of new stratification establishment, representing about 70% of the total number of ciliates. The genera *Vorticella* and *Rhabdostyla* were the most important within the assemblage. When *Rhabdostyla* sp. absolutely dominated the ciliate assemblage, it colonised a centric diatom, *Cyclotella quillensis* (from March) and/or a filamentous cyanobacterium, *Nodularia* cf. *spumigena*, peaking in May when a peritrichous ciliate maximum of 12 cells ml^{-1} was observed. *Vorticella aquadulcis* complex was observed mostly unattached. Its incidence was apparently related to APP development at the end of stratification and during the mixis. During the stratification period, peritrichs were not observed abundant either in the anoxic hypolimnion or around the oxycline.

Among peritrichs, *Vorticella* sp. showed the highest APP uptake, typically ingesting 150 APP $cell^{-1}$ h^{-1}, though a maximum of 2000 APP $cell^{-1}$ h^{-1} was observed in September; *Rhabdostyla* sp. showed an average uptake of 27 APP $cell^{-1}$ h^{-1} with a maximum of 130

APP cell^{-1} h^{-1} (March). Even though several other ciliate species (particularly *Halteria* sp., scuticociliates and, at the end of stratification, *Euplotes* sp.) were observed to be full of APP, which indicates their feeding preferences, maximum standing stock elimination (at the end of stratification) was only about 10%. Those results could not be confirmed using the FLP-disappearance method, as data values were near to the method error. However, in the fractionated samples without metazooplankton (screened through 63 µm) and without ciliates (filtered through 2 µm polycarbonate membrane), negligible growth of APP was observed. No growth was found at the surface layer (apparent UV inhibition) and in the anoxic layers (coinciding with 1% of available light at about 25–30 m) though it was confirmed at depths of 20 m. In such conditions, even slowly growing ciliates could control APP development.

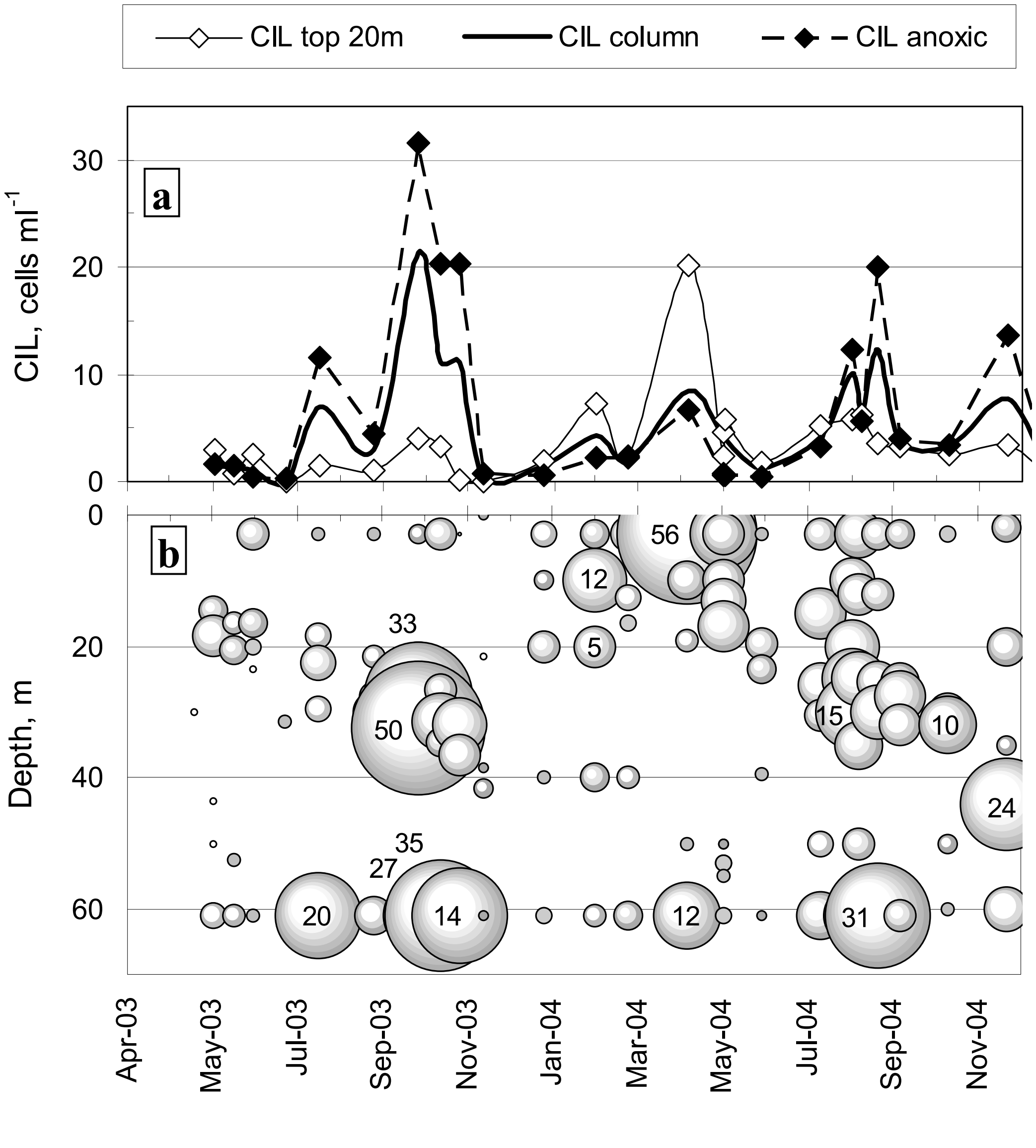


Fig. 7: Annual development of total ciliate numbers in the surface 20 m, throughout the water column and in the anoxic layer **(a)**; total ciliate numbers (proportional to the bubble area) in the surface layer, thermocline and oxycline (if present) and in the very bottom **(b)**.

4. SPECIAL INVESTIGATIONS

4.1 Stable morphospecies within the 16S rRNA monophyletic genus *Microcystis* (Kützing) Kützing

J. Komárková in collaboration with Italian colleagues (M.A. Mugnai, S. Turicchia and C. Sili, CNR Institute for Ecosystem Study, Sesto Fiorentino, Italy) and O. Komárek (Masaryk University, Brno) analyzed natural samples and cultivated clones of *Microcystis*, one of the most important genera of cyanobacteria forming toxic water blooms in eutrophic water-bodies all over the world.

According to the Botanical Code criteria, the genus *Microcystis* includes 10 morphospecies described from the temperate zone and about 20 morphospecies from subtropical and tropical regions (see [1] below). Many of these taxa (botanical species–BS) are difficult to identify especially at the unicellular state, which is a natural consequence of long-term cultivation of isolated strains. Even in natural samples, the shape of colonies is very variable and if the size of cells does not differ, a decision between the names of morphospecies offered by keys is sometimes impossible.

The up to date phylogenetic tree (16S rRNA) shows a tight relation between different individual BS of the genus *Microcystis*. The results of genetic analysis of several tens of isolated clones seem to speak in favour of the final bacteriological taxonomical solution published by Otsuka et al. [2] who grouped all the up to now known BS under one name. He used the name *Microcystis aeruginosa* Kützing 1833, a nomenclatoric type of the genus according to the Botanical Code, to establish a large species comprising all the botanical species belonging to the *Microcystis* genus. The assumption is that DNA-DNA re-association values >70% between the species (clones) are sufficient to assign them to the same species category according to the Bacteriological Code. Another serious argument for this approach emerges from the positions of BS strain sequences in the phylogenetic tree (Fig. 8). Thus, *M. wesenbergii*, which can be easily identified and thus cannot be misinterpreted, appears in several positions spread among other sequences.

Samples were taken from 40 selected eutrophic and hypertrophic water-bodies in the Czech Republic and from the Bubano reservoir, Italy. The investigated strains were isolated from the same natural localities and were maintained in the cyanobacterial collections of the Hydrobiological Institute AS CR, České Budějovice and the CNR Institute for Ecosystem Study, Firenze (Italy). Five morphotypes of *Microcystis* kept for two years in our culture collection were used to determine changes in size of cells and colony morphology under the crossed influence of temperature and light irradiation. The experimental equipment – a cross gradient table – provided four combinations of two factors most influencing photosynthesis in cyanobacteria: temperature (10–32ºC) and light irradiance (8–45 μmol m^{-2} sec^{-1})

The study was focused on cell diameter and investigated it in detail as concerned statistically significant decisive ranges (ANOVA stat-program). Cell size is the sole criterion to differentiate between some of the "botanical species" (*M. ichthyoblabe* and *M. flos-aquae*, for example). We have confirmed that three of the investigated morphospecies (*M. aeruginosa, M. viridis* and *M. wesenbergii*) mantained their cell sizes well when measured either as natural populations or as cultivated strains. The results also confirm the coexistence of two dimensionally distinct groups of cells in one single clone of *M. ichthyoblabe*: a large

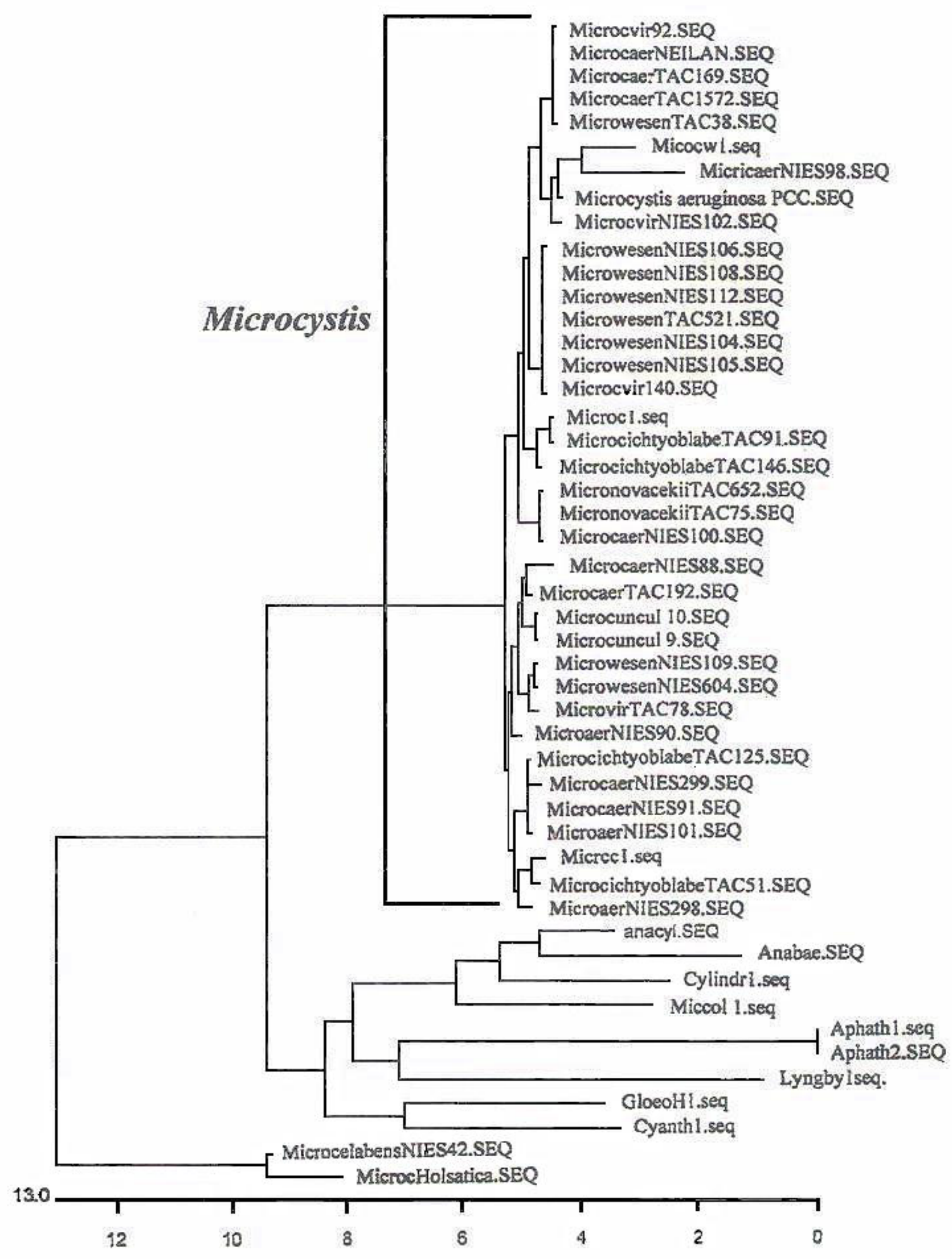


Fig. 8: Part of phylogenetic tree of *Microcystis* complex (Microcomplet.MEG). CLUSTAL method with Weighted residue weight table. International Gene Bank, 04-16-1999. The tree indicates no differences among the BS.

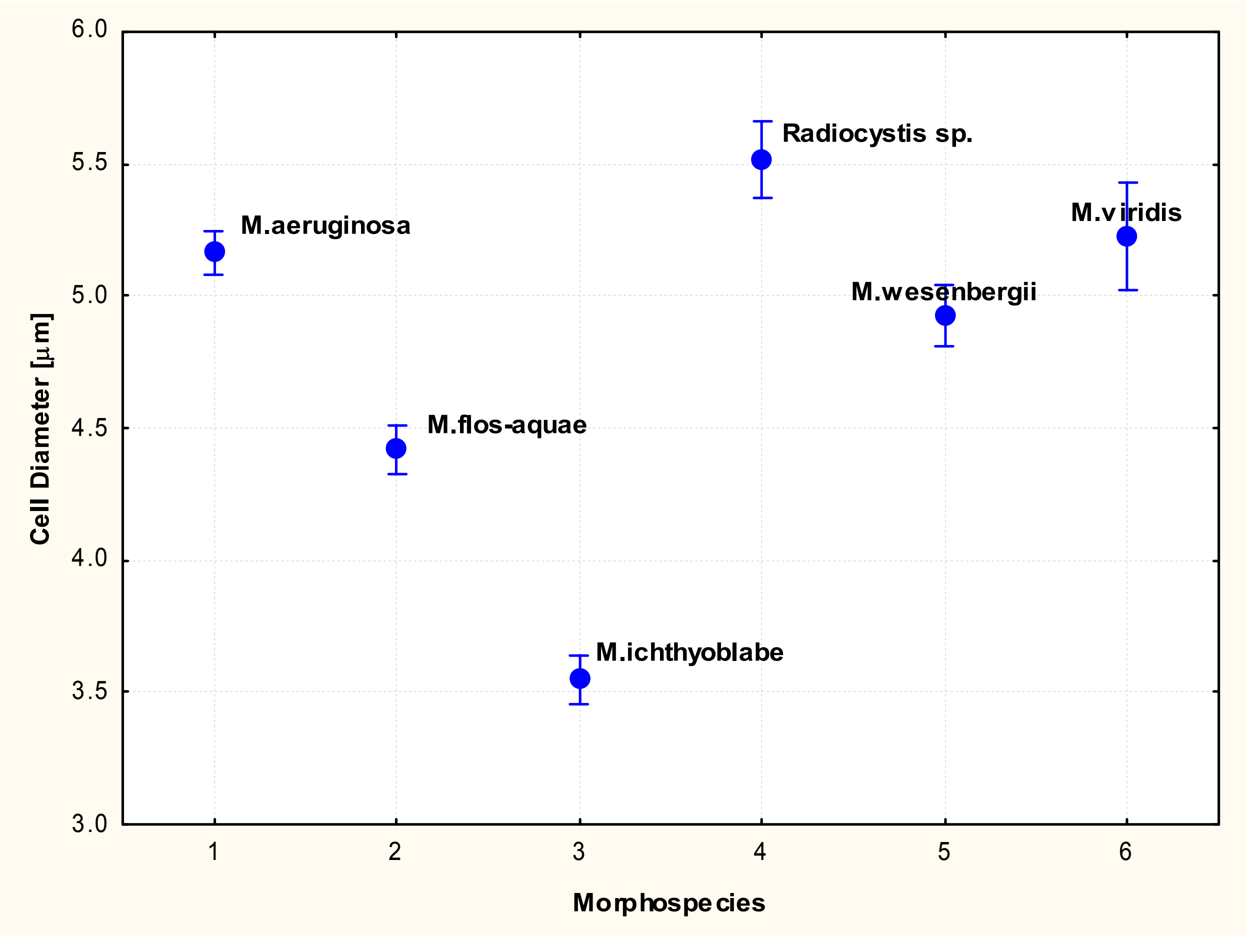
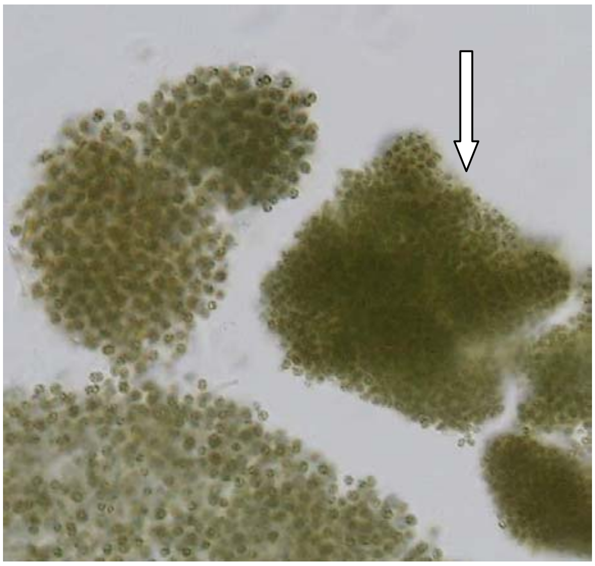


Fig. 9: Whisker Plot (ANOVA) of cell diameter means of six "botanical species" of *Microcystis* identified in samples from localities sampled in 2004. Differences between the group of *M. aeruginosa, M. wesenbergii* and *M. viridis,* and *M. flos-aquae*, *M. ichthyoblabe* are evidently statisticaly significant. Dimensions of *Radiocystis* (No 4) belong to large cells with many aerotopes forming concentric structured colonies resembling *R. fernandoi*.

one (A, corresponding to the BS *M. flos-aquae*) and a smaller one (B, corresponding to BS *M. ichthyoblabe*) (Fig. 9). Differences in their sizes were statistically significant, but on the basis of all the other morphological characters they clearly belonged to one single morphospecies. During the growth of colonies after re-inoculation to a fresh medium, small but quickly dividing cells started to develop from one of the large cells in the center or at the border of the colony (Fig. 10). Such "nanocyte" formation inside colonies of *M. flos-aquae* were found both in natural populations and in cultures. In cross gradient experiments, intensive "nanocyte" production occurred especially in fast growth conditions. Our observations have confirmed the convergence of two traditional "botanical species": *Microcystis ichthyoblabe,* and *M. flos-aquae.* Further "botanical species" probably very close or identical to *M. ichthyoblabe* are *M. natans* and *M. firma*. According to the Botanical Code, the group should be named *M. ichthyoblabe* Kützing 1843 as this name has a priority. However, official identification with the synonyms was avoided, as the nomenclatoric rules for the Cyanobacteria group should undergo a basic reconstruction in the close future.

According to the presented results [3], it is certain that within the range of the "*Microcystis* cluster" according to Watanabe or the new bacterial species *M. aeruginosa* according to Otsuka four morphotypes (*M. aeruginosa, M. ichthyoblabe, M. viridis* and *M. wesenbergii*) can be distinguished.



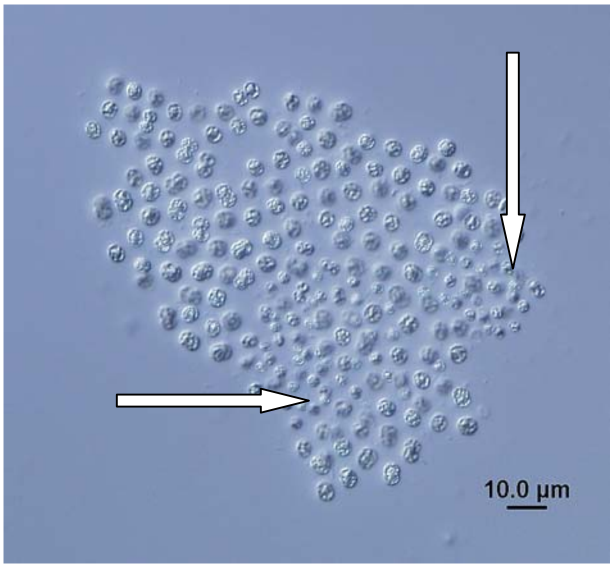


Fig. 10: *Microcystis ichthyoblabe/flos-aquae*. Left: densely packed cells growing fast. Right: colony after fresh inoculation: arrows point at groups of small, quickly growing cells.

Whether the last two BS are identical or not is a question for further research. Molecular analyses, however, may in the future prove their individuality.

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4.2 The relationship between morphological and molecular features of planktic and benthic genera from the family Nostocales

K. Kaštovská together with P. Rajaniemi, A. Rantala and K. Sivonen (University of Helsinki, Finland), J. Komárek and P. Hrouzek (University of South Bohemia, Czech Republic), and L. Hoffman and R. Willame (Public Research Centrum-Gabriel Lippmann, Luxembourg) collaborated on a project aimed at a phylogenetic and morphological evaluation of the genera *Anabaena, Aphanizomenon, Trichormus* and *Nostoc.*

We focused on combined genetic and phenotypic relationships of the chosen genera. The old botanical classification is often in disagreement with recent molecular data. We tried to find important morphological features, which are suitable for classification and combined them together with genetic analyses. We isolated new strains of *Anabaena, Aphanizomenon* and *Nostoc*. Detailed morphological analyses of these strains were carried out at the time of isolation in order to avoid the difficulties in identification. The phylogeny of the strains was investigated by the sequencing of two housekeeping genes, 16S rRNA and *rpo*B, as well as of a carbon fixation associated gene, *rbc*LX.

Results of our study have confirmed the monophyly of heterocytous cyanobacteria (Nostocales). Within this group, phylogenetic and morphological studies have shown that genera such as *Anabaena* and *Aphanizomenon* are intermixed. Simultaneously we were not able to confirm hypotheses that benthic and planktic species of *Anabaena* create different clusters and are genetically separated. According to the morphological and phylogenetic data those species were intermixed. In addition these results have confirmed that *Anabaena* and *Aphanizomenon* are not monophyletic as previously assumed.

Our study also has confirmed the correctness of recent separation of genus *Trichormus* from *Anabaena.* But our detailed study has revealed that *Trichormus* strains were morphologically and phylogenetically heterogeneous and did not form a monophyletic cluster. These *Trichormus* strains, which were representatives of three species, might actually belong to three genera according to the evolutionary distances. *Nostoc* strains were also heterogeneous, and seemed to form a monophyletic cluster, which may have contained at least two different genera.

We found that certain morphological features were stable and could be used to separate different phylogenetic clusters. For example, the width and length of akinetes were useful features for the classification of the *Anabaena/Aphanizomenon* strains. We studied the taxonomy of the freshly isolated anabaenoid strains using a combined morphological and phylogenetic approach and found that the taxonomy of these genera did not follow the current classification of strains and it needs a revision. For more detailed information about our work see Rajaniemi et al 2005.

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