Biology Centre of the Czech Academy of Sciences, v. v. i.,
Institute of Hydrobiology

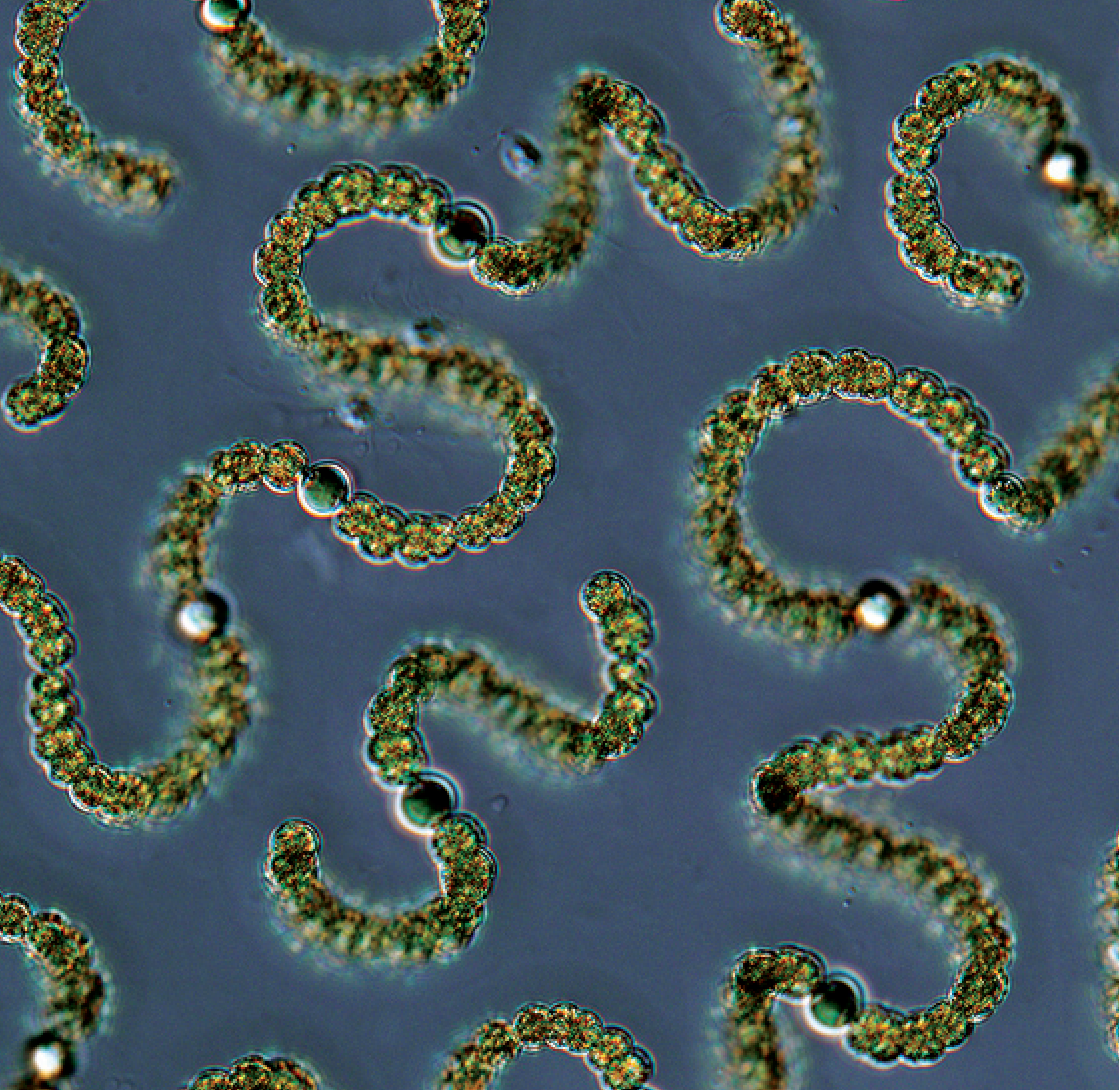
Biologické centrum AV ČR, v. v. i., Hydrobiologický ústav
České Budějovice

58th ANNUAL REPORT

For the Year 2017

58. VÝROČNÍ ZPRÁVA

za rok 2017



Coiled filaments of planktonic cyanobacterium Dolichospermum. /
Zakroucená vlákna planktonní sinice rodu Dolichospermum. *(Foto: P. Znachor)*

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Content / Obsah

Awards

Ocenění

Jiří Kopáček

Professor Jiří Kopáček was awarded the Prize of the President of the Czech Science Foundation.

The Prize honored a five year-long project that studied the effect of natural die-back of mountain spruce forest on microclimate, chemistry, and bio-diversity of terrestrial and aquatic ecosystems. The project was solved in collaboration of three scientific institutions (Biology Centre CAS, University of South Bohemia in České Budějovice, and Czech University of Life Sciences in Prague). The scientific team has created a new biogeochemical model linking cycles of carbon, nitrogen and sulphur in soils, enabling better forecasting of nutrients lost from forest ecosystems depending on global atmospheric pollution trends and climate changes.

Jiří Kopáček

Profesor Jiří Kopáček obdržel Cenu předsedkyně Grantové agentury České republiky.

V rámci oceněného projektu byl po dobu pěti let zkoumán vliv přirozeného rozpadu horských smrkových porostů po kůrovcovém žíru na mikroklima, chemismus a biodiverzitu půdních a vodních ekosystémů. Na jeho řešení se podíleli výzkumníci ze tří institucí (Biologického centra AV ČR, Jihočeské univerzity v Českých Budějovicích a České zemědělské univerzity v Praze). Vědeckému týmu se podařilo zformulovat nový koncepční biogeochemický model, který propojuje cykly uhlíku, dusíku a síry v půdách a umožňuje přesnější předpovědi ztrát živin z lesních ekosystémů v závislosti na globálním vývoji znečišťování atmosféry a klimatických změn.

Professor Jiří Kopáček during ceremony. / Profesor Jiří Kopáček při předávání Ceny předsedkyně GA ČR. (Foto: GA ČR)

Petr Blabolil was honored by the Prize of Josef Hlávka for young scientist of the Czech Academy of Sciences.

Milan Říha was honored by the Premium of Otto Wichterle awarded by the Czech Academy of Sciences to extraordinary young scientists successfully solving demanding scientific problems.

Ivana Vejříková was honored by the Prize of Vojtěch Jarošík awarded by the Department of Ecology, Faculty of Science, Charles University in Prague and the Czech Society for Ecology for the outstanding student paper in 2016.

Ivan Jarić was awarded the Fellowship of J. E. Purkyně of the Czech Academy of Sciences for his study of fish biology and behavior by telemetric methods.

Petr Blabolil and **Marek Šmejkal** were awarded the Prize of the Dean of the Faculty of Science, University of South Bohemia in České Budějovice for their outstanding PhD theses.

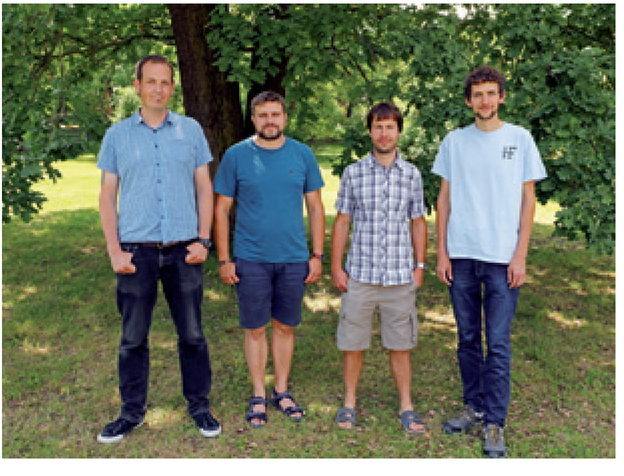
Petr Blabolil obdržel Cenu Josefa Hlávky pro nejlepší mladé vědecké pracovníky AV ČR.

Milan Říha obdržel Prémii Otto Wichterleho udělovanou Akademií věd ČR špičkovým vědcům do 35 let věku, kteří úspěšně splnili významný vědecký úkol.

Ivana Vejříková obdržela cenu Vojtěcha Jarošíka udělovanou Katedrou ekologie Přírodovědecké fakulty Univerzity Karlovy v Praze a České společnosti pro ekologii za vynikající studentskou publikaci v roce 2016.

Ivan Jarić získal stipendium J. E. Purkyněho udělované Akademií věd ČR na výzkum biologie a chování ryb pomocí telemetrických metod.

Petr Blabolil a **Markem Šmejkal** byli ocenění cenou děkana Přírodovědecké fakulty, Jihočeské university v Českých Budějovicích, za jejich doktorské práce.



Ivan Jarić, Milan Říha, Marek Šmejkal, Petr Blabolil. (Foto: P. Znachor)

Director's preface

Whitefish, catfish and artificial lakes

The Czech Republic has few small natural lakes. This has two obvious consequences. Firstly, the few natural lakes that are located in the Bohemian Forest receive a surprisingly high amount of attention from researchers interested in their development under different anthropogenic influences (and our institute plays an important role in these investigations). The second consequence is that Czechs have had to build other lakes themselves. The country now has tens of thousands of artificially built lakes – mainly fishponds, reservoirs and flooded former mines. These waterbodies greatly supplement the natural lakes in our landscape. And the fact that these are practically the only lakes we have, explains why many people approach them like lakes and welcome the idea of defining and maintaining their ecological potential. Not having enough natural lakes we consider the ecological state of the lakes we have.

Defining good ecological potential of artificially built lakes is not a trivial task at all. All of them were built in a landscape heavily influenced by human activities, are relatively young and do not have undisturbed reference states. Distant guidance for the reference state can be found in the undisturbed natural lakes in surrounding countries. Water reservoirs, which are the most common large waterbodies and the main object of investigations by our institute, are in an especially difficult position from the view of ecological potential. By definition of ecological potential, the primary purpose of the reservoirs cannot by judged as a stressor even if it often acts as an ecological stressor (power generation, water supply, flood protection and so on). Also the relative catchments of the reservoirs, where all the anthropogenic influences sum, and the intensity of human activities are usually larger than for the lakes of similar size. So the pressure on the reservoir systems is high and preserving good ecological potential here is a demanding task. Moreover, besides direct anthropogenic pressures the situation also changes with climatic changes.

Fish are often used as easily understood indicators of ecological state. They are also my specialization, so I use them as examples. In 2017 we published two papers showing that ecological potential of fish in reservoirs can be assessed by similar indices as in lakes (Poikane et al., 2017, Blabolil et al, 2017). Deep glacial lakes in all surrounding countries contain usually some kind of whitefish (*Coregonus*). This genus is a real sentinel of oligo to mesotrophic conditions with reasonable ecological state. It is also a dominant and very efficient food web player of open water and is often an important commercial fish. As a coldwater fish they are one of the few who are able bring fish life to deeper layers below the epilimnion, and use their productivity. In Czechia, two species, *Coregonus laveretus maraena* and *C. Peled* were extensively produced by aquaculture and were introduced into all lowland reservoirs. In some of the reservoirs (reported from: Lipno, Orlík, Římov, Švihov, Žlutice) they established self-reproducing populations

Úvod ředitele ústavu

Síh, sumec a umělá jezera

Česká republika má jen několik malých přírodních jezer. V důsledku toho je na několik málo Šumavských zaměřena překvapivě intenzivní vědecká pozornost ústavu. V ostatních částech země nezbylo než na místo přirozených jezer postavit nádrže umělé. V České republice jsou v současnosti desítky tisíc uměle vytvořených vodních těles – hlavně rybníků, nádrží a zaplavených důlních jam. Tato vodní tělesa do značné míry nahrazují přírodní. Z toho důvodu je k těmto vodním plochám přistupováno jako k přírodním a je snaha o udržení nebo zlepšení jejich ekologického potenciálu.

Definování dobrého ekologického stavu umělých vodních těles není jednoduchým úkolem. Všechna tato tělesa byla vybudována v krajině ovlivněné lidskou aktivitou, jsou relativně mladá a je velice obtížné najít referenční neovlivněné vodní plochy. V některých případech je možné k vzdálenému porovnání použít málo ovlivněná jezera v okolních zemích. Stanovení ekologického potenciálu údolních nádrží, na které se naše pracoviště zaměřuje především, je velice obtížné, protože samotné důvody vzniku těchto přehrad (výroba elektrické energie, zásoba pitné vody, protipovodňová ochrana) jsou často ekologickým stresovým faktorem, který se však do pojetí ekologického potenciálu nezahrnuje. Ekologický potenciál je zde také ovlivněn procesy v povodí a rovněž vývojem klimatu.

Ryby jsou velice často používány jako indikátor ekologického stavu, proto je použiji jako příklad. V roce 2017 byly publikovány dva články charakterizující ekologický potenciál údolních nádrží pomocí stejných indicií jako v přírodních jezerech (Poikane et al., 2017, Blaboli et al., 2017). Hluboká ledovcová jezera v okolních státech obsahují obvykle nějaký druh síha (*Coregonus*). Tento rod ryb je významným indikátorem oligo nebo mesotrofních vod, k tomu je významným článkem potravního řetězce a mívá i hospodářský význam. Jako studenomilná ryba je jednou z mála, která je schopna se živit v hlubokých částech jezer. V Čechách jsou dva druhy, *Coregonus laveretus maraena* and *C. Peled*, komerčně chovány a dokonce nasazovány do údolních nádrží. V některých z nich (Lipno, Orlík, Švihov, Žlutice) se dokonale přizpůsobily a úspěšně se rozmnožovaly (např. v Lipně v roce 2003 tvořily 15% rybí obsádky). Data analyzovaná kolegy z Univerzity v Tromso, Norsko ukázaly optimální podmínky pro jejich růst v českých vodách. Dalo by se věřit, že by mohlo dojít k ustálení těchto populací v údolních nádržích stejně jako je tomu v jezerech. Bohužel navzdory dobrému růstovému potenciálu, téměř všechny sledované populace síhů (Lipno, Římov, Žlutice) vymřely. Přímé příčiny nejsou známy, ale vymření samotné naznačuje, že podmínky v českých údolních nádržích jsou mnohem horší než v přírodních jezerech okolních států.

Tajemní hlubinní síhové však v Čechách neskončili. Před několika lety jsme s pomocí správců bývalých povrchových dolů započali unikátní experiment nasazení síhů do zatopených důlních jam – Medard a Most. Populace se dobře uchytily v obou jezerech a ukazují na jejich schopnost přežít v českých and reached high densities (for example in 2003 in the Lipno Reservoir whitefish represented some 15% of pelagic fish biomass). Growth data analysed by our colleague from the University in Tromso (Norway) showed near optimal growth conditions in Czech waters and there was a hope that the reservoirs could develop coldwater fish communities like lakes. Unfortunately, despite good growth, all investigated populations of whitefish (Lipno, Římov, Žlutice) died out completely. Direct causes of extinction were never directly elucidated but the sad story of whitefish populations clearly shows that the conditions in Czech reservoirs are substantially worse than in neighbouring lakes.

However, whitefish is not yet out of play in Czechia. A few years ago, with the support of lake managers, we started a unique experiment to introduce whitefish into deep lakes created by the flooding of former opencast mines – Medard and Most. So far whitefish have established in both lakes, reproduce every year and occupy a very important space of pelagic planktivore, illustrating that the survival of these fish in our conditions is possible. Thanks to their low nutrient load and to whitefish, these lakes are the only lakes in the country with a significant fish presence in the hypolimnion thus resembling the trophic structure of natural lakes.

As we try to save whitefish where possible to get closer to a natural state, more changes happen in our waters. Cyprinid dominated fish communities were shown to be very stable in a number of studies. Their abundant presence was selected as the main fish indicator of degraded ecological state or potential (Poikane et al, 2017). In Czech conditions, where predatory fish are intensively angled, the populations of predators so far have not been able to control the spread of cyprinids and their overpopulating. Such state was valid for many decades but it may be changing. With the increase of spring temperatures, the conditions improved for the apex predator of European waters – wels catfish (*Silurus glanis*). Previously it was practically fully dependent on artificial stocking, while in the last decade it started to reproduce regularly in Czech reservoirs. The densities of this species became higher and the superdominance of cyprinids and populations of other predators seems to be under pressure. The situation is complicated by the fact that wels is underestimated by most ichthyological methods and the information on its biology is not sufficient. Recent paper of Vejřík et al, 2017 and subsequent telemetry work show its enormous generalism and adaptability in life strategies which predetermines its high ecological role in future.

Some desired species are vanishing while some new important players are emerging. These two examples show how difficult it is to define and maintain ecological potential of artificial and heavily modified water bodies in the changing word. The only one way to do it right is through thorough understanding of functioning of individual key elements of the food webs. However laborious it is to discover the secrets of the cryptic underwater world, the mysteries under the surface will never stop attracting the curiosity of people who love the water. This exciting process of discoveries and their applications is a future promise, that we should be able create very interesting ecosystems even in artificial and heavily modified water bodies in man-made landscapes.

Jan Kubečka

podmínkách. Díky přítomnosti síhů a nízkému přísunu živin jsou tato jezera u nás zřejmě jedinými, které mají rybí obsádkou v hypolimniu podobně jako tomu je v přírodních jezerech.

Hlavními rybami většiny vodních těles jsou však ryby kaprovité. Jejich množství bylo vybráno jako indikátor zhoršujícího se ekologického potenciálu (Poikane et al., 2017). V českých podmínkách, kde jsou rybí predátoři oblíbenou kořistí sportovních rybářů, nedochází k vyvinutí dostatečně početné populace predátorů schopné zvládnou přemnožení kaprovitých ryb. Takový stav se dosud pravidelně opakoval na většině nádrží. V posledních letech však pozorujeme zajímavou změnu. Se vzrůstem jarních teplot se zlepšily podmínky pro rozvoj vrcholového rybího predátora evropských vod – sumce velkého (*Silurus glanis*). Dříve byla populace sumce kompletně závislá na umělém nasazování, v posledních letech dochází k jejich přirozené reprodukci v údolních nádržích. Jejich počty narůstají v důsledku čehož se kaprovité ryby a populace dalších predátorů dostávají pod predační tlak. Situace je o to komplikovanější, že síla populace sumce je velice špatně odhadována s použitím stávajících rybářských metod a informace o jeho chování jsou nedostatečné. Čerstvá publikace Vejříka a kol., 2017 a rozsáhlé telemetrické studie Říhy a kol. prokázaly jejich překvapivou všestrannost a schopnost adaptace životní strategie předurčující jejich velkou ekologickou úlohu v budoucnu.

Některé žádané druhy mizí, zatímco jiné se objevují. Tyto příklady ukazují, jak je obtížné definovat a udržovat ekologický potenciál umělých a velmi ovlivněných vodních těles v měnícím se světě. Jedinou správnou cestou je podrobné poznání chování a funkce jednotlivých složek a jejich syntéza pro celý ekosystém. Jedině tento znalostní přístup je zárukou, že i z umělých a silně modifikovaných vodních těles vytvoříme zajímavé ekosystémy i v lidskou činností výrazně ovlivněné krajině.

Jan Kubečka

Historical photograph of Lipno reservoir whitefish (Coregonus sp.) from 2003 survey when the population was abundant. This fish is now most likely extinct. / Historické foto lipenského síha z průzkumu tehdy hojné populace v r. 2003. Dnes je tato populace s velkou pravděpodobností vymřelá. (Foto: J. Kubečka)

Departments

Department of Hydrochemistry and Ecosystem Modelling

At the Department of Hydrochemistry and Ecosystem Modelling we investigate biogeochemical nutrient cycles and processes that influence the chemical composition and quality of surface waters. We focus especially on processes in lentic waters – mountain lakes, reservoirs, and ponds, but we also pay considerable attention to the hydrology and water chemistry of runoff from different types of catchments, and to selected processes in the soil environment that influence the transport of mineral and organic substances into surface waters. One part of our research is linked to long-term monitoring of model reservoirs, especially the Slapy and Římov Reservoirs in the catchment of the Vltava River; another important area of study involves alpine lakes in the Tatra Mountains and mountain lakes in the Bohemian Forest (Šumava). For a more detailed understanding of key processes we complement our monitoring activities with field and laboratory experiments and with the application of mathematical models. Two crucial areas of our research concern eutrophication and acidification of aquatic ecosystems.

Winter sampling of water. / Zimní odběr vzorků vody. (Foto: J. Kaňa)

Eutrophication is the enrichment of ecosystems by nutrients, leading to intensive growth of biomass of algae, cyanobacteria

Oddělení

Oddělení hydrochemie a ekosystémového modelování

V oddělení hydrochemie a ekosystémového modelování zkoumáme biogeochemické koloběhy živin a procesy, které ovlivňují chemické složení a kvalitu povrchových vod. Zaměřujeme se především na procesy ve stojatých vodách – horských jezerech, údolních nádržích a rybnících, ale velkou pozornost věnujeme také hydrologii a chemickému složení odtoku vody z různých typů povodí a vybraným procesům v půdním prostředí, které ovlivňují odnos minerálních a organických látek do povrchových vod. Jedna část našich studií je založena na dlouhodobém monitoringu modelových nádrží, zejména nádrží Slapy a Římov v povodí Vltavy, druhou oblastí je výzkum alpinských jezer v Tatrách a lesních horských jezer na Šumavě. Pro detailní studium klíčových procesů tento monitoring doplňujeme terénními a laboratorními experimenty a rovněž aplikací matematických modelů. Dvěma stěžejními tématy bádání jsou eutrofizace a acidifikace vodních ekosystémů.

Eutrofizace je obohacování ekosystému živinami, jejímž důsledkem je ve stojatých vodách intenzivní tvorba organické hmoty řas, sinic a vodních rostlin, často doprovázená nežádoucím výskytem vodního květu, anoxiemi vody nade dnem, zhoršenou jakostí vody atd. Náš výzkum eutrofizace pokrývá všechny podstatné aspekty této problematiky od určování a řízení zdrojů živinového znečištění v povodí, přes transport živin říční sítí do nádrží, až po podmínky pro realizaci živin při tvorbě biomasy ve vlastní nádrži. Pro hodnocení významnosti různých přírodních a antropogenních

Determination of nitrate. / Stanovení dusičnanů. (Foto. P. Porcal)

Digestion of samples for organic nitrogen determination. / Mineralizace vzorků pro stanovení organického dusíku. (Foto: P. Porcal)

and aquatic macrophytes, often accompanied by an unwelcome incidence of water blooms, anoxia of water above the bottom, decrease in water quality, etc. Our eutrophication research covers all important aspects of this issue: determination and management of sources of nutrient pollution in catchment areas, research on the transport of nutrients via river networks into reservoirs, and investigations of the conditions necessary for nutrients to actually trigger the production of biomass in a reservoir. To evaluate the importance of various natural and anthropogenic sources of nitrogen and phosphorus in individual catchments we use mathematical models of varying complexity, from simple empirical mass-balance equations to dynamic complex models based on detailed descriptions of hydrological, physico-chemical, and biochemical processes in the soil, in groundwater, and in the river network. We evolve and develop methods to determine different nutrient forms and their accessibility within the catchment area and during their in-reservoir cycling between the sediments and the water column. A more recent addition to our research in this area has been the influence of environmental conditions and reservoir management on aquatic macrophytes.

In our research on the recovery from acidification of mountain lake ecosystems and their catchment areas, we exploit the unique opportunity to understand reactions in different terrestrial and aquatic environments to atmospheric pollution, that was extreme in Central Europe during the 1970s and 1980s, but that has returned to levels from the first half of the 20th century in the last two decades. While the level of atmospheric pollution by sulphur and nitrogen compounds entering the catchments is currently very low, acidification levels in the soil and waters remain relatively high and ecosystem recovery zdrojů dusíku a fosforu v konkrétních povodích používáme matematické modely o různé složitosti, od jednoduchých empirických bilančních rovnic až po dynamické komplexní modely pracující s detailním popisem hydrologických, fyzikálně-chemických a biochemických procesů v půdě, podzemní vodě a v říční síti. Vyvíjíme a dále rozpracováváme metody pro stanovení různých forem živin a jejich dostupnosti v povodí i ve vnitronádržovém koloběhu mezi sedimenty a vodním sloupcem. V poslední době byla výzkumná problematika oddělení doplněna o studium vlivu environmentálních podmínek a nádržového managementu na vodní makrofyta.

Při studiu zotavování ekosystémů horských jezer a jejich povodí z acidifikace nebo okyselení, využíváme unikátní příležitost k porozumění procesům v různých složkách terestrického a vodního prostředí při jejich reakci na znečištění atmosféry, které bylo ve střední Evropě v 70. až 80. letech 20. století extrémní, ale jež se v dvou posledních desetiletích vrátilo na úroveň z první poloviny 20. století. I když je atmosférické znečištění sloučeninami síry a dusíku vstupující do povodí v současnosti velmi nízké, v půdním i vodním prostředí okyselení dosud přetrvává a zotavování ekosystémů probíhá jen postupně. Odumírání lesních porostů v povodí horských jezer na Šumavě v důsledku kůrovcové kalamity poskytuje možnost sledovat dynamiku interakcí mezi rostlinami a mikrobiálními společenstvy v půdě

The change of winter and summer samplers. / Výměna zimních a letních srážkoměrů. (Foto: J. Kopáček) is gradual. Forest dieback in lake catchments due to bark beetle infestation enables us to investigate the dynamics of interactions between plants and microbial communities in the soil. It also gives us the opportunity to study the effects of disturbed equilibria in the soil on the export of nutrients and organic compounds into surface runoff and their ensuing impacts on lake ecosystems. Acidified mountain catchments are also useful as model localities for research on the causes and effects of the long-term rise in the concentration of humic substances in the outflow from catchments. This phenomenon is observed in many temperate parts of the world and impacts both lake ecology and drinking water quality. Our current photochemistry studies of humic substances show interesting relationships between humic substances in the aquatic environment and the availability of nutrients and microbial production in the aquatic ecosystem.

Sampling of Tatra Mountains lakes. / Vzorkování tatranských ples. (Foto: J. Kopáček)

Department of Aquatic Microbial Ecology

The Department of Aquatic Microbial Ecology is focused on researching freshwater microscopic organisms. There are two main groups of aquatic microorganisms, and they differ by function. The first group, the autotrophs, consist of microscopic algae and cyanobacteria which are jointly referred to as phytoplankton. They are responsible for creating new organic matter via photosythesis. The second group, the heterotrophs, are the bacteria and the protozoa which, on the contrary, co-operate on the decomposition of organic matter. Because the methodology is different for each group of organisms, our department has two interlinked working groups, concerned with the ecology of aquatic bacteria and protozoa, and the ecology of phytoplankton.

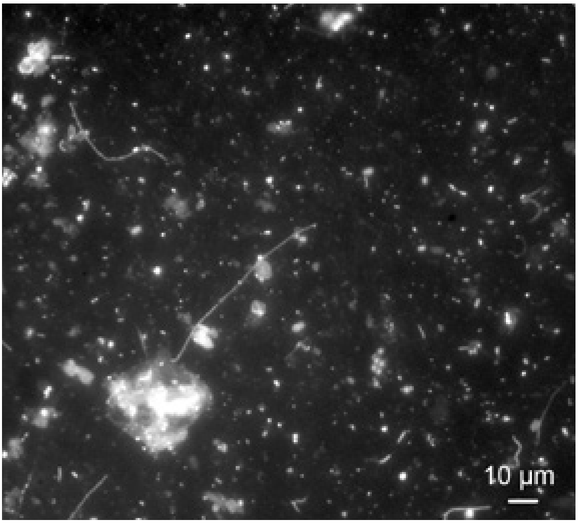
The group focusing on the **ecology of aquatic bacteria** is interested in the a důsledky narušení jejich rovnováh pro odnos živin a organických látek do povrchového odtoku a následně zkoumat dopady na vodní ekosystém jezer. Okyselením postižená horská povodí také využíváme jako modelové lokality pro výzkum příčin a důsledků dlouhodobého nárůstu koncentrací huminových látek v odtoku z povodí, ke kterému dochází v mírném klimatickém pásmu na mnoha místech zeměkoule a jenž má dopady i na ekologii jezer a jakost vodních zdrojů. Naše současné studie fotochemie huminových látek ukazují zajímavé souvislosti mezi přítomností huminových látek a dostupností živin či mikrobiální produkcí ve vodním ekosystému. Naše současné studie fotochemie huminových látek ukazují zajímavé souvislosti mezi huminovými látkami ve vodním prostředí a dostupností živin či mikrobiální produkcí ve vodním ekosystému.

Dissolved oxygen concentration measurement. / Měření koncentrace rozpuštěného kyslíku. (Foto: J. Kopáček)

Oddělení mikrobiální ekologie vody

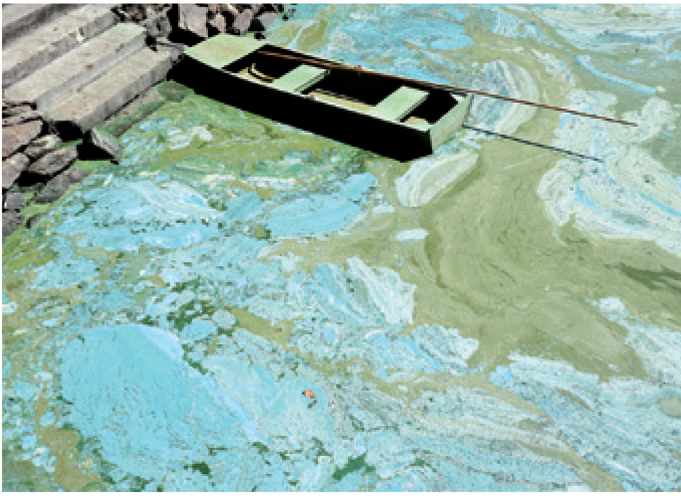
V oddělení mikrobiální ekologie vody se zabýváme výzkumem mikroskopických organismů, které žijí ve sladkých vodách. Předmět našeho zájmu, vodní mikroorganismy, se podle funkce dělí na dvě skupiny, z nichž první (autotrofové) je tvořena mikroskopickými řasami a sinicemi (souhrnně nazývanými fytoplankton) a je zodpovědná za tvorbu nové organické hmoty fotosyntézou. Druhou skupinu tvoří heterotrofové – jsou to bakterie a prvoci, kteří naopak spolupracují na rozkladu odumřelé organické hmoty. Protože se metodické přístupy ke studiu obou skupin liší, fungují z praktických důvodů v našem oddělení dvě úzce provázané pracovní skupiny, zaměřené (1) na studium ekologie vodních bakterií a prvoků, a (2) na studium ekologie fytoplanktonu.

Skupina **ekologie vodních baktérií** se zabývá taxonomií sladkovodních bakterií,



Fluorescence image of an aquatic microbial comunity. / Fluorescenční snímek vodního mikrobiálního společenstva. (Foto: J. Nedoma)

taxonomy of freshwater bacteria, their **biogeography, function**, and their **role in food chains**. In aquatic bacterial taxonomy, we try to find out which of the bacteria actually live in freshwaters – there are only some species or groups. We concentrate on two groups, betaproteobacteria and actinobacteria, which are typical for freshwaters (including those of Central Europe). We use molecular methods, based on the study of the genetic information of the bacteria. We have achieved considerable success in isolating and cultivating aquatic bacteria using unique methods developed by our researchers. Aquatic bacterial biogeography is a very young field of study and basic investigations on where and why different bacterial groups occur have only recently begun. Our researchers are contributing significantly to its development. We also study the unique microbial communities in acidified Bohemian Forest lakes as well as the development of microbial populations in a lake emerging in a former brown-coal quarry which is being inundated. The study of the functions of aquatic bacteria (the types of organic substances they decompose and utilise, how quickly they grow) and of bacteria in relation to other organisms (protozoa and small animals that feed on them and viruses that attack them) is a classical field within aquatic microbiology. We have made significant contributions to the current general trend in this field: attempts at maximum distinguishment of the individual species or taxonomic groups of bacteria and protozoa involved in the processes studied. The work of professor Karel Šimek (one of the most cited Czech ecologists) in this field is especially valued by the international scientific community. He has contributed significantly to understanding the relationships between bacteria, protozoa, and viruses: the protozoa influence the composition of bacterial communities by preferential feeding jejich **biogeografií**, **funkcí**, a jejich **zapojením do potravních řetězců**. V taxonomii sladkovodních bakterií studujeme jaké bakterie vůbec ve vodách žijí – jsou to jen určité druhy nebo skupiny. Soustřeďujeme se na dvě typické skupiny sladkých vod (včetně našich): betaproteobakterie a aktinobakterie. Používáme molekulární metody, založené na studiu genetické informace bakterií. Významné úspěchy jsme dosáhli při izolaci a kultivaci vodních bakterií unikátními metodami, vyvinutými našimi pracovníky. Biogeografie vodních bakterií je obor teprve shromažďující základní poznatky (kde se které bakterie vyskytují a proč) a naši pracovníci významně přispívají vodních bakterií (jaký typ organických látek rozkládají a využívají, jak rychle rostou) a jejich dalšího osudu ve vodním prostředí (bakteriemi se živí prvoci a drobní živočichové a napadají je viry). Současným obecným trendem, ke kterému přispíváme významnými poznatky, je dovedení tohoto studia na co nejvyšší úroveň taxonomického rozlišení (jednotlivé druhy či skupiny bakterií a prvoků). Ve světě jsou ceněny zejména práce profesora Karla Šimka (jenž patří mezi nejcitovanější české ekology), které zásadně přispívají k pochopení vztahů mezi bakteriemi, prvoky a viry: prvoci ovlivňují složení baktérií tím, že upřednostňují jako potravu různé druhy, typy, nebo

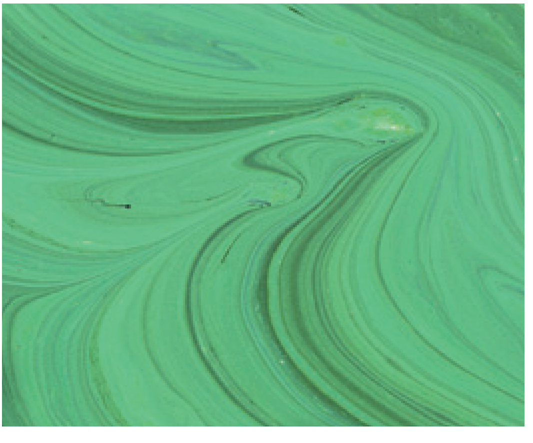


Cyanobacterial bloom decay, fishpond Dehtář. / Rozkládající se vodní květ na rybníce Dehtář. (Foto. P. Znachor)

k jejímu rozvoji. Studujeme také unikátní mikrobiální společenstva v okyselených šumavských jezerech a vývoj mikrobiálního osídlení jezera vznikajícího v zaplavovaném hnědouhelném lomu. Mezi klasické obory vodní mikrobiologie patří studium funkce velikosti bakterií. Tím se mění rychlost přenosu organické hmoty potravními řetězci přes zooplankton až k rybám.

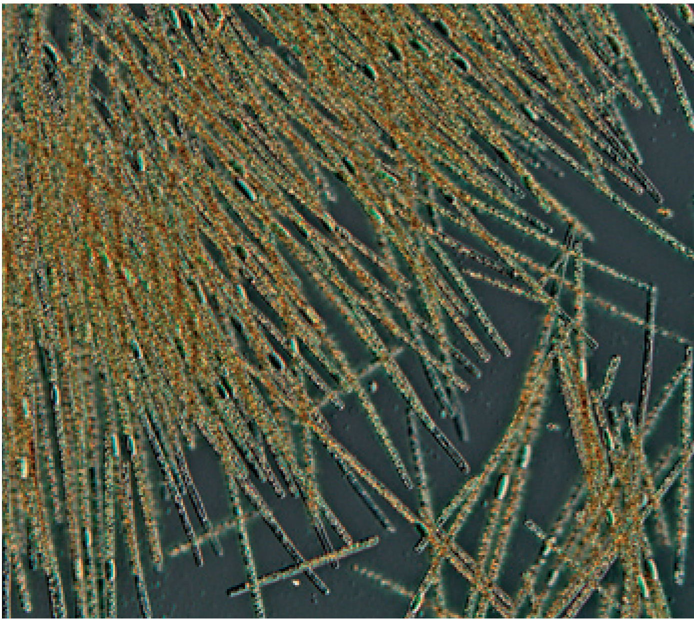
Skupina **ekologie fytoplanktonu** se zabývá výzkumem mikroskopických řas a sinic (tj. souhrnně fytoplanktonem) z hlediska on certain species, types or sizes of bacteria. This changes the rates of transfer of organic matter in the food chain via the zooplankton all the way up to the fish.

The **phytoplankton ecology group** focuses on the research of phytoplankton (consisting of microscopic algae and cyanobacteria) in terms of their **taxonomy, ecology, ecophysiology, and interaction with bacteria**. Internationally, our institute is one of the most respected research centers dealing with the taxonomy of cyanobacteria (also known as blue-green algae), which are known for their tendency to create unpleasant and dangerous water blooms. Our aim is to describe and reliably distinguish individual species using a combination of classical (microscopy) and modern (molecular) methods. Our institute hosts a unique collection of several hundred strains of cyanobacteria and algae isolated from various types of freshwaters. Our group tries to identify factors responsible for certain species or groups of algae or cyanobacteria being in a given place and time. We study competition for resources between phytoplankton species, the influence of extreme rainfall on the taxonomic composition of phytoplankton communities, and the differences between phytoplankton composition in different reservoir areas. We also focus on long-term changes in phytoplankton composition caused by global climate change. In algal and cyanobacterial ecophysiology, we concentrate on the relationship between the physiological traits of individual species and their occurrence in an aquatic ecosystem. Here, our development and implementation of modern fluorescent methods has gained us a considerable international reputation. The methods consist of marking cells using special fluorescent labels. This then enables microscopic comparisons of the qualities of individual cells, such as the production of certain substances, growth rates, cell damage or vitality. Research on the interaction of phytoplankton and bacteria is focused on factors influencing the production of organic substances by phytoplankton and their impact on the composition, activity, and growth of bacteria.



Close-up view on accumulated cyanobacterial bloom. / Detailní pohled na nahromaděný vodní květ sinic. (Foto: P. Znachor)

Colonial cyanobacterium Aphanizomenon klebahnii. / *Kolonální sinice* Aphanizomenon klebahnii. *(Foto: P. Znachor)*



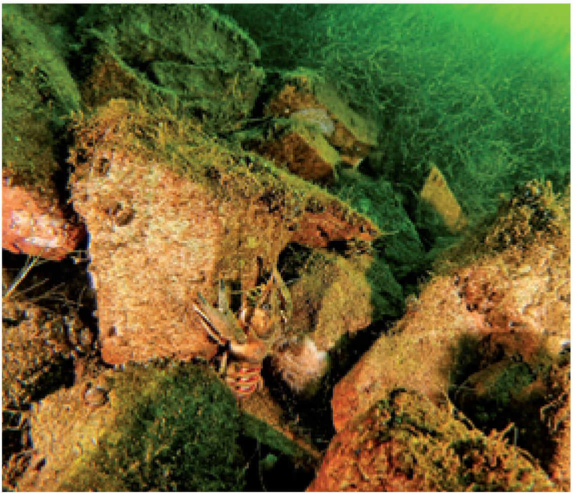
jeho **taxonomie, ekologie, ekofyziologie a interakce s bakteriemi**. V taxonomii sinic, známých jejich schopností tvořit nepříjemné a nebezpečné vodní květy, patří naše oddělení mezi významná světová pracoviště. Cílem je popis a spolehlivé rozlišení jednotlivých druhů za použití kombinace klasických (mikroskopie) a moderních přístupů (molekulární metody). Na našem pracovišti se nachází unikátní sbírka několika set kmenů sinic a řas izolovaných z různých druhů sladkých vod. V ekologii fytoplanktonu hledáme faktory zodpovědné za to, že se dané druhy nebo skupiny řas či sinic vyskytují v daný čas na daném místě. Studujeme kompetici mezi druhy fytoplanktonu (soutěž o zdroje), vliv extrémních srážek na složení fytoplanktonu a na jeho rozdílnost v různých místech údolních nádrží, a dále dlouhodobé změny ve složení fytoplanktonu v závislosti na globální změně klimatu. V ekofyziologii řas a sinic hledáme vztahy mezi vlastnostmi jednotlivých druhů a jejich schopností uplatnit se ve vodním ekosystému. Máme významné postavení v používání a vývoji moderních fluorescenčních metod, umožňujících označit buňky speciálními svítícími značkami a v mikroskopu na základě toho srovnávat vlastnosti jednotlivých buněk (produkci určitých látek, rychlost růstu, neporušenost či životaschopnost). Při studiu interakce fytoplanktonu a bakterií jde o výzkum faktorů ovlivňující produkci organických látek fytoplanktonem a jejich vliv na složení, aktivitu a růst bakterií.

Department of Fish and Zooplankton Ecology

The Department of Fish and Zooplankton Ecology focuses its research on the highest trophic levels in freshwater ecosystems, zooplankton and fish, and is divided into two sub-teams with different research and methodological approaches.

The Zooplankton Ecology Group (ZEG) conducts traditional zooplankton studies to follow evolutionary adaptations of key *Daphnia* species, using genetic approaches. work of the Zooplankton Ecology Group falls into five research areas:

- Studies of the interactions of trophic state, fish and zooplankton.
- Analyses of long-term changes in the zooplankton of model reservoirs.
- Genetic studies of the populations of the most common European hybrid complex Daphnia longispina and of their links to biotic and abiotic factors.



Invasive spinycheek crayfish (Orconectes limosus) in Lake Milada. / Invazní rak pruhovaný (Orconectes limosus) v jezeře Milada. (Foto: J. Peterka)

A basic principle of the group's work is the combination of field and laboratory techniques, where working hypotheses for laboratory experiments grow out of data obtained during fieldwork. The research focus, the genus *Daphnia*, is also a substantial and preferred food resource for planktivorous fish and, as such, forms an important link in the food pyramid and between the two groups of the department. Currently the

- "Founder effect" of newly colonized ecosystems of lakes in former coal quarries.
- Physio-ecological adaptations of the most common species Daphnia galeata, with exceptional plasticity.

The Fish Ecology Unit (FishEcU) functions largely as a national and international body in charge of quantitative fish stock assessments in lakes and reservoirs with its

Oddělení ekologie ryb a zooplanktonu

Oddělení eklogie ryb a zooplanktonu se zaměřuje na výzkum nejvýše postavených trofických úrovní ve sladkovodních ekosystémech – živočišného planktonu (označovaného jako zooplankton) a ryb. Protože obě studované trofické úrovně vyžadují odlišné metodické přístupy je oddělení tvořeno dvěma specializovanými laboratořemi.

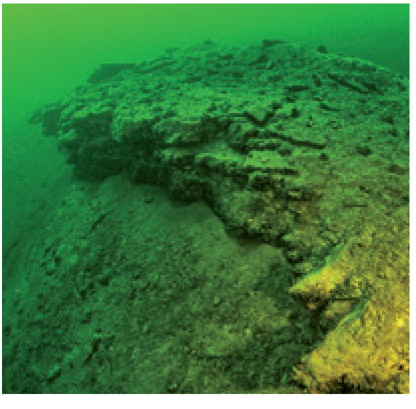
Předmětem studia **laboratoře ekologie zooplanktonu (ZEG – Zooplankton Ecology Group)** jsou hlavně planktonní korýši velkých a hlubokých nádrží, v našich podmínkách především přehradních nádrží a v poslední době také nových typů nádrží vznikajících zatopením důlních jam. Zvláštní pozornost je věnována filtrujícímu tzv. herbivornímu zooplanktonu, který však je schopen filtrovat nejen fytoplankton, ale obecně částice rozptýlené ve vodě včetně detritu a bakterioplanktonu. Jedná se zejména o perloočky rodu *Daphnia*, které zároveň jako významná a preferovaná složka potravy planktivorních ryb tvoří důležitý spojovací článek v potravní pyramidě. Základním principem práce je kombinace terénních a laboratorních přístupů, kdy pracovní hypotézy pro laboratorní experimenty vycházejí z poznatků získaných při terénních sledováních. V současné době se v zaměření laboratoře kombinuje pět výzkumných rovin:

- Studie interakcí úživnosti, ryb a zooplanktonu ve smyslu ovlivňování druhového i velikostního složení a časoprostorové distribuce zooplanktonu.

Research vessel Ota Oliva launching, Lake Medard. / Spouštění výzkumné lodě Ota Oliva na jezero Medard. (Foto: J. Peterka)

Lake Most sampling. / Vzorkování na jezeře Most. (Foto: J. Peterka)

main research topics being the spatio-temporal distribution of fish abundance and biomass, species- and size-specific behavioural traits, foraging ecology and role in trophic webs, and methodology of quantitative sampling of fish communities. The research results improve our general knowledge about fish and their role and influence within the whole aquatic ecosystem as well as providing qualified advice and support to practitioners managing fish stocks in lentic water environments.



Underwater landscape of Lake Most. / Podvodní krajina jezera Most. (Foto: J. Peterka)

Great emphasis is placed on research and development of methods for quantitative sampling of fish stocks. In this particular field FishEcU is a world leading research group in horizontal acoustic methods, gauging their limitations, determining the relationships between fish size and the strength of their acoustic echoes, improving the accuracy of acoustic detection of fish larvae, juveniles and aquatic invertebrates, and last but not least, the use of acoustic methods in research on fish behaviour. In addition to acoustic methods, the group draws on its tradition of passive

- Analýzy dlouhodobých změn v zooplanktonu modelové nádrže.
- Genetické studie populací, v Evropě nejrozšířenějšího, hybridního komplexu D. longispina a vazeb na abiotické a biotické faktory.
- Výzkum výhody zakladatele (priority effect) nově kolonizovaných biotopů jezer po těžbě uhlí a následné konfrontace se změnou prostředí po kolonizaci rybami.

Hlavní náplní **laboratoře ekologie ryb (FishEcU – Fish Ecology Unit)** je výzkum zřetelem na provázání s dalšími složkami vodního ekosystému. Získané poznatky slouží jednak k prohloubení znalostí o rybách a jejich roli a vlivu na celý vodní ekosystém, a jednak jsou využívány pro návrhy managementu rybích obsádek ve stojatých vodách.

Značné úsilí je věnováno výzkumu a vývoji metod pro kvantitativní vzorkování rybích obsádek. Jde hlavně o aplikace horizontálních akustických metod, odhalování jejich limitací, zjišťování vztahů mezi velikostí ryb a síly jejich akustického ozvu,

Electrofishing for European catfish (Silurus glanis). / Elektrolov sumce velkého (Silurus glanis). (Foto: L. Vejřík)

ryb ve velkých vnitrozemských vodách, zejména údolních nádrží a jezerech, se zaměřením na odhalení zákonitostí v rozmístění, chování, potravní aktivitě, početnosti a biomase ryb. V této oblasti pokrývá studium všechny aspekty dané problematiky, tj. zoologii, ekologii a etologii ryb se zpřesňování akustické detekce rybích larev a juvenilů, vodních bezobratlých a v neposlední řadě využití akustických metod při výzkumu chování ryb. Vedle akustických metod má laboratoř velkou tradici v používání pasivních a aktivních lovných prostředků. Rozvíjí metody vzorkování elektrolovem, and active fishing gear, developing sampling methods using electrofishing, beach seining, purse seining, trawling and gillnetting. FishEcU greatly contributed to the understanding of the ecology of lentic ecosystems through its results obtained by gillnetting, a common sampling method.

FishEcU research also clarified the hitherto little-understood behaviour patterns of fish in large inland waterbodies, and their trophic role in these ecosystems. The role of fish was assessed both from a "bottom-up" (food accessibility for fish under different conditions) and a "top-down" perspective (fish as consumers feeding on organisms from lower trophic levels and the implications for the qualitative composition of these lower levels and for water quality). Individual approaches (trophic effectiveness and selectivity) as well as approaches based on evaluating the impact of the whole fish community (food rations, consumption rates, bioenergetic modeling etc.) were used.

An important aspect of FishEcU's work is its complex approach; the absolute importance of individual species and size groups is derived by weighing the total picture of the fish community. This is made possible by a unique combination of quantitative and qualitative sampling methods.

European catfish (Silurus glanis) resting in branches of flooded tree. / Sumec velký (Silurus glanis) odpočívající ve větvích zatopeného stromu. (Foto: J. Peterka)

Processing of fish catch. / Zpracování úlovku ryb. (Foto: J. Kubečka)

zátahovými, košelkovými, vlečnými a tenatovými sítěmi, pro manipulační odlovy a pro studie migrací ryb využívá též odlovů do vrší a vězenců.

Laboratoř intenzivně přispívá k objasňování vzorců chování ryb ve velkých vnitrozemských vodách, které jsou doposud málo prostudovány, a jejich role v potravních sítích těchto vod. Aktivity laboratoře se zaměřují zejména na poznání vzorců distribuce ryb, horizontální a vertikální migrace, využívání domovských okrsků a chování ryb vůči odlovným prostředkům (únikovost a z toho plynoucí výběrovost). Používány jsou akustické techniky sledování, značení ryb, přímé sledování pomocí videotechniky, potápěči či dálkově ovládaným průzkumníkem (ROV). Role ryb je pak sledována jednak z pohledu „bottom-up" procesů – dostupnost potravy pro ryby za různých podmínek, tak „top-down" procesů – ryby jako konzumenti živící se na nižších trofických úrovních, a konsekvence z toho vyplývající jak pro kvalitativní složení těchto úrovní, tak nakonec kvalitu vody. Jsou uplatňovány jak přístupy individuální – potravní efektivita a výběrovost, tak přístupy založené na zhodnocení vlivu celého společenstva – potravní raciony, bioenergetické modelování atd.

Zásadní vlastností průzkumů prováděných laboratoří ekologie ryb je, že jsou prováděny komplexně, kdy celkový obraz rybího společenstva zohledňuje váženým způsobem absolutní významnost různých druhů a velikostních skupin. Tohoto výsledku je dosahováno unikátní kombinací kvantitativních a kvalitativních metod vzorkování.

Current Research Highlights / Aktuální body výzkumu

Metagenomic recovery of phage genomes of uncultured freshwater actinobacteria

After nearly 200 years of Microbiology itself, it has been realized that the collective efforts of the scientific community have only resulted in cultures of <1% of the vast majority of microbes that exist on the planet. An even worse scenario exists for the phages that infect these microbes as traditional microbiology requires clonal cultures for successful phage isolation. Paradoxically, the most common and abundant microbes are also the most difficult to grow in the laboratory. Thus, the most abundant lifeforms on earth (estimated to be at least 10 phages for every microbial cell in aquatic systems) remain exceptionally understudied. We focused on identifying phages that infect pelagic, freshwater Actinobacteria that are small microbes (ultramicrobacteria), quite unlike the larger soil Actinobacteria. They cannot be grown in the laboratory but massive populations (20–30% of all microbes) exist in nearly all freshwater environments. No phages are known.

Metagenomics provides a culture-free approach to recover phage genomes directly from the environment. We used deep metagenomic sequencing to assemble eight complete genomes of the first bacteriophages that infect freshwater Actinobacteria. They were identifiable because their genomes encode a transcription factor (*whiB*) that is found only in Actinobacteria and some in cultured mycobacteriophages. It appears that actinobacterial phages use *whiB* to modulate host gene expression during infection. Curiously, one of these phage genomes also encodes a eukaryotic toxin (similar to cholera toxin). Why does a bacterial phage carry a toxin that affects only eukaryotes? We think the presence of the phage protects the actinobacterial population from protists that are the primary predators in the aquatic environment. An infected bacterial cell is in essence a „trojan horse", deployed by the bacterial population, and any eukaryote that consumes an infected cell dies. This partnership between the bacteria and the phage improves the fitness of both. Phages are not always „harmful" to their host.

Rohit Ghai, Maliheh Mehrshad, Carolina Megumi Mizuno and Francisco Rodriguez-Valera. *The ISME Journal (2016) 11, 304–308 (2017) | doi:10.1038/ismej.2016.110*

Metagenomická rekonstrukce genomu virů infikujících nekultivovatelné sladkovodní aktinobakterie

Přestože výzkum mikroorganismů probíhá již dvě století, stále méně než 1% jejich celkových počtů se zatím podařilo izolovat, a tak i charakterizovat dle současných mikrobiologických standardů. Ještě horší je situace v oblasti výzkumu fágů (viry infikující mikroorganismy), neboť klasická mikrobiologie vyžaduje klonální kulturu pro jejich úspěšnou izolaci. Navíc ty nejpočetnější bakterie v planktonu se velmi obtížně izolují a udržují v laboratorních kulturách. Z toho logicky plyne, že ty nejpočetnější organismy na zemi (odhaduje se, že na každého mikroba připadá asi 10 fágů) jsou stále velmi málo prostudovány. Náš výzkum se zaměřil na identifikaci a popis bakteriofágů, které infikují sladkovodní planktonní aktinobakterie patřící k vůbec nejmenším prokaryotickým buňkám. Prozatím se nedaří jejich kultivace v čistých kulturách, přestože reprezentují nejpočetnější taxonomickou skupinu bakterií v planktonu (20–30% všech bakterií). Tudíž ani žádné jejich specifické fágy nejsou známé.

Metagenomika umožňuje detekci virových genomů bez kultivace, tj. přímo ve vzorcích z prostředí. Použili jsme metagenomickou sekvenaci s vysokým rozlišením, abychom zkompletovali osm kompletních genomů bakteriofágů infikujících aktinobakterie. Ty mohou být zjištěny na základě přítomnosti zabudovaného transcripčního faktoru *whiB*, který je specifický pouze pro aktinobakterie a také pro některé kultivované mykobakteriofágy. Zdá se, že fágy aktinobakterií používají tento transkripční faktor k regulaci exprese genů bakteriálního hostitele během infekce. Jeden ze studovaných fágových genomů kóduje překvapivě eukaryotický toxin, podobný toxinům bakterie způsobující choleru. Hádankou zůstává, proč bakteriofágy přenášejí geny působící pouze na eukaryontní organismy. Domníváme se, že přítomnost těchto fágů chrání populace aktionobakterií před predátory, zejména prvoky. Lze to také interpretovat, že infikovaná buňka představuje jakéhosi „trojského koně" v populaci bakterií. Její pozření predátorem jej usmrtí a tím sníží predační tlak. Tyto výsledky naznačují, že viry nemusí být vždy škodlivé pro své hostitele.

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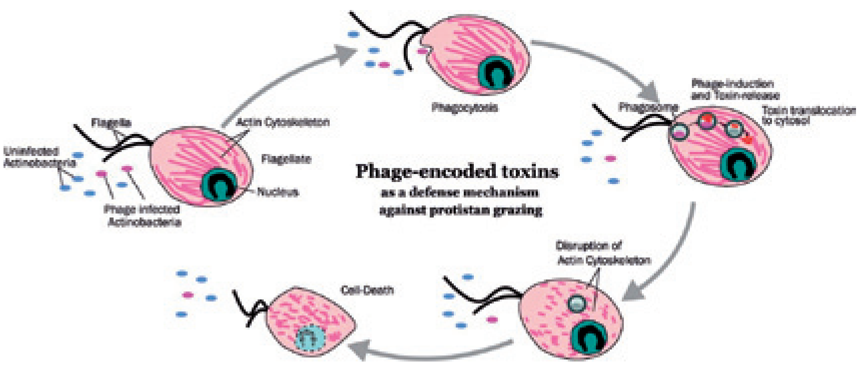
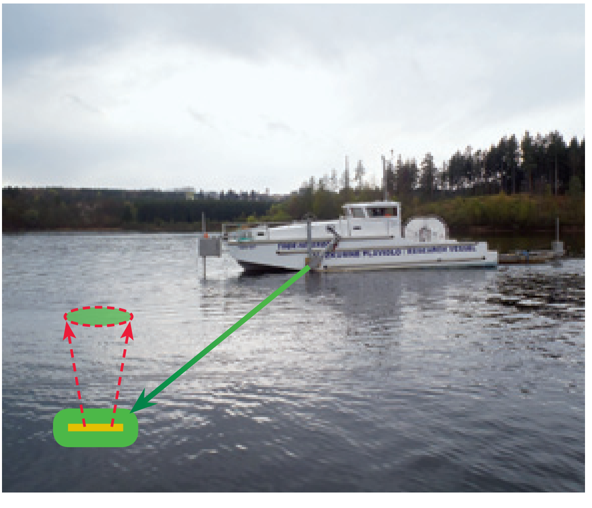


Conceptual diagram of the defensive role of phage-encoded toxins in the actinobacterial population against protist predation. / Zobrazení virové infekce jako možného obranného mechanismu chránícího populace aktinobakterií před predátory.

The adventure of shallow water hydroacoustics

The use of echosounders can be an extremely powerful tool for exploring aquatic ecosystems. Their undeniable advantage is their friendliness to the observed organisms, which are not distracted or damaged. For example, in marine systems the use of echosounders is a fundamental approach to studying fish communities and other pelagic organisms. However, when studying the fish communities of European lakes and reservoirs, we found that obtaining quantitative information with scientific echosounders is much harder. This is related to the fact that most fish live in shallow layers (0–4 m below surface) in many waterbodies. Paradoxically, exploration of these shallow layers appears to be much more difficult than exploration of deep layers.

One hope was to use so-called horizontal surveys with the ultrasonic cone pointing horizontally below the surface. This promising approach has several theoretical difficulties, about which the most serious was published in 2017. The complex ground truthing of the signal quality of horizontal echosounding showed a high level of unwanted interference of the surface-reflected ultrasound waves affecting the signal quality (Balk et al., 2017). This interference efficiently shortens the useable range and forces the sampled volume to the deeper layers. The possibilities of improving the reliability of horizontal surveys will be further studied, however, an alternative system has been developed to obtain quality information about the open water fish of reservoirs and lakes, using an acoustic transducer forward of a research vessel and immersed under a layer of surface fish to a depth of about 8 m. Unlike in horizontal applications the acoustic signals obtained by the "uplooking" system are acoustically very clean, noise free, allowing the monitoring not only of fish but also some forms of



Research vessel Thor Heyerdahl investigating the reservoir simultaneously by down, side and up looking acoustic systems. All transducers are positioned in front of the vessel, underwater parts of the uplooking system and the uplooking acoustic beam is drawn by software. (Foto: J. Kubečka) aquatic invertebrates. The latest results of the comparison with the samples of direct catches by trawling show very good agreement (Baran et al., 2017) and therefore this method is a very promising fish friendly approach to study the quantity, spatial occurrence and behavior of fish in large waters.

The research of plant-associated microbiomes at the Department of Aquatic Microbial Ecology (AME)

The researchers at AME have been focusing on plant–microbe interactions in aquatic carnivorous *Utricularia* for some years now. The miniature aquatic ecosystem within their traps is surprisingly complex and the AME team has made some exciting discoveries which made headline in the news section of the journal *Science*. They conclude that *Utricularia* traps can be, in terms of ecophysiological function, compared to sophisticated miniature portable cultivators or farms, which centre around complex microbial consortia acting synergistically to covert complex organic matter, often of algal origin, into a source of utilizable nutrients for the plants. In collaboration with Prof. Posch´s group at the Department of Plant and Microbial Biology, University of Zurich, the team has discovered and described a specialized *Utricularia*-associated ciliate species previously unknown to science. *Tetrahymena utriculariae*, as it has been named, is the only species in the famous model genus known to harbour endosymbiotic algae and has only, so far, been found inside of *Utricularia* traps.

These new findings on the composition and function of trap commensals, including bacteria, fungi, algae, and protozoa, were reviewed in the context of their ecological role in a chapter of the new important monograph on the physiology, ecology, and evolution of carnivorous plants by the Oxford University Press.

Sirová D., Bárta J., Borovec J., Vrba J. (2018) The *Utricularia*-associated microbiome: composition, function, and ecology. In: Carnivorous Plants: Physiology, ecology, and evolution. Edited by Aaron M. Ellison and Lubomír Adamec: © Oxford University Press Print ISBN-13: 9780198779841, 349–358.

Pitsch G, Adamec L, Dirren S, Nitsche F, Šimek K, Sirová D, Posch T. (2017). The green *Tetrahymena utriculariae* n. sp. (Ciliophora, Oligohymenophorea) with its endosymbiotic algae (*Micractinium* sp.), living in the feeding traps of a carnivorous aquatic plant. *J Eukaryot Microbiol*: doi: 10.1111/jeu.12369.

Šimek K, Pitsch G, Salcher MM, Sirová D, Shabarova T, Adamec L. et al. (2017). Ecological traits of the algae-bearing *Tetrahymena utriculariae* (Ciliophora) from traps of the aquatic carnivorous plant *Utricularia reflexa*. *J Eukaryot Microbiol*: doi: 10.1111/jeu.12368.

News at a glance: Carnivorous plant may be more of a gardener (2017). *Science*: Vol. 358, Issue 6360, pp. 152–154, doi: 10.1126/science.358.6360.152

Recent Research Outputs / Vybrané výsledky
(Ukončené granty)

Unveiling life strategies of important groups of planktonic Betaproteobacteria in relationship to carbon flow to higher trophic levels

This project provided important insights into the role of particular bacterial species on other narrow taxonomical units in carbon flow to higher trophic levels. Furthermore, we have shown some general trends in microdiversity and genomic traits mainly of the genus *Limnohabitans*. Our results also revealed important aspects of life styles and grazing-induced mortality rates of several core groups of planktonic bacteria including genera *Limnohabitans*, *Polynucleobacter*, *Methylopumilus* and two groups of Actinobacteria.

The project had five major project aims:

— To measure the growth potential of relevant isolated strains or genus-like taxa of the target bacteria by exploiting specifically designed in situ experiments in several habitats during different phases of plankton succession.

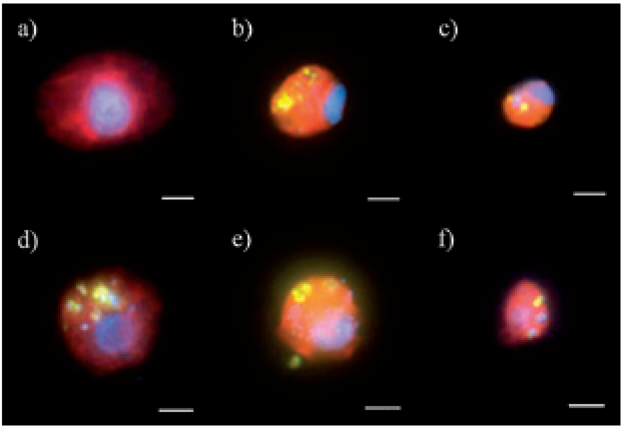
— To establish the nutritive value of the representative strains for natural heterotrophic nanoflagellate (HNF) communities when these bacteria are fed as the dominant food source; detecting HNF growth parameters and biomass yield related to a particular prey item.

- We address these aims in the following 5 papers published in core journals in the field [1, 2, 3, 4, 5], where we studied bacterioplankton dynamics and carbon flow from bacteria (using isolated strains from the target groups, i.e. *Limnohabitans, Polynucleobacter, Methylopumilus* and 2 groups of Actinobacteria) to flagellates in the Římov Reservoir and Cep Lake. The high temporal resolution study of Římov Reservoir [2] also showed the immense influence of the rapidly changing trophic structure of the system on the composition of bacterioplankton, with many short-lived peaks of bacteria affiliated to lineages of Betaproteobacteria and Flavobacteria. Though the data we also detected important life strategies of several genus- or species-like taxa, such as *Limnohabitans*, Ac1 lineage of Actinobacteria, and several lineages of Flavobacteria, in relationship to phytoplankton development and major top-down forces shaping community dynamics of these particular bacterial taxa.
- Flagellate growth parameters and biomass yield related to food quality of a particular prey item were experimentally tested and established (overview in [4]). Moreover, clear evidence about species-specific effects

of prey food quality on the resulting flagellate community composition were documented [1, 5].

Furthermore, a novel methodical experimental approach and clear evidence of significant shifts in flagellate communities induced by rapid changes in prey availability are presented in Grujčić et al. 2018 [5]. We combined amplicon sequencing and CARD-FISH probes targeting eukaryotic 18S rRNA genes to track specific responses of the natural HNF community to prey amendments. We also applied **a double-hybridization technique** that allowed simultaneous phylogenetic identification of both predator and prey. The community composition of flagellate bacterivores was strongly dependent upon prey type. Surprisingly, Cryptophyta and its CRY1 clade were the most abundant bacterivores although this phylum has been so far assumed to be mainly autotrophic. Thus, our study is the first report that colorless Cryptophyta are major bacterivores in summer plankton samples (see examples in Figure) and play a key role in the carbon transfer from bacteria to higher trophic levels.

- Moreover in a chemostat study [6], we documented how interspecific competition and protistan grazing



Double hybridization of bacterial prey and HNF predator. Each image is an overlay of three pictures of the same HNF cell observed under ultraviolet excitation (showing the blue nucleus after DAPI staining), green light excitation (red color corresponding to different HNF groups labeled with Alexa546 using CARD-FISH) and blue light excitation (yellow-green color corresponding to fluorescein-labeled Limnohabitans spp. or Polynucleobacter cells in food vacuoles after CARD-FISH with probe R-BT065 or PnecC-16S-445, respectively). Scale bar is 2μm. a) HNF hybridized with probe Kat-1452 targeting all Katablepharydophyta, b) bacteria and HNF hybridized with probes RBT065 targeting Limonhabitans and CRY1-652 targeting the CRY1 lineage of Cryptophyta, c) bacteria and HNF hybridized with probes PnecC-16S-445 targeting Polynucleobacter and CRY1-652 targeting the CRY1 lineage of Cryptophyta to (d and e) bacteria and HNF hybridized with probes R-BT065 targeting Limonhabitans and CryptB targeting all Cryptophyta, f) bacteria and HNF hybridized with probes PnecC-16S-445 targeting Polynucleobacter and CryptB targeting all Cryptophyta.

affect the coexistence of four freshwater planktonic strains of Betaproteobacteria of different genome size and life styles.

— To characterize intra-genus and intraspecies diversity in genomic and ecophysiological traits of the target bacteria based on experimental tests and genome analysis of closely related bacteria.

- Microdiversity and the presence of generalistic and opportunistic/specialist genotype groups within this genus Limnohabitans have been evaluated in a canyon-shaped reservoir [7].
- Furthermore, the results dealing with genomic traits related to bacterial photosynthesis in different lineages of the genus Limnohabitans were published in Kasalický et al. [8].
- The ecological relevance and factors shaping the dynamics of LimA lineage of Limnohabitans was studied by means of a newly designed CARD-FISH probe in 46 different freshwater ecosystems [9]. Our data revealed a wide distribution and high densities of LimA populations in freshwater environments and allowed us to draw conclusions about LimA dynamics and potential controlling factors. For example, LimA repetitively displayed higher abundances in surface waters during warm seasons and in systems rich in fresh humic/terrestrial material. This lineage can account for 20–25% of total bacteria in humic substance-rich environments, such e.g. humic ponds with a considerable input of fresh terrestrial material.
- In cooperation with colleagues from the University of Zurich (Neuenschwander S., Pernthaler J.) we analyzed 16 genomes of highly abundant freshwater microbes from the acI lineage of Actinobacteria. They represent very tiny microbes with significantly streamlined genomes (size only 1.2–1.4 Mbp) and low genomic GC content. A new order within Actinobacteria ('Candidatus Nanopelagiales') with two new genera ('Candidatus Nanopelagicus' and 'Candidatus Planktophila') and nine new species were proposed [10].

— To reveal if rate-specific differences in carbon-flow to higher trophic levels, which are expected between Limnohabitans and Polynucleobacter C-subcluster, can be linked to qualitative (e.g., gene content) or quantitative (e.g. genome size, gene families, functional groups of genes) genomic traits.

- These ecological issues are partially addressed in the published papers (e.g. [1, 3]. However, additionally we prepared an overview paper evaluating 11 different manipulation experiments conducted, dealing with the growth parameters of flagellates that grazed on different representative strains not only from various lineages of Limnohabitans and Polynucleobacter, but also using representative strains of Methylopumilus and Actinobacteria [4]. These data indicate that more rapidly growing bacterial strains (with larger genome and cell size) also usually support significantly more rapid growth of the flagellate predators. However, some strains, likely due to specific cell-surface properties (e.g. thick cell walls of

Humic rich Pohořský Stream above Jiřická Pond. / Pohořský potok nad Jiřickou nádrží bohatý na huminové látky. (Foto: P. Porcal)

gram-positive bacteria, Luna 2 cluster of Actinobacteria) supported either none, or frequently very limited flagellate growth. Thus the general trend can be modified by specific anti-grazer strategies since bacteria from the Luna 2 cluster were in fact bigger than strains from the Polynucleobacter C that supported relatively high growth rates of the predator communities [4].

Notably, the data from the field study [1] also showed that very tiny cells of acI lineage of Actinobacteria (with genome sizes only 1.2–1.4 Mbp, see [10] were strongly negatively selected in situ compared to much larger and rapidly growing bacteria from the R-BT cluster of Limnohabitans (with genome size ranging ~2.9–5.0 Mbp). The latter group with larger cell sizes was ingested approximately 4-times faster by natural HNF communities than the small Actinobacteria, which has far reaching consequences for carbon flow to higher trophic levels.

— To suggest important features of life strategies of the target bacterial groups that will contribute to refinements of life strategy concepts applicable for representative freshwater bacteria.

- Our estimates of flagellate predator growth rates closely resemble the maximum growth rates detected in rapidly growing bacterioplankton groups considered as "algal bloom specialists," such as those of the genera Limnohabitans, Fluviicola sp. and species-like tribes of Flavobacteria (those having large genome size and profound substrate versatility). Their short-lived peaks, co-occurring with various phytoplankton taxa, last usually for a few days only and are frequently terminated by enhanced HNF abundance and bacterivory (see the conceptual model in [4]). Thus importantly, the major taxa of bacterioplankton prey as well as predator communities possess high growth potential that apparently contributes to their relative growth balance in situ as suggested in the conceptual model [4]. Current data suggest that these bacteria do not possess high morphological versatility and they simply override the effects of the grazing pressure by fast division and growth rates.

Thus, our results above tentatively suggest the following life strategies that combine both ecophysiological and genomic traits:

(a) A relatively large genome size (e.g. Limnohabitans, some Flavobacteria) and correspondingly high growth potential in situ with the ability to form short-lived bacterial peaks that are accompanied by high mortality rates through protistan grazing [2, 4]. This strategy (resembling the "r" strategy described for higher organisms) obviously leads to considerably large contributions of these bacterial phyla to carbon flow to higher trophic levels. Moreover, it was also clearly

Measurement of primary production. / Stanovení primární produkce. (Foto: P. Znachor) reflected in high growth efficiencies and rates of carbon transfer to flagellate populations growing on the bacteria in manipulative experiments [1, 3, 4, 5].

(b) A moderate genome size (e.g. members of the genus Polynucloabacter C and D lineages) with the lower growth potential, medium to smaller cell sizes [1, 4], and a specific metabolic niche regarding substrate preferences that can lead to temporally large populations of these bacteria in e.g. humic substances-rich environments. These bacteria seem to be less vulnerable to flagellated bacterivores; likely thanks to their rather small cell volumes in situ.

(c) Among Actinobacteria (e.g. ac1 lineage) we found many features resembling the strategy originally described for tiny "microbacteria" in marine oligotrophic systems called "cryptic escape" [11]: Success is achieved in an environment by limiting the effective biomass in such a way as to discourage the success of phagotrophic predators, that is, by becoming "invisible" to them as a food source. This can be done in two ways: by reducing population size and by reducing the amount of biomass per individual. Such a trend is obvious for the ac1 cluster of Actinobacteria, with profound genome streamlining [10] and drastically reduced cell size (suboptimal for most flagellate grazers [2, 4]), and moderate growth potential. Surprisingly, this seems to be an extremely successful survival strategy among some bacterial phyla even in plankton of meso-eutrophic freshwaters [2, 10]. On the other hand, while sustaining numerically large populations, these bacterial strategists contribute disproportionally less to the overall carbon flow to higher trophic levels [2].

- The additional aspects of life strategies of several groups of Betaproteobacteria were also detailed in [1, 2, 4, 6, 12]. Moreover, new insights allowing for a certain level of generalization of the observed patterns in different lineages of Betaproteobacteria and Actinobacteria are presented in [7, 9, 10]. Last but not least, we propose a conceptual model explaining the tight linkages between rapid bacterial community shifts and succeeding flagellate predator community shifts, which optimize prey utilization rates and carbon flow from various bacteria to the microbial food chain [4].

[1] Šimek, K., Kasalický V., Jezbera J., Horňák K., Nedoma J., Hahn M.W., Bass D., Jost S., Boenigk J. 2013: Differential freshwater flagellate community response to bacterial food quality with a focus on *Limnohabitans* bacteria. ISME J. 7: 1519–1530.

[2] Šimek K, Nedoma J, Znachor P, Kasalický V, Jezbera J, Horňák K, Seďa J. 2014: A finely tuned symphony of factors modulates the microbial food web of a freshwater reservoir in spring. Limnol. Oceanogr. 59: 1477–1492.

[3] Grujčić V., Kasalický V., Šimek K. 2015: Prey-specific growth responses of freshwater flagellate communities induced by morphologically distinct bacteria from the genus *Limnohabitans*. Appl. Environ. Microbiol. 81: 4993–5002.

[4] Šimek K., Grujčić V., Hahn M.W., Horňák K., Jezberová J., Kasalický V., Nedoma J., Salcher M. M., Shabarova T. 2018: Bacterial prey food characteristics modulate community growth response of freshwater bacterivorous flagellates. Limnol. Oceanogr. 63: 484–502.

[5] Grujčić V., Nuy J., Salcher M., Shabarova T., Kasalický V., Boenigk J., Jensen M., Šimek K. 2018: Cryptophyta as major freshwater bacterivores in experiments with manipulated bacterial prey. ISME J., Published online: 20 February 2018. doi:10.1038/s41396-018-0057-5

[6] Salcher M. M., Ewert C., Šimek K., Kasalický V., Posch T. 2016: Interspecific competition and protistan grazing affect the coexistence of freshwater betaproteobacterial strains. FEMS Microb. Ecol. 92 (2), fiv156 doi: 10.1093/femsec/fiv156.

[7] Jezberová J., Jezbera J., Znachor P., Nedoma J., Kasalický V., Šimek K. 2017: *Limnohabitans* genus harbors generalist and opportunist gsubtypes: evidence from spatiotemporal succession in a canyon-shaped reservoir. Appl. Environ. Microbiol. 83: e01530–17.

[8] Kasalický V., Zeng Y., Pivosz K., Šimek K., Kratochvilová H., Koblížek K. 2018: Aerobic anoxygenic photosynthesis is commonly present within the genus Limnohabitans. Appl. Environ. Microbiol. 84 (1): e02116–17.

[9] Shabarova T., Kasalický V., Šimek K., Nedoma J., Znachor P., Posch T., Pernthaler J., Salcher M.M. 2017: Distribution and ecological preferences of the freshwater lineage LimA (genus *Limnohabitans*) revealed by a new double hybridization approach. Environ. Microbiol. 19: 1296–1309.

[10] Neuenschwander S.M., Ghai R., Pernthaler J., Salcher M.M. 2018. Microdiversification in genome-streamlined ubiquitous freshwater Actinobacteria. ISME J. 12: 185–198.

[11] Yooseph S., Nealson K.H. Rusch D.B., et. al. 2010. Genomic and functional adaptation in surface ocean planktonic prokaryotes. Nature 468 (7320): 60–6

[12] Salcher M. M., Šimek K. 2016: Isolation and cultivation of planktonic freshwater microbes is essential for a comprehensive understanding of their ecology. Aquat. Microb. Ecol. 77: 183–196.

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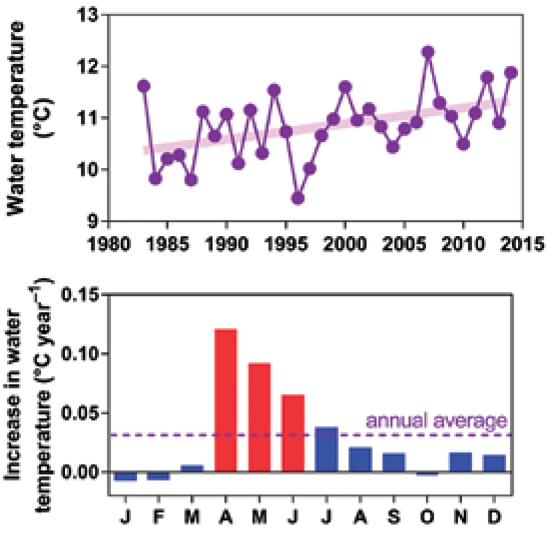
Phytoplankton responses to environmental forcing – lessons learned from 30-year monitoring of the Římov Reservoir

Our project has provided important insights into the long-term changes in the Římov Reservoir. It has been shown that the commonly used linear regression often does not capture key patterns in long-term trends and alternatives, but that conceptually simple models still provide a significantly better fit. Non-linear trends were particularly dominant in the reservoir hydrochemistry that changed abruptly in the early 1990s following pronounced socioeconomic changes in the catchment. We also identified a discontinuity in the time series of reservoir hydraulic conditions (late 1990s) in response to enhanced climatic forcing and consequent human measures to mitigate the impacts of the ongoing climate change. We detected the warming trend of surface water amounting to ~1 °C that was primarily driven by increasing spring temperatures (April–June, 0.4–1.2 °C per decade), in contrast to very little change in the rest of the season. Environmental changes had a large impact on phytoplankton. Over the last three decades, there has been a significant decrease in biomass of green algae. In contrast, diatom biomass significantly increased, showing a regime shift in 1997 that coincided with the shift in the hydraulic regime of the reservoir. Our analysis also confirmed the effect of weather on phytoplankton. Cyanobacteria benefiting from the enhanced water column stratification prevailed in dry and warm seasons, but in some years, they were replaced by desmids. In rainy seasons, diatoms were the most abundant. Analysis of high inflow episodes showed that extreme rainfalls represent nutrient pulses that are followed by a significant increase in overall phytoplankton biomass but do not necessarily result in a shift in phytoplankton composition.

The research was supported by the Czech Science Foundation project No. 15-13750S (2015–2017), principal investigator ***P. Znachor****.*



Long-term changes in annual means of water surface temperature with the solid line indicating an linear increasing trend (the upper panel). The lower panel shows monthly mean water temperatures; red bars indicate a statistically significant increase during 1983–2014.

Do long-term zooplankton data in the Slapy Reservoir reflect land use and/or climate changes in the past 50 years?

This collaborative project of the Institute of Hydrobiology with the University of South Bohemia in České Budějovice built upon the legacy of long-term regular sampling of the Slapy Reservoir, namely, fully processed all zooplankton samples, digitized and evaluated long-term data on chemistry and biota, and modelling assessments of the reservoir hydrodynamics.

The total dataset of crustacean zooplankton (species abundance) now exceeds 800 records of the regular three-week sampling for the periods of 1961–1969 and 1974–2017. In addition, species abundances of rotifers are available from 2011 onwards. The digitalized phytoplankton database (species abundance and biomass) covers the periods of 1963–1969 and 1986–2017 and the ciliate database has been completed for the years 1994–2017.

The mathematical model of reservoir hydrodynamics (CE-QUAL-W2) was assembled for the Slapy Reservoir with the required and rather detailed resolution over the period 1960–2016. The hydrological and operational data were used with 1-hour time steps to precisely describe the peaking operation of the hydro power stations at the reservoir cascade. The model was calibrated and used to reconstruct daily thermal stratification, the Schmidt stratification stability index, and water age in the water column. These daily simulated data indicated the changes in the timing of the onset of stratification and in the stability of water column with ongoing climatic changes more clearly than the originally measured three-weekly data. Both the analysis of measured data and the modelling of reservoir hydrodynamics confirmed our assumption that the canyon-shaped Slapy Reservoir in the reservoir cascade has become a warm monomictic lake in recent decades.

The long-term monitoring of water chemistry in the Slapy Reservoir, which collects water from a large, heterogeneous catchment, has provided a valuable evidence of socio-economic, land use, and hydrological effects on surface water. Kopáček et al. (2017) documented that uneconomical use of synthetic fertilizers, excessive drainage, poor treatment of wastewaters, and lack of appropriate legislation in the Czech water management contributed to water pollution during the period of planned economy until 1990. In contrast, economic recession after the reestablishment of a market economy in Czechia in 1990 and the improved legislation eventually resulted in decreasing (or levelling-off) trends in water pollution and significant decreases in nutrients and all major ionic components of water except for increasing Na^+ and Cl^- concentrations due to the steadily growing use of NaCl for winter de-icing of roads. Our results could serve for other rivers in the world as a potential model ecosystem and are especially relevant to similarly affected catchments developing sewer and sanitation systems, as well as to extensively drained and intensively fertilized agricultural areas.

Analysis of long-term phosphorus (P) concentrations in the Slapy Reservoir showed that variations in the epilimnetic P concentrations had a clear seasonality and were associated with both socio-economic and climate change drivers (Hejzlar et al. 2016, Vystavna et al. 2017). The increasing and decreasing P concentrations were detected in the winter-spring period during 1963–1991 and 1992–2015, respectively. These trends were mainly driven by changes in anthropogenic activities, such as P loads from sanitary systems and agriculture. The summer patterns of P concentrations were influenced by changes in climate and hydrology after 1991 (apparently by rising water temperature and increasing frequency of very low and extreme high water flows at the expense of mean flow values). These results demonstrate that climate change may lead to a greater susceptibility of aquatic ecosystems to the supply of nutrients and even result in elevated eutrophication at stable or decreasing external P loads. This conclusion highlights the necessity of further reductions of external P sources in the river network.

The analysis of elemental composition (body C, N, P content) of four dominant crustacean taxa in the reservoir zooplankton sampled during 2015 suggested certain seasonal variability in zooplankton stoichiometry. Unlike in most published papers considering zooplankton homeostasis, we documented certain stoichiometric plasticity for all three dominant zooplankton taxa (groups), namely Daphnia (Cladocera), Cyclops (Copepoda: Cyclopoida) and Eudiaptomus (Copepoda: Calanoida), which differ in their feeding mode. In particular, their P content differed between the mixing and stagnation phases as the seston stoichiometry (mainly C:P as the measure of food quality) varied when the epilimnion of the stratified reservoir became moderately P depleted (mean seston C:P ~230). We documented significant homeostasis for both the adult and juvenile Daphnia during the summer stagnation. (Šorf et al. in prep.)

We started to analyze if and how the above documented changes in water physics and chemistry affected the crustacean and rotifer zooplankton assemblages in the Slapy Reservoir. Based on its known P status and an apparent climate change (Vystavna et al. 2017), we compared zooplankton data of the two contrasting decades: the 1980s (high eutrophication, low temperature; 1983–1989) and the 2000s (reduced P, increasing temperature; 2003–2009). Crustacean zooplankton consisted of six copepod and 12 cladoceran taxa. Although the primary set of abiotic factors comprised of 18 more or less inter-correlated variables, we determined only four main drivers: temperature, conductivity, P concentration and theoretical retention time that were responsible for the explanation of crustacean zooplankton changes between the two decades and probably determined zooplankton long-term changes in general. We documented higher water temperature but lower conductivity and P in the 2000s compared to the 1980s. Such changes in the abiotic factors significantly influenced phytoplankton biomass, which further affected zooplankton. For instance, abundance of the calanoid copepod Eudiaptomus gracilis was by ~50% lower, while abundance of the cyclopoid copepod Thermocyclops crassus by ~50% higher in the latter decade. The significant increase in water temperature, likely corresponding to a possible climate change and/or to effects of a reservoir chain in the cascade, need deeper insights into the biotic interactions.

Hejzlar J., Vystavna Y., Kopáček J. 2016: Trends in the balance and material flows of phosphorus in the Czech Republic. Waste Forum, 2016, (4), 225–233.

Kopáček J., Hejzlar J., Porcal P., Posch M. 2017: Trends in riverine element fluxes: A chronicle of regional socio-economic changes. Water Research, 125: 374–383.

Šorf M., Hejzlar J., Řeháková K., Seďa J., Vrba J. (in preparation): Stoichiometric plasticity of crustacean zooplankton in a monomictic temperate reservoir: Species phosphorus allocation depends on mixing characteristics.

Vystavna Y., Hejzlar J., Kopáček J. 2017: Long-term trends of phosphorus concentrations in an artificial lake: Socioeconomic and climate drivers. PLoS ONE, 12(10): e0186917.

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The effect of solar light on key members of freshwater Betaproteobacteria

This completed Czech Science Foundation project (15-09721S) tested two hypothesis: (1) that the origin and structure of dissolved organic matter (DOM) differently affect bacterial isolates, and (2) that degradation of freshwater DOM by solar radiation changes the molecular structure of DOM and its availability to microbes, which in turn affects abundance, diversity and dynamics of microbial communities. A combination of irradiation and incubation experiments confirmed our hypothesis and showed that the source of dissolved organic matter, as well as water pH and temperature, were important factors affecting the bacterial community [1].

To support the project hypotheses, we conducted experiments that revealed several factors (such as temperature, DOM age and residence time, DOM source) affecting bacterial growth and different reactions of bacterial isolates and bacterial community composition [1, 2, 3, 4]. A paper based on this project [2] described the effect of temperature on photochemical changes of DOM. Mathematical modeling of processes identified two different pathways engaged in photochemical transformation of DOM to dissolved inorganic carbon (DIC) and particulate organic carbon (POC). Their production strongly depended on temperature. Direct oxidation of DOM to DIC dominated at low temperatures, while conversion of DOM to intermediate POC prior to its final oxidation to DIC dominated at high temperatures.

The effect of photodegradation on phosphorus (P) fractionation between dissolved and particulate forms (and thus limiting phosphorus availability for microorganisms) was described by Porcal et al. [3]. The photochemical transformation of DOM in surface waters exposed to UV radiation causes the precipitation of metal (Al and Fe) bearing complexes with high phosphorus sorption capacities. Irradiated samples and dark controls were then spiked with 33P-phosphate and the kinetics of P adsorption on freshly formed particles was determined after separation by ultracentrifugation. The P sorption was pH dependent, with the maximum sorption ability at pHs of 6–7. We show that this process can importantly contribute to the immobilization and lower bioavailability of P in the inlet areas of lakes due to the intensive photochemical degradation of allochthonous DOC-metal complexes.

The changes of dissolved organic matter properties, its autochthonous or allochthonous origin, during in situ photodegradation experiments were described by Porcal and Kopáček [4], documenting the different response of bacterial biomass in irradiated vs. control samples. The study was performed with water from the major tributary of Jiřická pond. In situ experiments were done to determine the effects of the photochemical degradation of DOM and subsequent formation of particulate matter on dissolved phosphorus concentrations in surface waters. After incubation, POC and particulate phosphorus (PP) were determined in both the filtrate and newly formed particles. The results revealed increasing concentrations of PP and POC in exposed samples with increasing exposure time (cumulative irradiation energy). Based on an enumeration of bacteria in the samples, we estimated the contribution of biotic and abiotic processes to the PP production. The biotic and abiotic PP productions were usually higher in exposed samples than in controls. The PP and POC production was affected by the properties of DOM, such as its humic content and freshness index. We show that the observed immobilization of dissolved P in bacteria and on photochemically-formed particles can contribute to a P limitation of primary production in headwater environments that receive waters rich in soil DOM.

The connection between environmental distribution of studied Limnohabitans lineages and DOM characteristics was described by Shabarova et al. [1]. The ecological relevance and factors shaping dynamics of Limnohabitans sp. were studied by fluorescence in situ hybridization. The double hybridization strategy, designed in this study using a 23S rRNA probe specifically targeting LimA and LimE and the already known16S rRNA probe R-BT-065 targeting LimBCDE lineages allowed the quantification of previously hidden LimA populations in environmental samples. This method applied on more than 1000 samples has shown high ecological relevance of LimA (detected in densities up to 20% of total cell counts in freshwater habitats). In contrast to already described preferences of Limnohabitans genus, highest densities of LimA were associated with terrestrial DOM sources. For example, in the Římov Reservoir, they were significantly more abundant at the riverine zone especially after flood events that introduced fresh terrestrial DOM. Statistical analyses of biological and physicochemical parameters obtained from small dynamic water bodies (e.g. Jiřická pond) confirmed a correspondence between LimA and allochthonous DOM, in opposite to lineages LimBCDE that were more related to algal primary production.

[1] Shabarova, T., Kasalický, V., Šimek, K., Nedoma, J., Znachor, P., Posch, T., Pernthaler, J., Salcher, M.M. 2017. Distribution and ecological preferences of the freshwater lineage LimA (genus Limnohabitans) revealed by a new double hybridization approach. Environmental Microbiology, 2017, 19 (3), 1296–1309.

[2] Porcal, P., Dillon, P.J., Molot, L.A. 2015. Temperature dependence of photodegradation of dissolved organic matter to dissolved inorganic carbon and particulate organic carbon. PLoS ONE 10, DOI:10.1371/journal.pone.0128884.

[3] Porcal, P., Frejlachová, K., Kopáček, J., Nedoma, J., Šavrdová, T. 2017. Photochemical cleaving of allochthonous organic-metal complexes contributes to phosphorus immobilization in surface waters. Chemosphere 167, 374–381.

[4] Porcal, P., Kopáček, J. 2018. Photochemical degradation of dissolved organic matter reduces the availability of phosphorus for aquatic primary producers. Chemosphere 193, 1018–1026.

*The research was supported by the Czech Science Foundation project No. 15-09721S (2015–2017), principal investigator **P. Porcal**.*

Changes in fish isotopic signals: linking land use and reservoir food webs

The primary goal of this project was to examine whether the stable isotope composition of freshwater top consumers (i.e., fishes) reflects the intensity of anthropogenic land use in reservoir catchments. We measured stable carbon and nitrogen isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) in fish scales recently collected in twenty Czech reservoirs that span a wide gradient of catchment land use. Consequently, we investigated the relationships between scale isotope values and various parameters of catchment land use and water quality. Fish scale $\delta^{15}N$ was strongly positively correlated with nitrogen concentrations in reservoir tributaries, and with the percentage of agricultural land and the human population density in reservoir catchments. These results indicate that nitrogen pollution from agricultural and domestic sources is consistently taken up through the reservoir food webs. In contrast, our analysis did not find a close association between scale $\delta^{13}C$ and the land use gradient. This is likely because the main sources of dissolved inorganic carbon varied widely among the reservoirs.

We also investigated the potential of archived fish scales as indicators of past ecological and environmental changes. To address this objective, we analysed for $\delta^{13}C$ and $\delta^{15}N$ in a unique long-term collection of fish scales originating from the Římov Reservoir – an ecosystem that has undergone well-documented historical changes in nutrient inputs and phytoplankton productivity. Immediately after reservoir filling in 1978, scale $\delta^{13}C$ and $\delta^{15}N$ values were relatively low but they increased rapidly over the next few years. The low initial $\delta^{13}C$ signal of fish scales indicates that shortly after filling the entire reservoir food web was probably substantially fuelled by carbon originating from the decomposition of flooded terrestrial organic matter. Fish scale $\delta^{13}C$ values were found highest in the late 1980s and the early 1990s, likely reflecting high autochthonous production of phytoplankton induced by elevated nutrient inputs from the catchment. Between the early 1990s and the present, the $\delta^{13}C$ of fish scales showed a declining trend that coincided with decreases in external nutrient inputs and in-reservoir primary productivity. Using long-term monitoring data of chlorophyll-*a* as a proxy for primary productivity, we tried to determine the possible relationship between reservoir primary productivity and fish scale $\delta^{13}C$ values. Before the correlation between inter-annual differences in scale $\delta^{13}C$ and chlorophyll-*a* was assessed, we adjusted the raw $\delta^{13}C$ values of fish scales for the so-called Suess effect – to take into account an accelerating decrease in $\delta^{13}C$ of atmospheric CO_2 caused by fossil fuel combustion. We found a significant positive relationship between scale $\delta^{13}C$ and chlorophyll-*a*, suggesting that the $\delta^{13}C$ signal of fish scales was controlled by reservoir primary productivity.

Our results provided novel insights into reservoir ecosystem processes, trophic functioning and nutrient cycling. Overall, our findings suggest that isotope values in fish scales can be useful indicators of human-induced environmental changes in freshwater ecosystems and their surrounding landscapes.

The research was supported by the Czech Science Foundation project No. 15-01625S (2015–2017), principal investigator ***M. Vašek****.*

Structuring effect of submerged macrophytes on trophic relationships and distribution of fish in deep lakes (MacFish)

The project objective was to gain a detailed understanding of the structuring effect that submerged macrophytes have on fish communities in deep lakes. In order to achieve this, two newly formed deep lakes of similar size and colonization history were contrasted, one with and the other without a well-developed community of submerged macrophytes. In order to achieve this, a plethora of different investigation methods were used, including diver observations, sampling of invertebrates, and sampling of fish with gillnets, trawling, longlines, electrofishing, echosounding and telemetry, with an emphasis on the non-lethal methods and covering all ontogenetic stages from fish larvae to mature adults.

The macrophyte community was found to influence the fish communities and shape the trophic interactions in several ways. In generalist fishes with different ontogenetic trajectories, we demonstrated how the succession of macrophyte vegetation, via its effects on the physical and biological complexity of the littoral zone and on the availability of small prey fish and zooplankton, can strongly influence individual niche variation, and hence the overall foodweb structures in lake ecosystems. Among the fish predators, both pike and wels were found to have a larger home range in the macrophyte-poor lake as compared to the macrophyte-rich lake. The difference was strongest in pike, which showed a clear reduction in activity as macrophytes developed in the macrophyte-poor lake, as well as an activity increase as macrophytes became reduced in the macrophyte-poor lake. This consistency in pike behaviour in the between lake contrast and within lake seasonal change provide strong evidence for the influence of the macrophyte community on pike habitat use and activity.

Over a three year period, the project has resulted in 4 book chapters, 12 impacted papers published or accepted for publishing, 7 impacted papers submitted, 21 oral or poster contributions on international conferences, 8 oral or poster contributions on national conferences, 6 reports for decision makers and stakeholders, 3 popularization papers and 9 presentations for broad public. Collaboration with partners from NINA (Norwegian Institute for Nature Research) helped to adopt new approaches, methods and technologies (particularly 3D acoustic positioning system and processing of spatio-temporal data) essential for the project success and FishEcU's future scientific growth.

*The research was supported by the Czech-Norwegian Research Programme CZ09 project No. 7F14316 (2014–2017), principal investigator **J. Peterka**.*

Data and Statistics

Regular monitoring of the Slapy and Římov Reservoirs: dissolved and dispersed substances in reservoir water

Annual and summer (April-September) 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 depths of 0.1 to 0.4 m at the deepest points of the reservoirs at three-week intervals, pre-filtered through a 200-μm polyamide sieve to remove large zooplankton, stored in the dark at 4 °C, and analysed within 48 hours 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.

Table 1: Annual (n=17) and summer (April–September; n=8) mean composition of the surface waters of the Slapy and Římov Reservoirs in 2017.

VARIABLES	UNIT	MEAN VALUES			
		Slapy		Římov	
		Annual	Summer	Annual	Summer
NO_3-N	μg l^{-1}	1764	1836	920	769
NO_2-N	μg l^{-1}	19	26	7.7	10.0
NH_4-N	μg l^{-1}	14	10	17	10
TON	μg l^{-1}	799	925	585	672
DON	μg l^{-1}	669	714	466	506
TN	μg l^{-1}	2595	2797	1530	1462
TP	μg l^{-1}	36.1	29.7	24.7	19.5
TDP	μg l^{-1}	21.2	10.8	14.1	9.1
COD	mg l^{-1}	21.7	23.4	17.7	19.5
DOC	mg l^{-1}	7.43	7.45	6.05	6.29
POC	mg l^{-1}	0.96	1.53	0.78	1.10
Ca^{2+}	mg l^{-1}	20.6	20.7	11.8	11.6
Mg^{2+}	mg l^{-1}	5.8	6.0	2.6	2.6
Na^{+}	mg l^{-1}	12.1	12.7	7.3	7.1
K^{+}	mg l^{-1}	4.0	4.1	2.2	2.1
SO_4^{2-}	mg l^{-1}	24.5	25.2	13.5	13.3
Cl^{-}	mg l^{-1}	16.6	17.3	7.3	7.0
Alkalinity (Gran titration)	meq l^{-1}	1.05	1.06	0.60	0.60
Conductivity at 25 °C	μS cm^{-1}	221	231	114	114

Regular monitoring of the Slapy and Římov Reservoirs: microbial characteristics, chlorophyl and zooplankton

Annual and summer mean concentrations of bacteria, protozoans and microzooplankton, as well as chlorophyll concentrations and zooplankton in the reservoirs (and inflows to Římov Reservoir), based on data by **M. Kaňová**, **M. Macek**, **R. Malá**, **P. Porcal**, **Z. Prachař**, **J. Seďa**, **K. Šimek**, **M. Šorf**, **M. Štojdlová**, **J. Vrba**, **K. Kocourková** and **P. Znachor** are shown in Table 2.

Table 2: Mean values of microbial characteristics, zooplankton and chlorophylla 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	bacteria DAPI	0 m	10^6 ml^{-1}	3.39	5.00
	het. nanoflag.	0 m	10^3 ml^{-1}	1.23	1.52
	chlorophyll a total	0–3 m	mg m^{-3}	10.64	17.87
	zooplankton abundance				
	Cladocera herbiv.	0–40 m	10^3 ind m^{-2}	761.6	1048.4
	Copepoda adult	0–40 m	10^3 ind m^{-2}	111.9	175.4
	total crustaceans adult	0–40 m	10^3 ind m^{-2}	876.2	1227.9
R	bacteria DAPI	0 m	10^6 ml^{-1}	3.05	4.16
	het. nanoflag.	0 m	10^3 ml^{-1}	1.10	1.51
	chlorophyll a total	0–4 m	mg m^{-3}	9.16	12.64
	chlorophyll a > 40μm	0–4 m	mg m^{-3}	4.04	5.31
	zooplankton biomass, protein N				
	Cladocera herbiv.	0–40 m	mg m^{-2}	74.5	96.0
	Copepoda	0–40 m	mg m^{-2}	51.7	66.8
	total crustaceans	0–40 m	mg m^{-2}	126.4	163.0
C	chlorophyll a	0 m	mg m^{-3}	3.67	3.39
M	chlorophyll a	0 m	mg m^{-3}	4.09	4.96

Projects

Projects financed by the Czech Science Foundation

2013–2017 Reg. code 13-00243S, Unveiling life strategies of selected groups of planktonic Betaproteobacteria in relationship to carbon flow to higher trophic levels (K. Šimek)

2015–2017 Reg. Code 15-04034S Do long-term zooplankton data in the Slapy Reservoir reflect land use and/or climate changes in the past 50 years? (J. Hejzlar, coordinated by Faculty of Science, USB České Budějovice)

2015–2017 Reg Code 15-24309S Long-term effect of fish reduction on Daphnia in a large reservoir. (J. Seďa)

2015–2017 Reg. Code 15-06721S The effect of solar light on key members of freshwater Betaproteobacteria. (P. Porcal)

2015–2017 Reg. Code 15-13750 Phytoplankton responses to environmental forcing. (P. Znachor)

2015–2017 Reg. Code 15-06625S Changes in fish isotopic signals: linking land use and reservoir food webs. (M. Vašek)

2015–2017 Reg. Code 15-12197S Factors regulating the phototrophic activity of freshwater community of Betaproteobacteria. (V. Kasalický)

2016–2018 Reg. Code 16-09381S Bioactive cyanobacterial lipopeptides: genome mining, detection, and structure-activity relationships (J. Mareš, coordinated by Centre ALGATECH, Institute of Microbiology of the CAS, v.v.i.)

2017–2019 Reg. Code 17-09310S Fishponds as models for exploring plankton diversity and dynamics of hypertrophic shallow lakes. (J. Nedoma, coordinated by Faculty of Science, USB České Budějovice)

2017–2019 Reg. Code 17-04828S Unveiling life strategies of uncultivated viruses in freshwater environments using metagenomics (Rohit Ghai)

2017–2019 Reg. Code 17-15229S Phosphorus dynamics in unmanaged terrestrial ecosystems: Links with nitrogen and carbon cycling (J. Kopáček)

2017–2019 Reg. Code 17-10493S Inside the leaf microbiome: bacterial and fungal endophytes in the context of ecosystem development (D. Sirová)

2017–2019 Reg. Code 17-05935S Role of changes in environmental chemistry on lake ecosystems at the Younger Dryas onset (E. Stuchlík, coordinated by Faculty of Science, Charles University, Prague)

Projects supported by the Czech Academy of Sciences

2016–2017 Proč zchudlo Lipno? Analýza rybí obsádky a rybářských úlovků pro efektivní management jezer. Lipno impoverished? Fish stock assessment for the effective fisheries management. (J. Kubečka)

2017–2018 Reg. Code JSPS-17-17 Unveiling flagellate and bacterial community dynamics and trophic interactions in two deep freshwater ecosystems by a unique methodological combination (K. Šimek)

Projects financed by the Technology Agency of the Czech Republic

2017–2020 Reg. Code TH02030633 Plovoucí zelené ostrovy, perspektivní alternativa pro zlepšení ekologického potenciálu a podporu rozvoje litorálních společenstev na vodních nádržích. Floating green islands, a perspective alternative for improvement of ecological potential and support of littoral habitats in water reservoirs (M. Hladík/J. Kubečka)

2017–2020 Reg. Code TH02030709 Vývoj technického opatření k zamezení migrace nežádoucích druhů ryb nad ÚN Lipno za účelem podpory obnovy populace pstruha obecného a perlorodky říční. Development of technical measure for protection of natural riverine fish stock against masive migration of undesirable fish species from Lipno Reservoir as encouragement of population of brown trout and freshwater pearl mussel Margaritifera margaritifera (M. Hladík/M. Muška)

International projects

2014–2017 Reg. Code 7F14316 Structuring effect of submerged macrophytes on trophic relationships and distribution of fish in deep lakes. Norway Funds (J. Peterka, M. Čech)

2016–2020 Co-creating a decision support framework to ensure sustainable fish production in Europe under climate change (ClimeFish H2020) (J. Kubečka)

Consultancies

2017–2018 Study of the limnological components of the ecosytem of Lake Medard – Libík (J. Peterka, P. Znachor)

2016–2017 Complex fish stock assessment of the three Biesbosch Reservoirs (De Gijster, Honderd en Dertig and Petrusplaat) (T. Jůza, J. Kubečka)

2016–2017 Fish stock assessment of Švihov Reservoir in 2016 (M. Šmejkal, J. Kubečka)

2016–2017 Fish stock assessment of Nýrsko, Karhov, Lučina Reservoirs (P. Blabolil, J. Kubečka)

2016–2017 Fish stock monitoring of the Lipno Reservoir (J. Kubečka)

Students' theses finished in 2017

Ph.D.

Blabolil Petr – Assessment of Czech water-bodies ecological potential based on fish community (Faculty of Science, University of South Bohemia, České Budějovice, supervised by J. Peterka)

Matoušů Anna – Aktivita a výskyt metanotrofních bakterií v povrchových vodách řeky Labe (Activity and occurrence of methane oxidizing bacteria in the water column along the River Elbe). (Faculty of Science, University of South Bohemia, České Budějovice, supervised by K. Šimek)

Šmejkal Marek – Ecology of top fish predators, European catfish and asp, with consequences to fish communities. (Faculty of Science, University of South Bohemia, České Budějovice, supervised by M. Prchalová)

Mgr. (Ing., M.Sc.)

Merzová Martina – Stav a role invazního mlže slávičky mnohotvárné (Dreissena polymorpha) ve vodárenské nádrži Želivka (State and role of invasive zebra mussel (Dreissena polymorpha) in the Želivka Reservoir). (Faculty of Agriculture, University of South Bohemia, České Budějovice, supervised by M. Říha)

Bc. (B.A.)

Pilsová Klára – Size exclusion chromatography – analytická metoda pro charakterizaci rozpuštěných organických látek (Size-exclusion chromatography – analytical method for characterization of dissolved organic matter). (Faculty of Science, University of South Bohemia, České Budějovice, supervised by P. Porcal)

Publications
(* authors from other institutions)

Papers in International Periodicals

2312 Alfreider, A.*, Baumer, A.*, Bogensperger, T.*, Posch, T.*, Salcher, M.M, Summerer, M.*, 2017: CO2 assimilation strategies in stratified lakes: Diversity and distribution patterns of chemolithoautotrophs. Environmental Microbiology, 19: 2754–2768.

2313 Al-Qahtani, A.A.*, Al-Anazi, M.R.*, Nazir, N.*, Ghai, R., Abdo, A.A.*, Sanai, F.M.*, Al-Hamoudi, W.K.*, Alswat, K.A.*, Al-Ashgar, H.I.*, Khan, M.Q.*, Albenmousa, A.*, Cruz, D.D.*, Bohol, M.F.F.*, Al-Ahdal, M.N.*, 2017: Hepatitis B virus (HBV) X gene mutations and their association with liver disease progression in HBV-infected patients. Oncotarget, 8: 105115–105125.

2314 Altman, J.*, Fibich, P.*, Šantrůčková, H.*, Doležal, J.*, Štěpánek, P.*, Kopáček, J., Hůnová, I.*, Oulehle, F.*, Tumajer, J.*, Cienciala, E.*, 2017: Environmental factors exert strong control over the climate-growth relationships of Picea abies in Central Europe. Science of the Total Environment, 609: 506–516.

2315 Andrei, A.-Ş., Baricz, A.*, Robeson II, M.S.*, Păuşan, M.R.*, Tămaş, T.*, Chiriac, C.*, Szekeres, E.*, Barbu-Tudoran, L.*, Levei, E.A.*, Coman, C.*, Podar, M.*, Banciu, H.L.*, 2017: Hypersaline sapropels act as hotspots for microbial dark matter. Scientific Reports, 7: 6150.

2316 Andrei, A.S., Pausan, M.R.*, Tamas, T.*, Har, N.*, Barbu-Tudoran, L.*, Leopold, N.*, Banciu, H.L*, 2017: Diversity and biomineralization potential of the epilithic bacterial communities inhabiting the oldest public stone monument of Cluj-Napoca (Transylvania, Romania). Frontiers in Microbiology, 8: 372.

2317 Balk H., Søvegjarto, B.S.*, Tušer M., Frouzová, J., Muška M., Draštík, V., Baran, R., Kubečka J., 2017: Surface-induced errors in target strength and position estimates during horizontal acoustic surveys. Fisheries Research, 188: 149–156.

2318 Baran, R., Jůza, T., Tušer, M., Balk, H., Blabolil, P., Čech, M., Draštík, V., Frouzová, J., Jayasinghe, A.D., Koliada, I., Mrkvička, T., Muška, M., Ricard, D., Sajdlová, Z., Vejřík, L., Kubečka, J. 2017: A novel upward-looking hydroacoustic method for improving pelagic fish surveys. Scientific Reports, 7: 4823.

2319 Bednařík, A.*, Blaser, M.*, Matoušů, A., Hekera, P.*, Rulík, M.*, 2017: Effect of weir impoundments on methane dynamics in a river. Science of the Total Environment, 584–585: 164–174.

2320 Beneš, F.*, Horecký, J.*, Senoo, T.*, Kamasová, L.*, Lamačová, A.*, Tátosová, J.*, Hardekopf, D.W.*, Stuchlík, E., 2017: Evidence for responses in water chemistry and macroinvertebrates in a strongly acidified mountain stream. Biologia, 72: 1049–1058.

2321 Blabolil, P., Boukal, D.S.*, Ricard, D., Kubečka, J., Říha, M., Vašek, M., Prchalová, M., Čech, M., Frouzová, J., Jůza, T., Muška, M., Tušer, M., Draštík, V., Šmejkal, M., Vejřík, L., Peterka, J., 2017: Optimal gillnet sampling design for the estimation of fish community indicators in heterogeneous freshwater ecosystems. Ecological Indicators, 77: 368–376.

2322 Blabolil, P., Říha, M., Ricard, D., Peterka, J., Prchalová, M., Vašek, M., Čech, M., Frouzová, J., Jůza, T., Muška, M., Tušer, M., Draštík, V., Sajdlová, Z., Šmejkal, M., Vejřík, L., Matěna, J., Boukal, D.*, Ritterbusch, D.*, Kubečka, J., 2017: A simple fish-based approach to assess the ecological quality of freshwater reservoirs in Central Europe. Knowledge and Management of Aquatic Ecosystems, 418: 53.

2323 Bonar, S.A.*, Mercado-Silva, N.*, Hubert, W.A.*, Beard, T.D. Jr.*, Dave, G.*, Kubečka, J., Graeb, B.D.S.*, Lester, N.P.*, Porath, M.*, Winfield, I.J.*, 2017: Standard methods for sampling freshwater fishes: Opportunities for international collaboration. Fisheries, 42 (3): 151–156.

2324 Cabello-Yeves, P.J.*, Ghai, R., Mehrshad, M., Picazo, A.*, Camacho, A.*, Rodriguez-Valera, F.*, 2017: Reconstruction of diverse Verrucomicrobial genomes from metagenome datasets of freshwater reservoirs. Frontiers in Microbiology, 8: 2131.

2325 Cabello-Yeves, P.J.*, Haro-Moreno, J.M.*, Martin-Cuadrado, A.B.*, Ghai, R., Picazo, A.*, Camacho, A.*, Rodriguez-Valera, F.*, 2017: Novel Synechococcus genomes reconstructed from freshwater reservoirs. Frontiers in Microbiology, 8: 1151.

2326 Carda-Diegez, M.*, Ghai, R., Rodriguez-Valera, F.*, Amaro, C.*, 2017: Wild eel microbiome reveals that skin mucus of fish could be a natural niche for aquatic mucosal pathogen evolution. Microbiome, 5: 162.

2327 Čech, M., Frouzová, J., Peterka, J., Jůza, T., Draštík, V., Vašek, M., Kubečka, J., 2017: Sampling of deep benthic perch fry: insight into the diel vertical migrations. Hydrobiologia, 784: 1–8.

2328 Devetter, M.*, Háněl, L.*, Řeháková, K., Doležal, J.*, 2017: Diversity and feeding strategies of soil microfauna along elevation gradients in Himalayan cold deserts. PLoS ONE 12 (11): e0187646.

2329 Draštík, V., Godlewska, M.*, Balk, H.*, Clabburn, P.*, Kubečka, J., Morrissey, E.*, Hateley, J.*, Winfield, I.J.*, Mrkvička, T., Guillard, J.*, 2017: Fish hydroacoustic survey standardization: A step forward based on comparisons of methods and systems from vertical surveys of a large deep lake. Limnology and Oceanography: Methods, 15: 836–846.

2330 Eloranta, A.P.*, Vejříková, I., Čech, M., Vejřík, L., Holubová, M., Šmejkal, M., Frouzová, J., Kiljunen, M.*, Jones, R.I.*, Peterka, J., 2017: Some like it deep: Intraspecific niche segregation in ruffe (Gymnocephalus cernua). Freshwater Biology, 62: 1401–1409.

2331 Estlander, S.*, Kahilainen, K.K.*, Horppila, J.*, Olin, M.*, Rask, M.*, Kubečka, J., Peterka, J., Říha, M., Huuskonen, H.*, Nurminen, L.*, 2017: Latitudinal variation in sexual dimorphism in life-history traits of a freshwater fish. Ecology and Evolution, 7: 665–673.

2332 Gabaldon, C., Devetter, M.*, Hejzlar, J., Šimek, K., Znachor, P., Nedoma, J., Seďa, J., 2017: Repeated flood disturbance enhances rotifer dominance and diversity in a zooplankton community of a small dammed mountain pond. Journal of Limnology, 76: 292–304.

2333 Gabaldón, C., Fontaneto, D.*, Carmona, M.J.*, Montero-Pau, J.*, Serra, M.*, 2017: Ecological differentiation in cryptic rotifer species: what we can learn from the Brachionus plicatilis complex. Hydrobiologia, 796: 7–18.

2334 Galica, T., Hrouzek, P.*, Mareš, J., 2017: Genome mining reveals high incidence of putative lipopeptide biosynthesis NRPS/PKS clusters containing fatty acyl-AMP ligase genes in biofilm-forming cyanobacteria. Journal of Phycology, 53: 985–998.

2335 Ghai, R., Mehrshad, M.*, Megumi Mizuno, C.*, Rodriguez-Valera, F.*, 2017: Metagenomic recovery of phage genomes of uncultured freshwater actinobacteria. The ISME Journal, 11: 304–308.

2336 Halačka, K.*, Muška, M., Mendel, J.*, Vetešník, L.*, 2017: A newly discovered population of the Balkan spiny loach Sabanejewia balcanica (Karaman, 1922) in the River Jihlava, Czech Republic. Folia Zoologica, 66 (3): 163–166.

2337 Hoetzinger, M.*, Schmidt, J.*, Jezberová, J.*, Koll, U.*, Hahn, M.W.*, 2017: Microdiversification of a pelagic Polynucleobacter species is mainly driven by acquisition of genomic islands from a partially interspecific gene pool. Applied and Environmental Microbiology, 83: e02266–16.

2338 Horňák, K.*, Kasalický, V., Šimek, K., Grossart, H.P.*, 2017: Strain-specific consumption and transformation of alga-derived dissolved organic matter by members of the Limnohabitans-C and Polynucleobacter-B clusters of Betaproteobacteria. Environmental Microbiology, 19: 4519–4535.

2339 Jarić, I., Roberts, D.L.*, Gessner, J.*, Solow, A.R.*, Courchamp, F.*, 2017: Science responses to IUCN Red Listing. PeerJ, 5: e4025.

2340 Jezberová, J., Jezbera, J., Znachor, P., Nedoma, J., Kasalický, V., Šimek, K., 2017: The Limnohabitans genus harbors generalistic and opportunistic subtypes: Evidence from spatiotemporal succession in a canyon-shaped reservoir. Applied and Environmental Microbiology, 83: e01530–17.

2341 Johansen, J.R.*, Mareš, J., Pietrasiak, N.*, Bohunická, M.*, Zima, J. Jr.*, Štenclová, L., Hauer, T.*, 2017: Highly divergent 16S rRNA sequences in ribosomal operons of Scytonema hyalinum (Cyanobacteria). PLoS ONE, 12: e0186393.

2342 Kalous, L.*, Kuříková P.*, Kohout, J.*, Rylková, K.*, Petrtýl, M.*, Čech M., 2017: Differences in spatial communities of European perch (Perca fluviatilis Linnaeus, 1758) fry in a canyon-shaped reservoir are not attributable to genetics. Journal of Applied Ichthyology, 33: 306–313.

2343 Koh, H.W.*, Hur, M.*, Kang, M.S.*, Ku, Y.B.*, Ghai, R., Park, S.J.*, 2017: Physiological and genomic insights into the lifestyle of arsenite-oxidizing Herminiimonas arsenitoxidans. Scientific Reports, 7: 15007.

2344 Komárek, J.*, Komárková, J., Ventura, S.*, Kozlíková-Zapomělová, E., Rejmánková, E.*, 2017: Taxonomic evaluation of cyanobacterial microflora from alkaline marshes of northern Belize. 3. Diversity of heterocytous genera. Nova Hedwigia, 105 (3–4): 445–486.

2345 Kopáček, J., Fluksová, H.*, Hejzlar, J., Kaňa, J., Porcal, P., Turek, J., 2017: Changes in surface water chemistry caused by natural forest dieback in an unmanaged mountain catchment. Science of the Total Environment, 584–585: 971–981.

2346 Kopáček, J., Hejzlar, J., Porcal, P., Posch, M.*, 2017: Trends in riverine element fluxes: A chronicle of regional socio-economic changes. Water Research, 125: 374–383.

2347 Kopáček, J., Kaňa, J., Bičárová, S.*, Fernandez, I.J.*, Hejzlar, J., Kahounová, M.*, Norton, S.A.*, Stuchlík, E., 2017: Climate change increasing calcium and magnesium leaching from granitic alpine catchments. Environmental Science & Technology, 51: 159–166.

2348 Křeček, J.*, Palán, J.*, Stuchlík, E., 2017: Acid atmospheric deposition in a forested mountain catchment. iForest-Biogeosciences and Forestry, 10: 680–686.
2349 Matěna, J., Matěnová, V.*, Blabolil, P., Kopáček, J., Peltanová, J.*, Šorf, M.*, Žaloudík, J., Vrba, J., 2017: Recovery of brown trout populations in streams exposed to atmospheric acidification in the Bohemian Forest. Folia Zoologica, 66 (1): 1–10.
2350 Matoušů, A., Osudar, R.*, Šimek, K., Bussmann, I.*, 2017: Methane distribution and methane oxidation in the water column of the Elbe estuary, Germany. Aquatic Sciences, 79: 443–458.
2351 Novotná, Z.*, Rimpelová, S.*, Juřík, P.*, Veselý, M.*, Kolská, Z.*, Hubáček, T., Borovec, J., Švorčík, V.*, 2017: Tuning Surface Chemistry of Polyetheretherketone by Gold Coating and Plasma Treatment. Nanoscale Research Letters, 12: 424.
2352 Novotná, Z.*, Rimpelová, S.*, Juřík, P.*, Veselý, M.*, Kolská, Z.*, Hubáček, T., Ruml, T.*, Švorčík, V.*, 2017: The interplay of plasma treatment and gold coating and ultra-high molecular weight polyethylene: On the cytocompatibility. Materials Science & Engineering C-Materials for Biological Applications, 71: 125–131.
2353 Pitsch, G.*, Adamec, A.*, Dirren, S.*, Nitsche, F.*, Šimek, K., Sirová, D., Posch, T.*, 2017: The Green Tetrahymena utriculariae n. sp. (Ciliophora, Oligohymenophorea) with its endosymbiotic algae (Micractinium sp.), living in traps of a carnivorous aquatic plant. Journal of Eukaryotic Microbiology, 64: 322–335.
2354 Poikane, S.*, Ritterbusch, D.*, Argillier, C.*, Białokoz, W.*, Blabolil, P., Breine, J.*, Jaarsma, N.*, Krause, T.*, Kubečka, J., Lauridsen, T.L.*, Nõges, P.*, Peirson, G.*, Virbickas, T.*, 2017: Response of the fish communities to multiple pressures: Development of a total anthropogenic pressure intensity index. Science of the Total Environment, 586: 502–511.
2355 Polívková, M.*, Hubáček, T., Staszek, M.*, Švorčík, V.*, Siegel, J.*, 2017: Antimicrobial treatment of polymeric medical devices by silver nanomaterials and related technology. International Journal of Molecular Sciences, 18: 419.
2356 Polívková, M.*, Siegel, J.*, Rimpelová, S.*, Hubáček, T., Kolská, Z.*, Švorčík, V.*, 2017: Cytotoxicity of Pd nanostructures supported on PEN: Influence of sterilization on Pd/PEN interface. Materials Science and Engineering C, 70: 479–486.
2357 Polívková, M.*, Štrublová, V.*, Hubáček, T., Rimpelová, S.*, Švorčík, V.*, Siegel, J.*, 2017: Surface characterization and antibacterial response of silver nanowire arrays supported on laser-treated polyethylene naphthalate. Materials Science and Engineering C, 72: 512–518.
2358 Porcal, P., Frejlachová, K.*, Kopáček, J., Nedoma, J., Šavrdová, T.*, 2017: Photochemical cleaving of allochthonous organic-metal complexes contributes to phosphorus immobilization in surface waters. Chemosphere, 167: 374–381.
2359 Řeháková, K., Čapková, K., Dvorský, M.*, Kopecký, M.*, Altman, J.*, Šmilauer, P.*, Doležal, J.*, 2017: Interactions between soil phototrophs and vascular plants in Himalayan cold deserts. Soil Biology & Biochemistry, 115: 568–578.
2360 Říha, M., Walsh, M.G.*, Connerton, M.J.*, Holden, J.*, Weidel, B.C.*, Sullivan, P.J.*, Holda, T.J.*, Rudstam, L.G.*, 2017: Vertical distribution of alewife in the Lake Ontario offshore: Implications for resource use. Journal of Great Lake Research, 43: 823–837.

2361 Saber, A. A.*, Cantonati, M.*, Mareš, J., Anesi, A.*, Guella, G.*, 2017: Polyphasic characterization of Westiellopsis prolifica (Hapalosiphonaceae, Cyanobacteria) from the El-Farafra Oasis (Western Desert, Egypt). Phycologia, 56: 697–709.

2362 Sajdlová, Z., Jůza, T., Frouzová, J., Seďa, J., Čech, M., 2017: Bathypelagic percid fry, a strongly predominating fry community in a deep European reservoir. Hydrobiologia, 787: 341–352.

2363 Shabarova, T., Kasalický, V., Šimek, K., Nedoma, J., Znachor, P., Posch, T.*, Pernthaler, J.*, Salcher, M.M., 2017: Distribution and ecological preferences of the freshwater lineage LimA (genus Limnohabitans) revealed by a new double hybridization approach. Environmental Microbiology, 19: 1296–1309.

2364 Shalygin, S.*, Shalygina, R.*, Johansen, J.R.*, Pietrasiak, N.*, Gómez, E.B.*, Bohunická, M.*, Mareš, J., Sheil, C.A.*, 2017: Cyanomargarita gen. nov. (Nostocales, Cyanobacteria): convergent evolution resulting in a cryptic genus. Journal of Phycology, 53: 762–777.

2365 Shevchenko, V.*, Mager, T.*, Kovalev, K.*, Polovinkin, V.*, Alekseev, A.*, Juettner, J.*, Chizhov, I.*, Bamann, C.*, Vavourakis, C.*, Ghai, R., Gushchin, I.*, Borshchevskiy, V.*, Rogachev, A.*, Melnikov, I.*, Popov, A.*, Balandin, T.*, Rodriguez-Valera, F*, Manstein, D.J.*, Bueldt, G.*, Bamberg, E.*, Gordeliy, V.*, 2017: Inward H+ pump xenorhodopsin: Mechanism and alternative optogenetic approach. Science Advances, 3: e1603187.

2366 Siegel, J.*, Lyutakov, O.*, Polívková, M.*, Staszek, M.*, Hubáček, T., Švorčík, V.*, 2017: Laser-assisted immobilization of colloid silver nanoparticles on polyethyleneterephthalate. Applied Surface Science, 420: 661–668.

2367 Šimek, K., Pitsch, G.*, Salcher, M.M., Sirova, D., Shabarova, T., Adamec, L.*, Posch, T.*, 2017: Ecological traits of the algae-bearing Tetrahymena utriculariae (Ciliophora) from traps of the aquatic carnivorous plant Utricularia reflexa. Journal of Eukaryotic Microbiology, 64: 336–348.

2368 Šmejkal, M., Baran, R., Blabolil, P., Vejřík, L., Prchalová, M., Bartoň, D., Mrkvička, T., Kubečka, J., 2017: Early life-history predator-prey reversal in two cyprinid fishes. Scientific Reports, 7: 6924.

2369 Šmejkal, M., Ricard, D., Vejřík, L., Mrkvička, T., Vebrová, L., Baran, R., Blabolil, P., Sajdlová, Z., Vejříková, I., Prchalová, M., Kubečka, J., 2017: Seasonal and daily protandry in a cyprinid fish. Scientific Reports, 7: 4737.

2370 Šorf, M.*, Cábová, M.*, Rychtecký, P., 2017: Environmentally-induced plasticity of life history parameters in the cladoceran Simocephalus vetulus. Limnologica, 66: 40–43.

2371 Stuchlík, E., Bitušík, P.*, Hardekopf, D.W.*, Hořická, Z., Kahounová, M.*, Tátosová, J.*, Vondrák, D., Dočkalová, K., 2017: Complexity in the biological recovery of Tatra Mountain lakes from acidification. Water, Air, and Soil Pollution, 228: 184.

2372 Tavşanoğlu, Ü.N.*, Šorf, M., Stefanidis, K.*, Brucet, S.*, Türkan, S.*, Agasild, H.*, Baho, D.L.*, Scharfenberger, U.*, Hejzlar, J., Papastergiadou, E.*, Adrian, R.*, Angeler, D.G.*, Zingel, P.*, Çakıroğlu, A.İ.*, Özen, A.*, Drakare, S.*, Søndergaard, M.*, Jeppesen, E.*, Beklioğlu, M.*, 2017: Effects of nutrient and water level changes on the composition and size structure of zooplankton communities in shallow lakes under different climatic conditions: a pan-European mesocosm experiment. Aquatic Ecology, 51: 257–273.

2373 Tlapáková, L*., Žaloudík, J., Kolejka, J.*, 2017: Thematic survey of subsurface drainage systems in the Czech Republic. Journal of Maps, 13: 55–65.

2374 Tušer, M., Picek, T.*, Sajdlová, Z., Jůza, T., Muška, M., Frouzová, J., 2017: Seasonal and spatial dynamics of gas ebullition in a temperate water-storage reservoir. Water Resources Research, 53 (10): 8266–8276.

2375 Valdespino-Castillo, P.M.*, Alcántara-Hernández, R.J.*, Merino-Ibarra, M.*, Alcocer, J.*, Macek, M., Moreno-Guillén, O.A.*, Falcón, L.I.*, 2017: Phylotype dynamics of bacterial P utilization genes in microbialites and bacterioplankton of a monomictic endorheic lake. Microbial Ecology, 73: 296–309.

2376 Vašek, M., Vejřík, L., Vejříková, I., Šmejkal, M., Baran, R., Muška, M., Kubečka, J., Peterka, J., 2017: Development of non-lethal monitoring of stable isotopes in asp (Leuciscus aspius): a comparison of muscle, fin and scale tissues. Hydrobiologia, 785: 327–335.

2377 Vejřík, L., Vejříková, I., Blabolil, P., Eloranta, A.P.*, Kočvara, L., Peterka, J., Sajdlová, Z., Chung, S.H.T., Šmejkal, M., Kiljunen, M.*, Čech, M., 2017: European catfsh (Silurus glanis) as a freshwater apex predator drives ecosystem via its diet adaptability. Scientific Reports, 7: 15970.

2378 Vejřík, L., Vejříková, I., Kočvara, L., Sajdlová, Z., Chung, S.H.T., Šmejkal, M., Peterka, J., Čech, M., 2017: Thirty-year-old paradigm about unpalatable perch egg strands disclaimed by the freshwater top-predator, the European catfish (Silurus glanis). PLoS ONE, 12: e0169000.

2379 Vejříková, I., Eloranta, A.P.*, Vejřik, L., Šmejkal, M., Čech, M., Sajdlová, Z., Frouzová, J., Kiljunen, M.*, Peterka, J., 2017: Macrophytes shape trophic niche variation among generalist fishes. PLoS ONE, 12: e0177114.

2380 Voráčová, K.*, Hájek, J., Mareš, J., Urajová, P.*, Kuzma, M.*, Cheel, J.*, Villunger, A.*, Kapuscik, A.*, Bally, M.*, Novák, P.*, Kabeláč, M.*, Krumschnabel, G.*, Lukeš, M.*, Voloshko, L.*, Kopecký, J.*, Hrouzek, P.*, 2017: The cyanobacterial metabolite nocuolin A is a natural oxadiazine that triggers apoptosis in human cancer cells. PLoS ONE, 12: e0172850.

2381 Vystavna, Y., Diadin, D.*, Grynenko, V.*,Yakovlev,V.*, Vergeles, Y.*, Huneau, F.*, Rossi, P.M.*, Hejzlar, J., Knöller,K.*, 2017: Determination of dominant sources of nitrate contamination in transboundary (Russian Federation/Ukraine) catchment with heterogeneous land use. Environmental Monitoring and Assessment, 189: 509.

2382 Vystavna, Y., Diadin, D.*, Yakovlev, V.*, Hejzlar, J., Vadillo, I.*, Huneau, F.*, Lehmann, M.F.*, 2017: Nitrate contamination in a shallow urban aquifer in East Ukraine: evidence from hydrochemical, stable isotopes of nitrate and land use analysis. Environmental Earth Sciences, 76: 463.

2383 Vystavna, Y., Frková, Z., Marchand, L.*, Vergeles, Y.*, Stolberg, F.*, 2017: Removal efficiency of pharmaceuticals in a full scale constructed wetland in East Ukraine. Ecological Engineering, 108: 50–58.

2384 Vystavna, Y., Hejzlar, J., Kopáček, J., 2017: Long-term trends of phosphorus concentrations in an artificial lake: Socio-economic and climate drivers. PLoS ONE, 12: e0186917.

2385 Vystavna, Y., Zaichenko, L.*, Klimenko, N.*, Ratsep, R.*, 2017: Trace metals transfer during vine cultivation and winemaking processes. Journal of the Science of Food and Agriculture, 97: 4520–4525.

2386 Weyhenmeyer, G.A.*, MacKay, M.*, Stockwell, J.D.*, Thiery, W.*, Grossart, H.P.*, Augusto-Silva, P.B.*, Baulch, H.M.*, De Eyto, E.*, Hejzlar, J., Kangur, K.*, Kirillin, G.*, Pierson, D.C.*, Rusak, J.A.*, Sadro, S.*, Woolway, R.I.*, 2017: Citizen science shows systematic changes in the temperature difference between air and inland waters with global warming. Scientific Reports, 7: 43890.

2387 Younginger, B.S.*, Sirová, D., Cruzan, M.B.*, Ballhorn, D.J.*, 2017: Is biomass a reliable estimate of plant fitness? Applications in Plant Sciences, 5: 1600094.

Proceedings or Monographs

2388 Ritterbusch, D.*, Argillier, C.*, Arle, J.*, Białokoz, W.*, Birzaks, J.*, Blabolil, P., Breine, J.*, Draszkiewicz-Mioduszewska, H.*, Jaarsma, N.*, Karottki, I.*, Krause, T.*, Kubečka, J., Lauridsen, T.*, Logez, M.*, Maire, A.*, Palm, A.*, Peirson, G.*, Říha, M., Szlakowski, J.*, Virbickas, T.*, Poikane, S.*, 2017: Water Framework Directive Intercalibration: Central-Baltic Lake Fish fauna ecological assessment methods; Part A: Descriptions of fish-based lake assessment methods; EUR 28022 EN. Luxembourg, Publications Office of the European Union, JRC Technical Report ISBN 978-92-79-59936-1: 95 p.

Papers and Books in Czech

2389 Blabolil, P., 2017: Hodnocení ekologického potenciálu českých nádrží na základě složení rybí obsádky – obhajená dizertační práce [Assessment of the ecological potential of Czech water-bodies based on fish communities – defended Ph.D. thesis]. Vodní hospodářství, 67 (8): 11–13.

2390 Blabolil, P., Stránský, J.*, 2017: Mládí v oboru [Youth in the discipline]. Vodní hospodářství, 67 (12): 26–29.

2391 Bojková, J.*, Bufková, I.*, Rádková, V.*, Soldán, T.*, Vrba, J., 2017: Jak se žije v revitalizovaných potocích na Šumavě [Life in the restored brooks in the Šumava Mts.]. Živa, 2017 (2): 74–76.

2392 Borovec, J., Jan, J., Hubáček, T., Tomková, I., 2017: Spojení výsledku analýz složení částic a pórové vody – nastavení rozhodovacích kritérií pro management sedimentů [Combining the results of particle and pore water analyzes – setting decision criteria for sediment management]. In: Hucko, P., Tölgyessy, P. (eds.) Zborník prednášok z VIII. Konferencie s medzinárodnou účasťou Sedimenty vodných tokov a nádrží, Bratislava, May 17–18, 2017. Slovenská vodohospodárska spoločnosť pri Výskumnom ústave vodného hospodárstva, ISBN 978-80-89740-13-0: pp. 255–260.

2393 Borovec, J., Jan, J., Vrzák, J.*, Knotek, J.*, 2016: Metodika lokalizace sedimentů a stanovení jejich vlastností za účelem sanace [Methodology for identification and quantification of sediments in water reservoirs]. Biologické centrum AV ČR, v. v. i., Č. Budějovice, ISBN 978-80-86668-41-3: 68 p.

2394 Borovec, J., Jan, J., Vrzák, J.*, Knotek, J.*, 2017: Metodika identifikace a kvantifikace sedimentů ve vodních nádržích [Methodology for identification and quantification of sediments in water reservoirs]. In: Hucko, P., Tölgyessy, P. (eds.) Zborník prednášok z VIII. Konferencie s medzinárodnou účasťou Sedimenty vodných tokov a nádrží, Bratislava, May 17–18, 2017. Slovenská vodohospodárska spoločnosť pri Výskumnom ústave vodného hospodárstva, ISBN 978-80-89740-13-0: pp. 95–100.

2395 Borovec, J., Torrijos, J.*, Jan, J., Dadejík, M.*, Borecký, K.*, Vrzák, J.*, 2017: Využití výzkumného sonaru pro stanovení mocnosti sedimentů [Use of a research sonar to determine sediment thickness]. In: Kosour, D. et al. (eds.) Sborník konference Vodní nádrže 2017, Brno, October 3–4, 2017. Povodí Moravy, s. p., ISBN 978-80-905368-5-2: pp. 132–134.

2396 Borovec, J., Vrzák, J.*, Knotek, J.*, 2017: Využití výzkumného sonaru pro stanovení mocnosti sedimentů [Use of a research sonar to determine sediment thickness]. In: Hucko, P., Tölgyessy, P. (eds.) Zborník prednášok z VIII. Konferencie s medzinárodnou účasťou Sedimenty vodných tokov a nádrží, Bratislava, May 17–18, 2017. Slovenská vodohospodárska spoločnosť pri Výskumnom ústave vodného hospodárstva, ISBN 978-80-89740-13-0: pp. 249–254.

2397 Hejzlar, J., Jarošík, J., Kopáček, J., Vystavna, Y., 2017: Koncentrace fosforu v nádržích Orlík a Slapy: výsledek socioekonomického vývoje v povodí a změny klimatu [Phosphorus concentration in the Orlík and Slapy reservoirs: a result of socio-economic trends in the catchment and climate change]. In: Kosour, D. et al. (eds.) Sborník konference Vodní nádrže 2017, Brno, October 3–4, 2017. Povodí Moravy, s. p., ISBN 978-80-905368-5-2: pp. 60–67.

2398 Jan, J., Borovec, J., Petráš, D.*, Osafo, N.*, Tomková, I., Hubáček, T., 2017: Vliv dostupnosti akceptorů elektronů na biogeochemické procesy a cyklus fosforu v sedimentu [Effect of terminal electron acceptors on biogeochemical processess and phosphorus cycle in sediment]. In: Kosour, D. et al. (eds.) Sborník konference Vodní nádrže 2017, Brno, October 3–4, 2017. Povodí Moravy, s. p., ISBN 978-80-905368-5-2: pp. 80–85.

2399 Kubečka, J., Boukal, D.*, Baran, R., Blabolil, P., Čech, M., Draštík, V., Frouzová, J., Hejzlar, J., Jůza, T., Matěna, J., Muška, M., Prchalová, M., Říha, M., Šmejkal, M., Tušer, M., Vašek, M., Vejříková, I., 2017: Může Lipno uspokojit všechny? [Can Lipno satisfy everyone]. Rybářství, 2017 (4): 52–54.

2400 Lusk, S.*, Hanel, L.*, Lojkásek, B.*, Lusková, V.*, Muška, M., 2017: Červený seznam mihulí a ryb České republiky [The Red List of lampreys and fishes of the Czech Republic]. Příroda, 2017 (34): 51–82.

2401 Muška, M., Blabolil, P., 2017: Zajímavý nález mihule potoční (Lampetra planeri, Cephalaspidomorphi: Petromyzontiformes: Petromyzontidae) v Českých Budějovicích [Notable record of the brook lamprey (Lampetra planeri, Cephalaspidomorphi: Petromyzontiformes: Petromyzontidae) in České Budějovice town, Czech Republic]. Sborník Jihočeského Muzea v Českých Budějovicích, 2017 (57): 127–130.

2402 Muška, M., Kortan, D.*, 2017: Nově zjištěný výskyt piskoře pruhovaného (Misgurnus fossilis, Actinopterygii: Cypriniformes: Cobitidea) v přírodní památce Tůně u Špačků u Českých Budějovic [New record of the weather loach (Misgurnus fossilis, Actinopterygii: Cypriniformes: Cobitidea) in the Tůně u Špačků Nature Monument near České Budějovice town]. Sborník Jihočeského Muzea v Českých Budějovicích, 2017 (57): 131–133.

2403 Petřík, P.*, Salzmann, K.*, Hejzlar, J., Pithart, D.*, Fanta, J.*, 2017: Voda v krajině a revitalizace [Water in landscape and revitalisations]. In: Vokurka, A. (ed) Sborník příspěvků z konference Krajinné inženýrství 2017, Praha, October 19, 2017. Ministerstvo zemědělství ČR, ISBN 978-80-263-1341-0: pp. 125–133.
2404 Šmejkal, M., Blabolil, P., Sajdlová, Z., 2017: Chemická signalizace ve vodním prostředí [Chemical signalization in aquatic environment]. Rybářství, 2017 (7): 48–49.
2405 Vejřík, L., Vejříková, I., Peterka, J., 2017: Mizející podmořské pralesy [Underwater forests are disappearing]. Rybářství, 2017 (5): 94–95.


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Flooded trees in Most Lake. / Zatopené stromy v jezeře Most. (Foto: J. Peterka)

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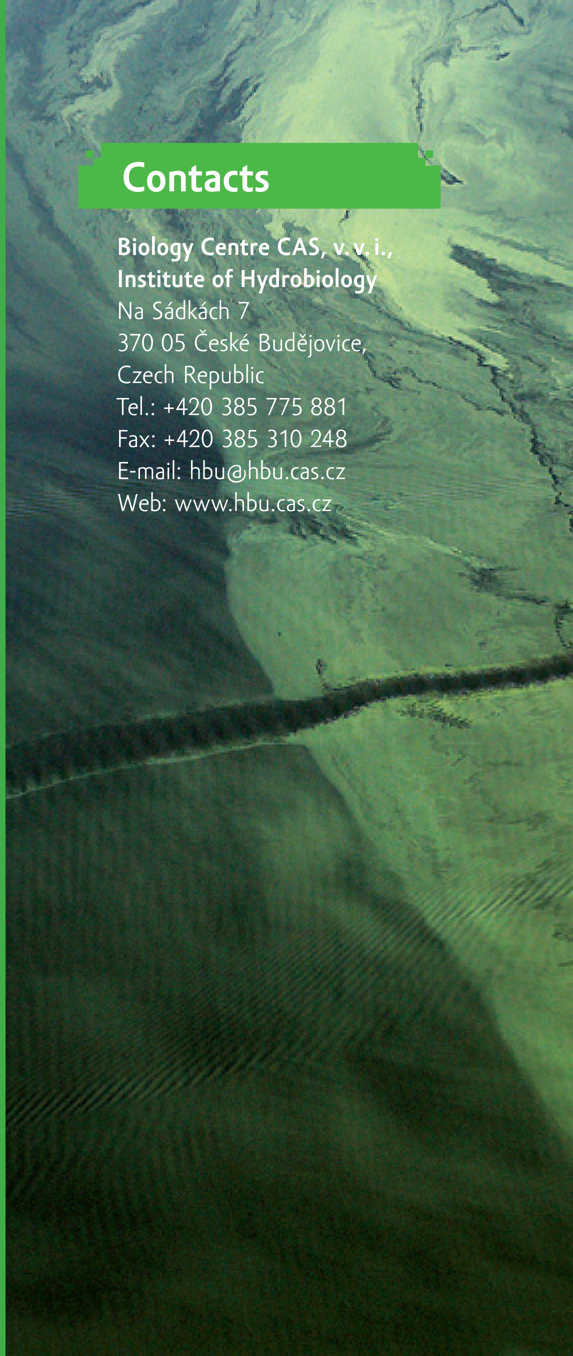

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