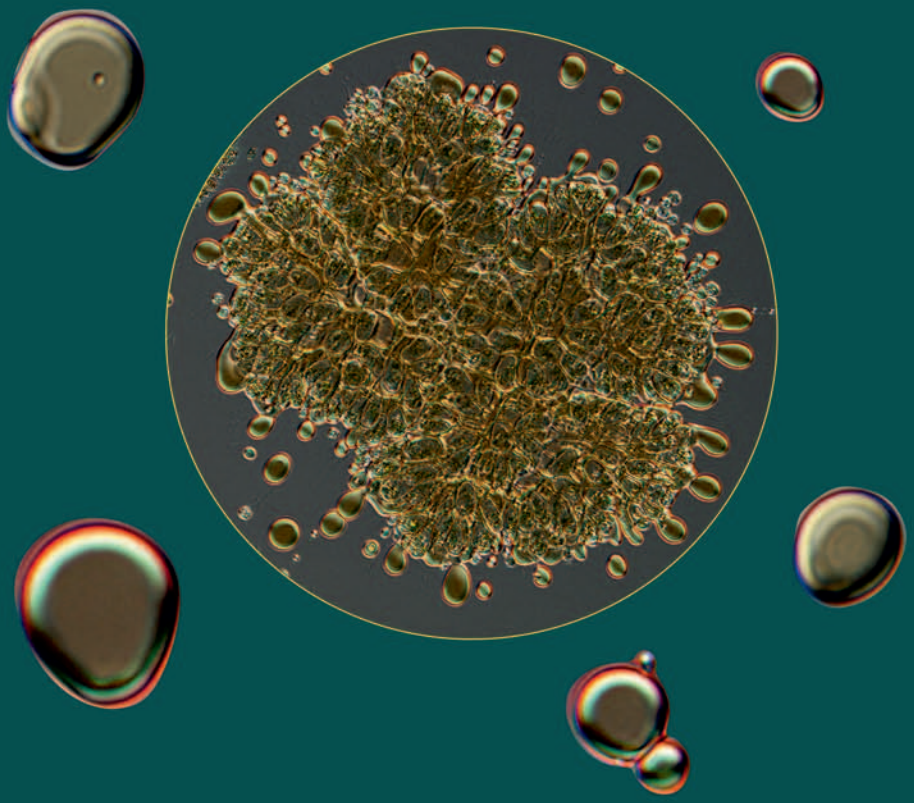
The 37th International Conference
of the Polish Phycological Society

Green future:
algae – applications and perspective

Abstract & Programme Book



Kraków, Dobczyce – Jałowcowa Góra
22–25 May 2018
Poland

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Organisers
Karol Starmach Department of Freshwater Biology of the Institute of Nature Conservation,
Polish Academy of Sciences, Kraków, Poland
Department of Phycology of the W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków, Poland
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a tribute to
Prof. dr hab. Halina Bucka

Dear Colleagues,

Welcome to Kraków and Dobczyce for the 37th International Conference of the Polish Phycological Society, which has been organized by the Department of Freshwater Biology of the Institute of Nature Conservation, Phycology Department of the Botany Institute, Polish Academy of Sciences and Polish Phycological Society.

The Conference is a tribute to prof. dr hab. Halina Bucka who was a great Polish scientist. She introduced many of us to the algae world, which was her great passion. The main topic of our meeting is 'Green future: algae – applications and perspectives'. We are pleased to announce that there are more than 100 participants registered from 15 countries, who will present results of their research and share ideas about algal biotechnology, ecology, biodiversity including molecular aspects. More than 90 contributors will present 33 oral presentations and 58 will be displayed as posters.

We will have an opportunity to see the oldest part of Jagiellonian University, founded in 1364 by the King of Poland Casimir III the Great. This is the oldest university in Poland and the second oldest in Central Europe. Travelling around the Old Market Square, which is one of the largest medieval town squares in Europe, everyone will be touched by the ghost of Polish history.

We hope that this conference will be both enjoyable and professionally rewarding for you.

On the behalf of Organising Committee
Elżbieta Wilk-Woźniak

Programme

Tuesday 22nd May, Kraków, Dobczyce – Jałowcowa Góra

8.00–13.30 Registration (Institute of Nature Conservation, Polish Academy of Sciences, Adama Mickiewicza 33 ave.)

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Plenary Session
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11.15–13.30

11.15–12.15 John Day
Building the algal biotechnology sector

12.15–12.45 Coffee break

12.45–13.30 Beata Messyasz
Characteristics and the importance of freshwater macroalgal biomass as a source of bioactive compounds

13.30–13.40 Kraków experience

13.40–14.00 Stroll through the old town

14.00–16.00 Lunch in the restaurant 'Morskie Oko', Plac Szczepański 8

16.00–18.00 Sightseeing: Collegium Maius, Main Market Square

18.30 Departure to the Conference venue Dobczyce **–** Jałowcowa Góra

19.30 Dinner

Wednesday 23rd May, Dobczyce – Jałowcowa Góra

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Commercial and environmental applications of microalgae: research activities at Arizona State University's Arizona Center for Algae Technology and Innovation (*AzCATI*)

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Pseudanabaena galeata – a source of novel anticancer metabolites

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A fresh analysis of the heavy metals in Spirulina

10.40–11.00 Monika Graczyk-Raczyńska
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12.10–12.40 Katarzyna Piwosz
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13.00–13.20 Katarzyna A. Palińska, Stjepko Golubic
Marine microbial endoliths: morphological vs. molecular diversity

13.20–13.40 Łukasz Łach, Iwona Jasser, Jan Kwiatowski
Testing 16S rDNA amplicon primers for environmental cyanobacteria diversity studies

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10.30–10.50 Xue Bai, Xu Chen
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Cyanobacterial diversity in microbial mats of the wetlands in the cold desert of the Eastern Pamir Mountains

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Non-steroidal anti-inflammatory drugs can affect the algal resting stage of Haema-tococcus pluvialis: a case study

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13.00–13.20 Ewa A. Dembowska
Impacts of hydrological conditions on the phytoplankton in the oxbow lakes in the Lower Vistula Valley

13.20–13.40 Elżbieta Wilk-Woźniak, Judita Koreivienė, Evanthia Mantzouki, Wojciech Krztoń, Edward Walusiak, Damian Chmura, Jūratė Karosienė, Jūratė Kasperovičienė, Ksenija Savadova, Irma Vitonytė et al.
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15.30–16.30 Poster session

16.30–18.30 Trip to Dobczyce Castel

18.30–19.30 General meeting of the members of the PPS

20.30 Banquet

Friday 25th May, Dobczyce – Jałowcowa Góra, Kraków

7.30–9.00 Breakfast

Departure

Plenary lectures

Building the algal biotechnology sector

John G. Day

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Algae are not a simple group of aquatic organisms, in reality they have been unilaterally 'lumped together' based on their 'aquatic nature' and capacity to photosynthesise. They are from phenotypic, phylogenetic, ecological and functional perspectives hugely diverse organisms and in comparison to those conventional employed in biotechnology, (classically well-studied taxa including bacteria such as *Escherichia coli* and yeast including *Saccharomyces cerevisiae*), they are relatively poorly studied. It is this diversity, in both microalgae and seaweeds, along with their capacity for photosynthesis, which provides opportunities for biotechnological exploitation. Although there are a variety of historical examples of commercial exploitation of algae, much of the potential has yet to be realised and this will be discussed in the talk. A key factor that will be highlighted is that over the past 15 years, we have had a phase of unparalleled R&D focussing on algae, and are on the brink of a new biotechnological revolution with applications of algal-derived biological-resources as varied as new pharma, cosmeceuticals, nutraceuticals, functional foods and future biofuels. I will briefly outline the current status of algal biotechnology and how the work at SAMS, associated with Culture Collection of Algae and Protozoa (CCAP), is underpinning and driving the development of this rapidly expanding sector in the UK and internationally.

Characteristics and the importance of freshwater macroalgal biomass as a source of bioactive compounds

Beata Messyasz

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Freshwater macroalgae are a morphologically, physiologically and biochemically diversified group, which contains many valuable components such as high amounts of saccharides, proteins, lipids, phenolics, amino acids, micronutrients, vitamins, and dietary fiber. An extract from macroalgal biomass is a mixture of different biologically active compounds. It should be noted that the factors, which influence the composition of algal extracts depend on the species, habitat conditions, season of the year, age, geographical location, and processing technologies. Within the filamentous green algae, *Cladophora glomerata* (L.) Kütz. is a cosmopolitan species, which occurs in a wide range of trophic states in morphometrically differentiated water reservoirs. Thus, *C. glomerata* is a model for using the properties of freshwater algal biomass as the source of bioactive compounds. Freshwater *C. glomerata* thalli were collected from the shallow Lake Oporzyńskie situated in the northern part of the Wielkopolska region (western Poland) during July – August of 2013–2016 when algal biomass (compact and dense mats) was at its annual maximum. In the thalli of *C. glomerata*, the fatty acid composition was at it peak of C16:0, C18:1 (n=9) (high values were also in marine mono- and multispecies biomass), C18:1 (n=7), C18:2 (n=6), C18:3 (n=3) and C18:3 (n=6), showing a wide range of biological activity. High antioxidant activity of the extract from *C. glomerata* resulted from a high content of phenol and polyphenol compounds. Moreover, ulvan (sulphated polysaccharides) presence in the freshwater alga means that *C. glomerata* can be a new natural raw product in a wide range of potential applications. Seasonal variability in the properties of *C. glomerata* was also analysed in relation to the physicochemical parameters of the water.

The study was supported by the National Science Centre grant No. 2014/13/B/NZ8/04690 and by the National Centre for Research and Development grant No. PBS/1/A1/2/2012.

Lectures

Non-steroidal anti-inflammatory drugs can affect the algal resting stage of *Haematococcus pluvialis*: a case study

István Bácsi[1], József Deli[2,3], Sándor Gonda[4], Ilona Mészáros[5], Gréta Veréb[6], Dalma Dobronoki[1], Viktória B-Béres[7,8], Gábor Vasas[4]

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An undesirable consequence of increasing drug use in human and veterinary medicine is the appearance of the drugs in both natural and potable water. Therefore, to study the effects of pharmaceuticals on non-target aquatic organisms is a recent issue both from ecological and economical point of view. In this study, the effects of three non-steroidal anti-inflammatory drugs (NSAIDs: diclofenac, diflunisal and mefenamic acid) on growth, cyst formation and associated physiological changes of the flagellated green alga, *Haematococcus pluvialis*, were investigated. All three drugs inhibited growth and inhibition ranged from 29 to 81% based on the vegetative cell numbers on the 14th day of the experiments. Higher concentrations of the drugs led to a higher proportion of cysts, which exceeded 60% of the total cell number by the 14th day in diclofenac and diflunisal treatments. On the contrary, astaxanthin (stored red ketocarotenoid) content decreased in treated cultures with an increasing drug concentration. Although the above-mentioned phenomena were significant only at higher drug concentrations (0.075–0.1 mg ml^{-1}), the new data suggested that micro-contaminants such as NSAIDs with diverse chemical structures may have different target points in physiological processes, and could lead to the defect of storage accumulation during the resting stage, resulting in potential ecological or economical risks.

Stomatocyst communities along environmental gradients in three montane peatlands in Central China

Xue Bai, Xu Chen

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Chrysophytes are sensitive to environment changes in alpine peatlands, within which acidic and oligotrophic conditions favor the proliferation of chrysophytes. Previous investigations of chrysophyte stomatocysts conducted in temperate and boreal regions provided basic knowledge on their morphology and distribution, while the subtropical areas have been less explored. Forty-nine *Sphagnum* samples were collected from three montane peatlands in Hubei Province, central China. Twenty-five morphotypes were identified using both SEM and LM according to the standards of three international atlases, including seven new morphotypes. Canonical correspondence analysis based on cyst composition and measured environmental variables showed that oxidation reduction potential (ORP), conductivity, depth to water table (DWT) and NO^{2-} are four significant ($p<0.01$) environmental variables for explaining variance in cyst composition. Along the water table gradient, stomatocysts 120 and 134 preferred wet hollows, while stomatocyst HB2 and Hansen #80 were abundant in dry hummocks. Along the ion strength gradient, stomatocysts 110, 181 and 187 thrived in the habitats with high conductivity. Our results showed that we can improve the knowledge of stomatocyst distribution in subtropical peatlands, and highlight their potential for monitoring peatland environmental changes.

Feeding mechanisms, cell fine structure and dinoflagellate phylogeny

António José Calado

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Heterotrophic and mixotrophic dinoflagellates consume food particles in a number of different ways. Some of these feeding mechanisms are associated with particular cell features that can be usually recognized by TEM examination of serially sectioned cells. In addition, cells that are feeding or attempting to feed often display recognizable behaviours. Some of the features associated with food uptake mechanisms seem to be plesiomorphic, whereas others display a much more restricted distribution and appear to be more recent. The detailed examination of structures potentially involved in food uptake often requires a good understanding of the organization of the whole ventral area, because of the close proximity between microtubular and fibrous flagellar root systems and some types of feeding apparatuses. Until the 1990's, dinoflagellate classification was dominated by a set of 'easily' visible, external characters, such as the presence of a cingulum and its path on the cell surface, or of well-defined plates and their arrangement. Our current understanding of dinoflagellate phylogeny is largely based on molecular markers and reveals important mis-mashes between the distribution of classical features and evolutionary units. Mapping details of flagellar root and pusular organization, as well as feeding mechanisms and related structures, onto the emerging phylogenetic scheme is the current challenge.

Pseudanabaena galeata – a source of novel anticancer metabolites

Marta Cegłowska[1], Agnieszka Felczykowska[2], Karolina Szubert[3], Alicja Kosakowska[1], Hanna Mazur-Marzec[1,3]

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Cyanobacteria are prolific producers of bioactive compounds (secondary metabolites). A significant number of these compounds are characterized by cytotoxic activity and activity against key metabolic enzymes. The first studies into biotechnological application of cyanometabolites were mainly focused on cyanobacteria from tropical regions. Recently, however, the biotechnological potential of cyanobacteria from temperate waters has been revealed. In or study, the activity of metabolites produced by the Baltic cyanobacterium, *Pseudanabaena galeata* CCNP1313, was investigated. The strain was isolated from the Gulf of Gdańsk (Southern Baltic Sea) and grown in culture. In the first stage of the studies, potent and selective antiproliferative activity of a crude extract tested against two cancer cell lines (MCF-7 breast cancer cells, and HeLa cervical cancer cells) was observed. The observed effects were dose-dependent. What is important, is that the healthy cells (HDFa human dermal fibroblasts) were found to be much less sensitive to the tested material than cancer cells. In the second stage of the studies, the extract was fractionated using flash chromatography and preparative chromatography with DAD and ELSD detectors. A potent cytotoxic activity of the collected fractions against breast cancer cell lines (T47D) was confirmed. Structure elucidation of the active agents was performed with a LC-MS/MS system. Based on the analyses, the detected compounds were classified as peptides.

The study was partially supported by the Polish State Committee for Scientific Research (grant No. NCN/2016/21/B/NZ9/02304) and by the statutory programme of the Institute of Oceanology, PAS (grant No. II.3).

Impacts of hydrological conditions on the phytoplankton in the oxbow lakes in the Lower Vistula Valley

Ewa A. Dembowska

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Compared to natural lakes, oxbow lakes show greater variation in water levels. All investigated oxbow lakes were created as a result of regulation of the Lower Vistula at the end of the 19th century. During the five-year research project, there were significant differences in water level, i.e. levels typical of the lower course of the Vistula (mean water levels – MWL) as well as water levels deviating from the norm: extremely high or low. These shifts had a major influence on planktonic algal communities. Isolation of the lake from the river had a negative impact on the biological diversity of its phytoplankton communities. Inflow of river water to the oxbow lake may increase or decrease the phytoplankton diversity, depending on the size and duration of the flooding. The type and degree of connectivity to the river affects the species composition, abundance and biomass of the phytoplankton in the lake. Extreme flood causes severe environmental stress, resulting in changes in the development of phytoplankton and macrophytes. Changes within plant communities lead to shifts in alternative stable states (from clean water state to turbid water state and *vice versa*). Changes in the phytoplankton abundance in lakes exposed to frequent shifts between limno- and potamophase are rather insignificant, while high biodiversity is stimulated by short-term, frequent disturbances.

Commercial and environmental applications of microalgae: research activities at Arizona State University's Arizona Center for Algae Technology and Innovation (AzCATI)

Thomas A. Dempster

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Indoor facilities at the Arizona Center for Algae Technology and Innovation (AzCATI) allow for high-throughput screening of 10's of strains and/or culture conditions simultaneously in our 2,000 m^2 laboratory facility. Our testbed has over 300,000 L of indoor and outdoor cultivation capacity spanning a wide variety of culture vessels, including open systems (i.e. vertical flat-panel PBRs and 1,000 – 100,000 L raceway ponds) and closed systems (i.e. closed Helix PBR and covered pond/horizontal bag-type reactors suited for GM algae testing). AzCATI offers extensive co-located analytical laboratory capabilities, including robust QA/QC analysis methods and instrumentation (GC, IC-HPLC, LC/MS/MS, elemental analysis) for rapid measurement of biomass producti-vity and composition (i.e. total lipid/FAME, starch/carbohydrate, amino acids/protein, pigments, CHONS, advanced microscopy) and extra-cellular nutrient levels (i.e. ICP, GC-FAME). ASU has also established processes for review and approval of large-scale (>10 L) cultivation of GM algae and has correspondingly received approval for outdoor studies in closed systems at scales of up to 4000 L. In the last 5 years, AzCATI has worked with approximately 75 different companies, universities and national laboratories to assist in the commercialization of microalgae biomass and high-value co-products. This presentation will provide a more detailed view of the AzCATI facility and brief overviews of several projects including the use of microalgae for biofuels, bioactive molecules, animal feeds, human dietary supplements, carbon capture from coal burning power plants and wastewater bioremediation.

Algae as food: nutritional, functional or simply tasty?

Monika Graczyk-Raczyńska

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With plenteous evidence on health benefits of algal and algae-derived food, recent years brought micro-, but also macroalgae, trending as nutritional food of the future, possible superfood. Rich in protein, vitamins, PUFAs and polysaccharides, algae are already widely applied in food industry. They are used not only in forms recognizable to consumers as seaweeds, but are also e.g. employed for the production of hydrocolloids, such as agar, alginate and carrageenan that are used as food additives and thickening and stabilisation agents in meals and beverages. Algal products have also been advertised as functional food, thanks to the allegedly beneficial phytochemicals, or bioactive compounds, proven in the *in-vitro* tests to have anti-inflammatory, antitumor and other therapeutic effects. The enormous growth of world population is close to exhausting the existing resources of food and thus has created a global demand for shift to plant-based nutrition and rediscovery of some of our old and almost forgotten food resources and diets. Possibly almost every human society that lived near any type of water reservoir used algae for food or at least as fodder, fertilizer or for medicinal purposes. Although most of the algal food that Europeans know are related to Asian cuisine and culture, archaeological studies show that seaweeds have been part of the human diet in the Western Hemisphere for thousands of years. Elements of that ancient tradition are still present in modern European cuisine of some regions, where we can find dishes prepared with such algae as dulse (*Palmaria palmata*), laver (*Porphyra umbilicalis*) or Irish moss (usually *Chondrus crispus*). However, despite a strong movement to introduce and serve algae to the European tables, they are still regarded as an exotic component of the menu.

Cyanobacterial diversity in microbial mats of the wetlands in the cold desert of the Eastern Pamir Mountains

Iwona Jasser[1], Małgorzata Sandzewicz[1], Sophia Kharachko[1], Nataliia Khomutovska[1], Małgorzata Suska-Malawska[1], Iwona Kostrzewska-Szlakowska[2], Jan Kwiatowski[3]

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Cyanobacteria are often main components of microbial mats, and especially in extreme environments they play an important role as primary producers. In wetlands, they may overgrow bottoms, edges and sometimes even surfaces of little pools and streams, forming mats of variable thickness, structure and texture. Because cyanobacteria, besides other secondary metabolites, may produce toxins, their presence may pose a threat for other organisms, including farm animals and humans relying on scarce water resources. Here we present the results of a study of about 40 mats collected in July 2017 from wetlands of a cold desert in the Eastern Pamir Mountains, Tajikistan. The ponds, streams and pools differed in temperature, salinity, nutrients and other environmental parameters, while the mats represented a range of types from thin, flat and deliquescent to spectacular, colourful and thick structures. We characterized the mats according to macroscopic features and identified cyanobacteria using microscopic analyses. We have found several taxa such as *Nostoc*, *Trichormus*, *Calothrix*, *Nodularia*, *Phormidium*, *Oscillatoria*, *Lyngbya* and *Leptolyngbya*, which belong to genera known for producing hepatotoxins and/or neurotoxins. We also looked for relationships between the type of mat, the diversity of cyanobacteria as well as the presence of potentially toxic taxa, and different environmental variables.

Do we need a Red List of microalgae? A way to compile the Red List of microscopic algae of the Czech Republic: the Euglenophyta model

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Nature, species, and biodiversity protection should be priority of every country. Publishing of Red Lists of animals or higher plants is quite common, but practical protection of algae and especially microalgae are rather complex tasks with several complications. These complications come from our poor knowledge on biodiversity (taxonomy, phylogeny) of microalgae together with insufficient data on their worldwide distribution (under sampling). The need to protect microorganisms, especially -microalgae and/or heterotrophic protists, is crucial due to their role as bioindicators and evaluation of the quality of their habitats. That is why it is necessary to have a Red List of these organisms as a practical manual for the protection of their habitat and subsequently also as a basis for the protection of these organisms. The microorganisms should not be viewed as rare species (in terms of their distribution, ecology or taxonomy), but as little-known species, and Red List would reflect this idea. We propose a Red List of microalgae with reflection on autecology of listed species with a combination of flagship species for endangered biotopes: habitat protection must be understood as a synonym for species conservation.

Former military area Brdy (Czech Republic) as a refugium of pristine freshwater within an agriculture landscape

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Brdy Protected Landscape Area (PLA) presents an extraordinary large area with very low human impact. The area served for more than 50 years as a military training area. During this period most remnants of settlement disappeared, which allowed development of undisturbed communities with very limited nutrient loading. The high quality of aquatic ecosystems, especially in the central part of the PLA is reflected in specific algal communities. In the frame of our study, we found 1122 taxa of phototrophic microorganisms, including new records for the country and several first records of occurrence outside *locus classicus*.

Biomineralization by cyanobacteria in endolithic habitats from Eastern Pamir

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The role of cyanobacteria in cold and hot desert ecosystems is significant, because of their primary production ability. Rock colonization is an adaptation evolved under extreme environmental conditions. Cyanobacteria penetrating rock substratum deeply are termed endoliths and are divided into three types: chasmoendoliths, cryptoendoliths and euendoliths. Rock penetrating microorganisms can cause mineralization. Because of the biomineralization, cyanobacteria play an important role in formation of mineral deposits such as carbonates, silicates and calcium-containing minerals. Extra- and intracellular biomineralization processes promoted by cyanobacteria have been studied by many investigators. Endolithic colonization of cyanobacteria including chasmoendoliths and cryptoendoliths is a widespread phenomenon in Eastern Pamir Mts., which we reported previously. However, the mechanisms of mineralization processes of Pamiran endoliths are not understood. This study is the first step of exploration of mineralization mechanisms induced by rock-inhabiting microorganisms in Eastern Pamir Mts. Fifty samples were collected in July 2017, among which granites and limestones dominated. In contrast to our previous study, we have also assembled pegmatites with clearly visible cryptoendolithic cyanobacterial colonization. In this study we present the diversity of endolithic cyanobacteria based on morphological analysis and sequencing of hypervariable regions of 16S rRNA gene. We applied scanning electron microscopy to recognize the relationships between minerals' crystals and the type of living cyanobacteria, as well as the rock chemical composition.

Why the biomass of *Cylindrospermopsis raciborskii* decreased significantly in the lake's phytoplankton in 2017?

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Cylindrospermopsis raciborskii is a diazotrophic, filamentous cyanobacterium common in tropical and subtropical regions. Due to its successful expansion of its range towards the temperate zone, it has been considered as an invasive species in many countries. In Poland, a common occurrence of this species in western regions was reported many times during the last decade. Several hypotheses have been proposed to explain this phenomenon, including climate change, phenotypic plasticity or occurrence of different ecotypes. Among environmental factors related to expansion of *C. raciborskii*, temperature and light conditions were frequently investigated. However, distribution patterns and factors driving its expansion still seem to be not fully understood. The aim of this study was to examine environmental factors responsible for a significant decrease of *C. raciborskii* biomass in 2017. Therefore, comparison of phytoplankton studies and physico-chemical properties of the aquatic ecosystem was conducted on eight lakes in western Poland during 2008–2017 period. The study showed that the biomass of *C. raciborskii* and its contribution to total phytoplankton biomass in 2017 was significantly lower when compared to 2014, 2013, 2010 and 2008. The biomass of this cyanobacterium ranged from 0.02–0.36 mg/l in 2017 while in earlier years it ranged from 0.03–3.12 mg/l. The maximum contribution of *C. raciborskii* biomass was almost five times lower than the maximum contribution in previous years. Water temperature, pH, visibility and other physico-chemical factors measured in 2017 did not differ significantly from values reported in previous years. However, according to Polish National Institute of Meteorology and Water Management (IMGW), the mean air temperature in 2017 was the lowest within the last four years while precipitation was significantly higher. Therefore, climatic conditions of the regions where the lakes are located seem to have had a strong influence on the biomass of *C. raciborskii*.

How long is the history of toxic phytoplankton blooms in Norwegian Fjords?

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Fjords are characteristic elements of the Norwegian coastline. They were formed thousands of years ago during the retreat of the glacier from the Scandinavian ice sheet. In our previous work, we detected *Nodularia spumigena* specific markers in deep sediments from the southern part of the Norwegian coast. The aim of the current study was to broaden our knowledge of the history and distribution area of toxic phytoplankton blooms in coastal waters of Norway. For the purpose of this study, four-m cores were collected from Oslofjorden (southern coast of Norway) and Balsfjorden (northern coast of Norway). The two stations are located in the areas characterized by different climatic and environmental conditions, which had an impact on the biological diversity of the ecosystems. Today, in this area, mainly the blooms of dinoflagellates, diatoms and haptophytes are recorded, and data on the occurrence of cyanobacteria are scarce. To reconstruct the history of toxic phytoplankton blooms in the Norwegian Fjords, specific molecular markers were applied. The occurrence of dinoflagellates and cyanobacteria was followed based on the analysis of saxitoxins and nodularin as well as the genes involved in their biosynthesis. The results of chemical and genetic analyses revealed for the first time that a thousand years ago, the toxic cyanobacterium, *Nodularia spumigena*, occurred in both places, i.e. in the coastal waters off Oslo and Tromsø. Saxitoxins were not detected in the sediments, but genetic markers indicated the permanent presence of dinoflagellates. Further studies are needed to elucidate what kind of processes and environmental conditions had an effect on the phytoplankton structure in Norwegian Fjords.

Prospecting of indigenous freshwater microalgae as a valuable regional resource

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Microalgae represent a very diverse group of organisms and are essential primary producers in freshwaters. They have a major importance both in terms of fundamental research and as natural resources useful to humans. Native algae are adapted to prevail under the regional conditions and pose no risk to become noxious invaders. Therefore, those species are primed for application to regional needs and should be investigated for their potential. Integration of fundamental knowledge with phycoprospecting of indigenous microalgae for various types of applications has been adapted for Lithuanian algae flora. Long term studies on local microalgae flora, species biology and ecological role provided a basis for the establishment of a culture collection of indigenous cyanobacteria and algae. Culture isolates are used for the investigations in two areas: i) to test wastewater remediation and simultaneous use of algae biomass for low-value products; ii) to study economically important algae and their high value biocompounds. To achieve these purposes, various species of coccoid algae were tested for their suitability for nutrient treatment from municipal, sugar factory and pig farm wastewater. Accumulated lipids, a source for biofuel production, were assessed in microalgae biomass by conventional and new methodology with fluorescent dyes. As high-value products, total fatty acid content in some cyanobacteria and algae was investigated using gas chromatography. *Haematococcus pliuvialis* strains were screened and culture conditions were optimized for biomass and astaxanthin accumulation. To enhance high-value products extraction, piezomechanical systems were tested for the microalgae cell wall disruption. The research revealed a high necessity for further investigations of indigenous microalgae as a valuable and relatively untapped bioresource and their importance not only for regional use but also for broader applications.

16S rDNA metagenomics as a method to investigate relationships between taxonomic composition of cyanobacteria and water quality

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In recent decades, an increase in anthropogenic pressure and climate change have exerted immense stress on freshwater habitats. The monitoring of phylogenetic diversity is crucial for understanding the human influence, through acceleration of eutrophication processes, on microbial communities. As new technologies become more accessible, validating new methods becomes an essential part of scientific research. Studies leveraging next-generation sequencing technologies can provide new insights into microbial ecology. We use 16S rDNA metagenomics as a method to explore taxonomical composition of prokaryotic organisms and to describe dominant cyanobacterial communities along a trophic gradient. During our studies, we investigated 15 diverse, interconnected lakes, belonging to the Great Mazurian Lake District, which exhibit a pronounced trophic gradient from mesotrophic to eutrophic. We looked at the relationships between taxonomical composition of cyanobacteria and various water parameters, and we looked for patterns that can help with monitoring and improving the quality of water reservoirs.

The hot spot in a cold environment: puzzling *Parvodinium* (Peridiniopsidaceae, Peridiniales) from the Polish Tatra Mountains

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Because of a great variety of remote localities and cold habitats, the Tatra Mountains are home to many freshwater protist lineages, including dinophytes. This group has been subjected to a number of studies from this area dating mostly to the first half of the 20th century, however their true diversity remains elusive until today. The authors collected water tow samples at five lakes in the Tatra Mountains in order to establish monoclonal strains. We found four lineages that were distinctive in terms of morphology and DNA sequence data and that could be assigned to the peridinialean *Parvodinium* clade. They can be readily distinguished based on a general shape, size, thecal plate tabulation pattern and presence or absence of an antapical protuberance. The plate overlap pattern is considered conserved at higher taxonomic levels, and the divergent keystone plate 3′ in *Parvodinium marciniakii*, sp. nov., thus appears as a crucial diagnostic characteristic. For taxonomic conclusion, we describe two species new to science (i.e. with antapical protuberance: *P. marciniakii*, sp. nov., and *P. trawinskii*, sp. nov.) and clarify three old scientific names (i.e. without antapical protuberance: *P. mixtum*, sp. nov., with the two varieties *P. mixtum* var. *conjunctum*, var. nov., and *P. mixtum* var. *remotum*, var. nov.). Our study emphasises that the biodiversity assessment, particularly of protist species adapted to cold environments, is anything but completed as shown from remote and unexplored European landscapes such as the Tatra Mountains.

Testing 16S rDNA amplicon primers for environmental cyanobacteria diversity studies

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The environmental diversity of cyanobacteria has traditionally been assayed using 16S rDNA sequences. The advent of next generation sequencing (NGS) allows for an amplicon metagenomic approach. However, using the standard V3–V4 amplicon fragment of 16S rDNA is not sufficient in obtaining a satisfactory answer with respect to cyanobacteria. In particular, the genetic differences within- and between-species are not traceable within this short fragment and usually it allows only for identification to the genus level. Exploring the observation that the V6 region variability is the most suitable to study cyanobacterial diversity, we are testing the set of primers covering the hypervariable regions V5–V7.We compare the specificity of already published and newly designed primer sets by in silico and in vitro analyses. Using these primers, we aim at quick detection of potentially toxic cyanobacterial species present in the environment and thus the prediction of hazards resulting from cyanobacterial toxic blooms, or toxic species present in microbial mats in natural and artificial environments, such as water tanks.

Limnospira gen. nov. (Cyanobacteria) – a next chapter in superfood`s history

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The genus *Arthrospira* is widely known for its utilization in the food industry mainly as food supplements or food additives. The commercial biomass production, in most cases under the incorrect name 'Spirulina', exceeds even twice the global market of *Chlorella* microalgae. Due to their utilization, most commonly studied species are *Arthrospira platensis*, *A. maxima* and *A. fusiformis* occurring in highly alkaline and saline environments. In our study, we have investigated the type species of the genus *Arthrospira* (*A. jenneri*) using a polyphasic approach. Samples of benthic mats were collected from an urban reservoir (pH 7.4, cond. 367 μS cm^{-1}), where *A. jenneri* grew as a high biomass throughout the year in the form of spiral and straight trichomes. Morphological observations and comparison of the 16S–23S ITS secondary structures confirmed that both types belong to single species of *A. jenneri.* The original description states that *A. jenneri* belongs to mat forming species without gas-vesicles grouped into aerotopes. However, detailed ultrastructural studies of both coiled and straight trichomes revealed the presence of aerotopes near the cross walls. To investigate the phylogenetic relationship between *A. jenneri* and other strains of *Arthrospira*, the 16S rRNA gene sequences of *Arthrospira* and other representatives of simple trichal cyanobacteria were obtained from GenBank. Phylogenetic analyses grouped *Arthrospira* sequences from GenBank (57 records) into a single homogenous cluster, closely related to *Lyngbya* representatives; while the sequences of *Arthrospira jenneri* obtained by us (17 records) formed a cluster related to *Kamptonema*, *Microcoleus* and *Tychonema* with low sequence similarity in the 16S rRNA gene to the *Arthrospira* group. Based on the molecular investigations and differences in ecology, we propose the establishment of a new genus, *Limnospira*, which would encompass the species *Arthrospira platensis, A. maxima*, *A. fusiformis*, *A. indica* and *A. erdosensis*, with a type species *Limnospira platensis*.

Marine microbial endoliths: morphological vs. molecular diversity

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A combined genotype-phenotype diversity analysis of endolithic microorganisms by pyrosequencing and microscopy was carried out across the intertidal and supratidal ranges of the Adriatic limestone coast. The coastal profiles represent ecotones between the sea and land, which express gradients of water supply, solar illumination, and salinity. The use of scanning electron microscopy imagery of resin casts showed that euendolith penetration remained shallow in the uppermost zones and was progressively deeper in the lower ranges where the water supply was more frequent. Microbial genotypes and phenotypes along the coastal profile showed large differences in dominance of taxa, but less in their diversity. The linkage between morphotypes observed along the profile and sequences was achieved by sequencing single cells/filaments, which were morphologically identified prior to their amplification. Molecular signatures of *Hormathonema* spp., *Hyella caespitosa*, *Scytonema endolithicum*, S*olentia paulocellulare* and *Kyrtuthrix dalmatica* were found on the profile and their specific placement was confirmed by morphological observations. A total of 13 cyanobacterial morphospecies and 17 genotypes were found. Most cyanobacterial sequences belonged to the Pleurocapsales (33%), only 2% of the sequences belonged to the Nostocales and Oscillatoriales. The sequences corresponding to the cyanobacterial genus *Hormathonema* exhibited the highest abundances among all detected sequences, which is consistent with the microscopic observations in other parts of the world. The results of our investigation underline the importance of a combined approach in comparing molecular data with microscopic observations in all phases of the study. Further RNA studies are needed to identify the actively growing parts of the endolithic community.

Survival of harmful cyanobacteria in the Bystrzyca river outflowing from a dam reservoir in Lublin City (E Poland)

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Perennial blooms of cyanobacteria in the Zemborzycki dam reservoir on the Bystrzyca river in Lublin have occurred for decades due to strong water eutrophication. The cyanobacterial assemblages consist of numerous potential toxin-producers belonging mainly to Nostocales, and Oscillatoriales, which develop in various proportions during the vegetative season. Due to the transfer of cyanobacteria from the reservoir to the outflowing river, their horizontal distribution and the capability of microcystin (MC) and anatoxin-a production were studied. The occurrence of harmful cyanobacteria in the river flowing in Lublin was detected in summer 2017 within a 10.5 km distance from the dam (in four sampling sites). The taxonomic composition of cyanobacteria in the river (14 species) was very similar to that in the reservoir (16 species) and did not change with the distance from the dam. Their total biomass was generally higher in August than in September. However, the biomass of various taxa decreased in the river to different extents. Generally, in the reservoir and river the biomass of Nostocales with strait trichomes (*Aphanizomenon* spp., *Cuspidothrix issatschenkoi*, *Sphaerospermopsis aphanizomenoides*) predominated, independent of water temperature. However, the contribution of *Planktothrix* spp. and *Cylindrospermopsis raciborskii* in the biomass was higher in September at 15°C than in August (at 20–25°C), while the contribution of other Nostocales with strait trichomes was 2-fold higher at the higher temperatures than at 15°C. The strongest decrease in the biomass of *Dolichospermum* spp. transferred to the river was found in August. Over the whole river segment and the period of investigation, 3 to 5 variants of intracellular MCs were found, with total concentrations of 1.5–11.8 μg MCs/L (0.32–0.95 μg MCs/mg of biomass). The neurotoxin anatoxin-a was detected only periodically (1.2 μg/L) in summer during the strongest development of Nostocales. The obtained results indicate that differences in water temperature accounted mainly for the composition of the harmful cyanobacterial phytoplankton in the nutrient-rich river.

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Getting insight into the invisible: application of molecular methods to study the ecology of pico- and nanophytoplankton

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Pico- and nanophytoplankton tend to dominate total phytoplankton abundance, biomass and primary production at global and annual scales. However, due to their inconspicuous morphology, which is, moreover, often unpreserved during fixation of environmental samples, their diversity, distribution and dynamics are still poorly described. The limitation of classical microscopic studies can be overcome by the application of molecular methods. These have already providedunpreceded insight into the diversity of pico- and nanophytoplankton. A set of tools is now available for high throughput, cost-effective analysis of pico- and nanophytoplanktonic communities at high taxonomic (18S rDNA-based) resolution (high throughput sequencing methods). However, these methods tend to obscure the real abundances of organisms present in the water, and they also do not provide any information on morphology. This limitation can be efficiently overcome by the detection of specific, 18S rDNA gene-defined groups by fluorescence in situ hybridization (FISH). In my talk, I will provide a short overview of both methods, present their advantages and disadvantages, and show how their use, either in combination or separately, can bring new light on the community structure, dynamics and function of pico- and nanophytoplankton, mainly using examples of my own research in the coastal waters in the Baltic Sea.

Screening microbial mats from the Eastern Pamir region for the presence of cyanotoxin coding genes

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Microbial mats are aggregations including prokaryotic and eukaryotic microorganisms. They occur at the borderline of two environments – terrestrial and aquatic – and can be found around the globe. Cyanobacteria are very important components of these structures. They are primary producers, performing oxygenic photosynthesis and some of them can fix atmospheric nitrogen. That makes them very good colonizers. However, some cyanobacteria produce toxins among other secondary metabolites, therefore their presence in mat communities can be potentially harmful for other organisms. About 40 mats were collected for this study from the Eastern Pamir Mountains, Tajikistan, in the summer of 2017. The studied region represents cold mountain desert with extreme environmental conditions: very cold and dry winters and cool, dry summers. The sites of sampling exhibited high variations of temperature and salinity. Water temperature in ponds, pools and streams, where the mats were sampled, ranged from 11 to 48°C while conductivity was between 270 and almost 80000 μS/cm^2. Analysis of water samples by ELISA strip tests indicated the presence of dissolved toxins in water above the mats: in five out of eleven samples in the case of microcystins and in three out of eleven samples in the case of anatoxins. No cylindrospermopsin was detected in eleven samples tested. Mats were further screened by classic PCR-based methods to find out which toxin-gene-clusters were present in the studied communities and which toxins could be potentially produced by these cyanobacteria. The studied toxin gene-clusters were: mcy – microcystin, nda – nodularin, cyr – cylindrospermopsin, sxt – saxitoxin and ana – anatoxin. No clear agreement was obtained between the presence of toxins and of genes for toxin biosynthesis in the studied samples. The relationship between potential for toxin production and environmental conditions was also analysed.

A fresh analysis of the heavy metals in *Spirulina*

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Spirulina has been recommended by commercial suppliers as a protein source, vitamin supplement, diet pill and as a treatment for anaemia (Johnson & Shubert 1986). In a previous investigation, Johnson & Shubert (1986) analysed eight different commercial samples of *Spirulina* for major, trace and heavy metals (including three multiple lots of one product), which were produced in the USA, Thailand, Mexico, Taiwan and/or Israel. All samples contained low levels of trace and heavy metals (Cd, Cr, Cu, Mn, Mo, Ni, Se, V, Zn). However, some samples contained elevated levels of mercury (9.1–24.4 μg/g Hg) and lead (1.3–6.7 μg/g Pb). *Spirulina* contained levels of mercury that exceeded FDA's 'prudent' limit. We selected three *Spirulina* commercial products (one of which was from the same producer as in the previous investigation). The products were produced in the USA and two other locations that were not identified. The commercial suppliers made similar claims about their products, but included 'reduces tiredness and fatigue', 'improved immune system function', 'cell protection', 'antioxidant protection', 'cardiovascular health', 'eye and brain health', 'anti-ageing benefits', and 'cellular health' (a disclaimer stated that 'these statements have not been evaluated by the Food and Drug Administration and is not intended to diagnose, treat, cure or prevent any disease'). A plant reference material was used to control the quality of digestion and analysis. The concentrations of Ag, As, Cd, Cr, Cu, Mn, Hg, Pb, V, and Zn, were analysed using ICP-MS (Agilent 7700x). The concentrations of metals were very low, including Hg (<0.005 μg/g). The level of lead was slightly elevated in two out of three samples (0.6–0.8 μg/g), which should be taken into account when compared with the FDA's maximum daily intake limit for lead (6 μg/day), FDA (2018). Thus, the *Spirulina* samples are safe with respect to heavy metal content. It would be speculative as to why the concentrations are lower in the current samples, but one could assume that the nutrient sources were controlled or changed.

FDA 2018. https://www.fda.gov/Food/FoodborneIllnessContaminants/Metals/ucm557424.htm
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The diatoms of high altitude lakes in the Black Sea Region, Turkey

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The Black Sea region has high mountains parallel to the shoreline. There are many high altitude lakes (>3000 m) in the eastern part of the region and springs are mostly isolated in the mountains. In this study, samples were collected from two high altitude lakes (about 3400 m) and some small streams flowing into the lakes in July 2015. As a result, the genus *Genkalia* and over 50 diatom taxa from the *Adlafia*, *Cavinula*, *Encyonema*, *Eunotia*, *Gomphonema*, *Luticola*, *Neidium*, *Psammothidium*, *Sellaphora* and *Stauroneis* genera are 'new record' for the Turkish freshwater diatom flora.

FOCUS. The biotechnological potential of marine natural resources – innovative e-learning courses

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The Earth is home to an estimated 10 million species, of which 80% live in the seas and oceans. This overwhelming dominance of marine natural resources constitutes a rich potential for biotechnological exploitation. Additionally, the wide diversity of environmental conditions (e.g. high pressure, high salinity and extreme temperatures) in which marine organisms can thrive, have activated new biochemical traits that are not yet well recognized. Among marine organisms, special attention is focused on macroalgae, microalgae, cyanobacteria and their products.

Marine biotechnology is a branch of biotechnology that makes use of marine natural resources and provides beneficial solutions for society. Many marine natural products are biologically active and are found to be useful in fighting diseases in modern society (e.g. cancer treatment) or in improving life quality. Value added products, namely food, feed, cosmetics, cosmeceuticals, nutraceuticals and finally pharmaceuticals are just some of the numerous examples.

Recently, a cross-border team including marine biotechnology specialists from Poland, Lithuania and Sweden, has started working on innovative e-learning courses (FOCUS project, Interreg South Baltic Programme) to enhance interest and spread the knowledge about marine biotechnology. A further aim of the project is to increase the employability of highly educated future workers.

The big challenge: an algal assessment of the ecological status of Austrian rivers

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In this oral presentation, I will firstly introduce you to the phytobenthos methods used in Austria. Afterwards, I will turn particularly to the all groups of benthic algae and describe some selected problems for phytobenthos assessment in Austria, such as the over-reliance on diatoms mainly to the exclusion of other groups, the (mis)understanding of measures of algal abundance, a definition of ecological classes and so on.

Cyanotoxins and their producers in the lakes of Central and Eastern Europe

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Climatic conditions are one of the important triggers for cyanobacteria proliferation, and also have an impact on species composition and distribution of cyanotoxins in the European freshwaters. The European Multi Lake Survey action draws the general pattern of cyanobacteria blooms presence and cyanotoxins across the continent based on snapshot sampling in a 2015 dataset of more than 300 lakes. The results indicated that temperature, through direct and indirect effects, was the main driver of cyanotoxin distribution and toxin quota (Mantzouki et al. 2018). The aim of this presentation is to analyse in more details the relations between cyanotoxin concentrations and structure versus cyanobacteria biomass and species composition based on data from more than 60 Polish and 15 Lithuanian lakes sampled in the summer of 2015. Microcystins were the most regularly found type of toxin, with the concentration up to 21.6 μg/L in Polish and 5.67 μg/L in Lithuanian lakes. They were found in 74% of Polish lakes and in 86% of Lithuanian lakes. Cytotoxic cylindrospermopsin and neurotoxic anatoxin-a were found to be less frequent: cylindropsermopsin in 53% of Polish and Lithuanian lakes, with the concentration up to 2.00 μg/L and 0.38 μg/L, respectively and anatoxin-a in 42% of Polish and in 60% of Lithuanian lakes, with the concentration up to 1.41 μg/L and 2.71 μg/L, respectively. The relation between the environmental variables, cyanotoxins and their potentially producers will be discussed.

Mantozuki E. et al. 2018. Temperature effects explain continental scale distribution of cyanobacterial toxins. Toxins 10(156): 1–24.

Can we use algal communities cultivated on wood chips in road soil protection against high salinity?

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One of the most onerous pollutants of the natural environment, both water and soil, is the increase in salinity that is most often generated during winter as a result of de-icing of roadways in large urban conurbations. The so-called road salt used for this purpose is almost pure sodium chloride (NaCl 90–97%). Its toxic effects on soils, groundwater and plant growth have concerned environmental scientists and ecologists for decades and have been the subject of many studies. Protection of roadside plants is mainly achieved by using physical barriers with a limited capacity to retain road salt. One of the currently tested solutions in Poland is ODSALAX technology. This captures the harmful salt by means of a system of retention and transfer trays filled with absorbent based on *Salix viminalis* L. chips. Our team has entered into cooperation with the ALCOR company to increase the effectiveness of ODSALAX and check how the desalination process can be improved by algae. The main objective of our joint research is therefore to answer the question of which selected algae, mainly chlorophytes and/or cyanobacteria, can be used to enhance the absorbing properties of willow chips, and thus whether algal communities can actively support the technology for capturing and utilizing road salt. Our pilot studies are conducted in laboratory conditions and include: 1) analysis of algal communities occurring in soil samples taken before using ODSALAX and willow chips; 2) analysis of the development of aerophyte taxa (*Nostoc commune* Vaucher ex Bornet & Flahault, *Chloroccocum*, *Klebsormidium* and *Stichococcus*) on willow chips and additionally pine sawdust. We observed that after 2 months the taxa used did not inhabit the surface of the chips but two species of fungi *Penicillium* sp. and *Aspergillus* sp. were growing.

This study was partly supported by the statutory funds of the W. Szafer Institute of Botany, Polish Academy of Sciences.

Differences and similarities of algal communities occurring in bromeliad tanks living in natural and semi-natural environments

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Phytotelemata, including bromeliads, provide terrestrial microhabitats for the growth of both aquatic and terrestrial organisms. This group of plants is increasingly researched as a model ecosystem. There are many studies about organisms of different trophic levels found in these kinds of niches, from viruses, bacteria, fungi and protozoa, to insects such as beetles, ants and especially mosquito larvae, and even frogs and lizards. Bromeliad tanks also provide habitats for algal development. The data for algae inhabiting tanks come from natural environments in the Neotropical zone, but Bromeliaceae are also components of semi-natural environments, as they are very often planted at different sites, including botanical gardens across the world. We found Bromeliaceae in Thailand, Southeast Asia. Here we describe the diversity of algae in terrestrial bromeliad tanks at the Queen Sirikit Botanical Garden, Chiang Mai, Thailand. We also compare the algal community of the studied bromeliad tanks to the data from Neotropical habitats. We studied about 40 samples of algae for occurrence and water characteristics. In 21 bromeliad tanks we identified 77 algal taxa. The most species-rich were the green algae (38 taxa), followed by euglenoids (16), diatoms (11) and cyanobacteria (8 taxa). There were fewer chrysophytes (2 taxa) and cryptophytes (2 taxa). Only a few taxa were recorded as dominant, including *Dictyosphaerium sphagnale* Hindák, *Oedogonium* sp., *Euglena mutabilis* F. Schmitz, *Astasia parvula* Skuja and *Eunotia* sp. We found single specimens of *Willea neglecta* (Fott & H. Ettl) John, Wynne & Tsarenko, *Mucidosphaerium sphagnale* (Hindák) C. Bock, Proschold & Krienitz, *Oedogonium curvum* Pringsheim ex Hirn and *Peranema sacculus* Christen, which are rarely reported worldwide. Our research confirms earlier observations that high content of NO_3^- and NH_4^+ compounds in the water of bromeliad tanks and the stable ambient conditions in greenhouses ensure abundant development of cyanobacteria and algae.

The authors thank the Queen Sirikit Botanical Garden for providing access to the study area. This study was partly supported by the statutory funds of the W. Szafer Institute of Botany, Polish Academy of Sciences.

Sponsors presentations

Cavity Ring-Down Spectroscopy (CRDS)

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Applications requiring trace gas analysis include environmental monitoring, emissions monitoring, greener automotive engine development, semiconductor fabs, cleanroom technology and bio-pharmaceutical process monitoring. All these applications can benefit from a turnkey analyzer that provides real-time speed, high precision and sensitivity to parts per billion and beyond. And, from a practical standpoint, the ideal trace gas analyzer requires minimal or no sample preparation or dilution, and is contained in a rugged, compact platform with low operating costs. Specifically, the latter means no need for a trained technician and, optimally, the capability for remote, unmanned operation.
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Posters

Potential use of morphological traits and newly developed functional groups of benthic algae in analyses of freshwater ecosystems

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Even though functional approaches in benthic algal assemblages started quite recently, their use to explain ecosystem functioning in freshwater is beyond dispute. Using ecologically relevant features of organisms enables (i) to compare effectively and efficiently habitats with different species composition; (ii) to avoid uncertainty due to taxonomically problematic species groups; (iii) to compare easily assemblages with high taxa number and (iv) to highlight general phenomena in ecosystem changes in context with climatic changes and natural or anthropogenic disturbances. In our studies, community dynamics of benthic diatoms were analysed in lowland watercourses based on the changes of morphological traits and functional groups. Our results pointed out, although trait dynamics were strongly connected to environmental variables, traits themselves are not applicable to indicate complex ecological processes. In contrast, we worked out a flexible and fine-scale functional classification system (combined eco-morphological functional groups, CEMFGs) which is suitable for understanding such kind of stochastic processes like colonisation. Furthermore, it also allows analysing of spatial and temporal changes in benthic algal assemblages.

Diatom assemblages in rivers differing in extent of their anthropogenic transformation (Upper Silesia and adjacent areas, southern Poland)

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The study was conducted in summer 2017 and involved sampling five sites located in rivers affected by industrial activities in the Upper Silesian industrial region and adjacent areas. Anthropogenic effects were visible primarily as alteration of the rivers' physical and chemical characteristics as well as the morphology of the river sections visited. Phytobenthos samples were collected from 25 cm^2 of the bottom in the initial stretch of the Centuria River (unaltered site), the downstream reach of the Mitręga River (the river is channelled, with fascine-reinforced banks and a dam reservoir); the downstream reach of the Mleczna River (the river is channelled, with fascine-reinforced banks and indirect supply of mine waters); and two sections of the Bolina River (the river is channelled, with banks and bottom variously reinforced; very heavy, but varying, pressure of mine water supply). The sites differed in the riverbed characteristics, water temperature and salinity, concentration of ammonium and phosphates in the water, and oxygen regime, but were fairly similar in terms of water pH.
The Bolina and Mleczna sites, characterised by the highest salinity (7–12 PSU in the up- and 16–34 PSU downstream of the Bolina, and 3–5 PSU of the Mleczna), showed a relatively low taxonomic richness (22 and 32 taxa in the up- and downstream reaches of the Bolina, respectively, and 23 taxa in the Mleczna). The phytobenthos was dominated by species typical of brackish and marine water: *Pleurosira laevis* var. *laevis* and var. *polymorpha*, *Ctenophora pulchella*, *Achnanthes brevipes* var. *intermedia*, *Halamphora coffeiformis*, *H. luciae*, *Navicula salinarum*, *Gyrosigma attenuatum* and *Pleurosigma salinarum*. The initial stretch of the Centuria and the downstream section of the Mitręga supported much higher taxonomic richness (55 and 70 taxa, respectively), the Centuria showing the presence of species typical of oligotrophic and oligosaprobic waters as well as those highly tolerant of trophic conditions, saprobic status, and nutrient contents (the dominants included *Planothidium dubium*, *Cocconeis pseudothumensis*, *C. neothumensis*, *Karayevia clevei*, *Amphora inariensis* and *Achnanthidium minutissimum* var. *minutissimum*). The taxa present in the Mitręga River were typical cosmopolitan ones, found in various types of water, but occurring quite frequently in waters of an elevated trophic status (no distinct dominants). The diatom flora at all the five sites sampled was found to closely reflect the extent of anthropogenic alteration of the environment.

Plastid-encoded *rbc*L phylogeny suggests widespread distribution of *Galdieria phlegrea* (Cyanidiophyceae, Rhodophyta)

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This study describes the discovery of the rare microscopic red alga *Galdieria phlegrea* (Cyanidiophyceae, Rhodophyta) in the extremely acidic habitats in Czechia and Spain. Taxonomic affiliation to *G. phlegrea* was revealed by plastid-encoded *rbc*L gene phylogeny. The same analysis demonstrated that the alga is closely related to other *G. phlegrea* strains originating from different extreme habitats in Italy and Turkey suggesting its wider distribution and ecological versatility than previously thought.

Perspectives on the use of algae as biological indicators for monitoring

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Algae are an ecologically important group of the most aquatic ecosystems and an important component of biological monitoring programmes. Algae are ideally suited for water quality assessment because of their fast reproduction rate and very short life cycle that make them valuable indicators of short-term impacts. Algal assemblages are typically species rich; algal species are also widely spread among ecosystems and geographical regions. Algae as primary producers are directly affected by physical and chemical factors. Algal assemblages are sensitive to some and readily accumulate some pollutants, and the algal metabolism is also sensitive to environmental disturbances. Algae are easily cultivated in laboratory conditions. The sampling of algae is straightforward, inexpensive and creates minimal impact on resident biota. Standard methods for evaluation of the functional and non-taxonomic structural characteristics of algal communities exist. Alterations and shifts in the species composition and productivity of algal assemblages in response to anthropogenic stresses should be considered in order to predict the effects on food interactions and other ecosystem components. Thus, for the biomonitoring of Bilikol Lake's (Kazakhstan) ecological situation, microalgal species composition and saprobic-indicator species were investigated; saprobity index was calculated according to the Pantle-Buck method. The number of algae identified in Bilikol Lake totals 102 species and subspecies. We have defined 4 divisions, 9 classes and 102 species of 32 genera. According to the results of the research, the algocenosis of Bilikol Lake was characterised by the predominance of green algae, with protococcus algae of the *Scenedesmus* and *Chlorella* genera being dominant. Among diatoms, representatives of the *Navicula*, *Fragilaria* and *Synedra* genera were dominant.

In the results of the analysis of certain indicator-saprobic microalgae species, the authors identified the presence of 29 indicators in Bilikol Lake. So, the composition of indicator-microalgae species in Bilikol Lake characterises the reservoir as α-mesosaprobic zone of organic contamination. The saprobity index according to the Pantle-Buck method is equal to 3.41. Bilikol Lake belongs to the class of eutrophic waters according to the comprehensive ecological classification of surface water quality on the abundance of phytoplankton.

Co-occurence of invasive species *Cylindrospermopsis raciborski*i with other species of cyanobacteria in eutro- and hypertrophic lakes of Wielkopolska region

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Cylindrospermopsis raciborskii (Wołoszyńska) Seenayya et Subba Raju 1972 is a freshwater, planktonic filamentous cyanobacterium, which belongs to the Nostocales order. For the first time it was observed in 1912 on the island of Java in Indonesia and originally it was considered as a tropical and subtropical species. The geographic range of the species has extended into the temperate zone over the years. The reason of such a noticeable expansion of this species is frequently related to: climate change, eutrophication, phenotypic plasticity and the existence of different ecotypes.
The purpose of this research was to recognize dominant and co-occurring cyanobacteria with *C. raciborskii*. The research was conducted in the north-west of Wielkopolska region during summer of 2016. The samples were collected from 17 lakes in the Wielkopolska region. Quantitative and qualitative analyses of phytoplankton were carried out. Phytoplankton composition and contribution of *C. raciborskii* in the total abundance of phytoplankton and the total phytoplankton biomass was determined. *C. raciborskii* was observed in 12 out of 17 lakes. Biomass of *C. raciborskii* ranged from 0.05 to 5.40 mg/L. The share of *C. raciborskii* biomass in the total phytoplankton biomass ranged from 0.19% to 36.68%. In lakes with high contribution of *C. raciborskii* in total phytoplankton biomass (over 5%) the following species of cyanobacteria dominated: *Planktothrix agardhii*, *Aphanizomenon gracile*, *Limnothrix redekei*, *Geitlerinema amphibium*, *Jaaginema subtilissimum*, *Planktolyngbya limnetica*, *Cuspidothrix issatschenkoi*. In lakes with low contribution of *Cylindrospermopsis raciborskii* in total phytoplankton biomass (below 5%) also filamentous cyanobacteria commonly occurred including: *Planktothrix agardhii*, *Pseudanabaena limnetica*, *P. catenata*, *Aphanizomenon flos-aquae*, *A. gracile*, *Planktolyngbya limnetica*, *Geitlerinema amphibium*. However, higher contribution of chroococcal cyanobacteria, among others: *Merismopedia glauca*, *M. punctata*, *Chroococcus minutus*, *C. minimus* was observed. Moreover, in lakes without *Cylindrospermopsis raciborskii*, similarly to the lakes with low contribution of *C. raciborskii*, abundant occurrence of chroococcal cyanobacteria from genera: *Chroococcus* sp., *Merismopedia* sp., *Coelomoron* sp., *Eucapsis* sp. was observed.

Current ecological plasticity of the rare macroalga *Lychnothamnus barbatus* and its future application as a bioindicator of low water fertility

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Among aquatic macrophytes, applied in the assessment of the trophic status of waters, macroscopic algae from the family Characeae indicate low water fertility. One of the rarest and most endangered charophytes world-wide, *Lychnothamnus barbatus*, is commonly applied as a bioindicator of oligo - mesotrophic waters. This study was carried out in Lake Kuźnickie (Greater Poland), a moderately eutrophic water body where a large population of *L. babatus* co-dominates in submerged vegetation with *Nitellopsis obtusa*, the stonewort frequently noted with *Lychnothamnus barbatus*, and with indicators of fertile waters, *Ceratophyllum demersum* and *Myriophyllum spicatum*. The study aim was to recognize the environmental conditions in which aquatic macrophytes indicative of different water trophy co-occur in the same lake. Depth of occurrence and coverage of macrophytes were studied in a 1 m depth gradient along 12 transects in July 2016 and July 2017. In addition physical-chemical parameters of water were analyzed in the pelagial. As a result, 23 taxa of aquatic macrophytes were recorded during both studied periods, including 11 charophytes, 11 angiosperms, one moss species, *Fontinalis antipyretica*, and a macroalga, *Voucheria* sp. Two charophytes, *Lychnothamnus barbatus* and *Nitellopsis obtusa*, and two angiosperms, *Ceratophyllum demersum* and *Myriophyllum spicatum*, had the highest frequencies and the relative species abundances in both studied seasons. Noteworthy, *Lychnothamnus barbatus* co-occurred with higher trophy indicators not only in the same lake but also at the same sites, more frequently with *Ceratophyllum demersum* than with *Nitellopsis obtusa* and *Myriophyllum spicatum*. However, *Lychnothamnus barbatus* preferred deeper sites while *Ceratophyllum demersum*, *Myriophyllum spicatum* and *Nitellopsis obtusa* abundantly inhabited shallower littoral areas. Therefore, we postulate that due to shade tolerance and light use efficiency *Lychnothamnus barbatus* is a better competitor at deeper sites compared to angiosperms and *Nitellopsis obtusa*. The joint effect on water transparency promotes co-occurrence of these species despite their different environmental preferences and indicator value. For the future application of *Lychnothamnus barbatus* as a bioindicator light availability seems more important than the nutrient concentration in water.

Intensive cyanobacterial blooms in lakes on Mała Wełna River

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With progressing eutrophication of inland waters and climate change, cyanobacterial blooms increase in frequencies and intensities worldwide. To prevent or hinder blooms, detailed analysis of each specific ecosystem is needed, including ecosystem functioning and potential sources of eutrophication. The present ecological state and drivers of eutrophication of two lakes located at Mała Wełna River (Wielkopolska District, Poland) are studied, in order to design suitable protection and restoration measures. The aim of this part of the study was to assess the intensity, composition, and seasonal extent of cyanobacterial blooms in the two lakes, in relation to nutrient concentration. Phytoplankton and nutrient samples were collected from April till October 2017, at two stations in each lake. A single screening sampling for cyanotoxin analysis was performed in August. Microcystins (MCs) and anatoxin-a (ANTX) were analysed in filtrated material, using HPLC-PDA and HPLC-FLD, respectively. Cyanobacteria dominated the total phytoplankton cell number in all samples, reaching the maximum value of $2067x10^3$ cells mL^{-1} in July in Budziszewskie Lake and $1947x10^3$ cells mL^{-1} in June in Rogozińskie Lake. In the total phytoplankton biomass, in spring and autumn diatoms and cryptophytes prevailed, along with cyanobacteria. Maximum cyanobacterial biomass was as high as 85.7 mg L^{-1} and 56 mg L^{-1} in Budziszewskie Lake and Rogozińskie Lake, respectively. The cyanobacterial community of both lakes was dominated by species typical of hypertrophic water bodies, ie. *Planktothrix agardhii*, *Pseudanabaena* spp. and *Limnothrix redeckei*, *Heterocytous cyanobacteria* (*Aphanizomenon* spp., *Dolichospermum* spp. and *Sphaerospermopsis aphanizomenoides*) accompanied the oscillatoriaceans in June and July. This abundant cyanobacterial community was enabled by high nutrient content in water. High MCs concentration of 15.95 ì g L^{-1} was noted. The most abundant variant of microcystins was dmMC-RR, and other MCs present in the sample were [DAsp3] MC-LR, MC-LF, MC-WR and MC-LW. No ANTX was detected. To sum up, in both hypertrophic lakes dwells hazardous phytoplankton community, indicating the necessity of protection and restoration of the studied lakes.

Inhibition of population growth of *Anabaena variabilis* by single and mixed steroid hormones

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Endocrine disrupters (EDCs) are exogenous substances that cause adverse effects by altering endocrine functions. The presence of EDCs in aquatic environments may disrupt algal development, change the structure of algal populations, and cause serious damage to entire ecosystems. Surface waters are contaminated with natural hormones, such as estrone (E1), 17-β-estradiol (E2), estriol (E3), progesterone (PRO), 5-pregnen-3b-ol-20-one (PRE) and testosterone (TST), as well as synthetic hormones such as 17-α-ethinylestradiol (EE2) and levonorgestrel (LNG).
Anabaena variabilis strain was obtained from the Faculty of Biology, University of Lodz. In order to provide the optimal conditions for growth, the algae cultures were carried out in the phytotron chamber at the light/dark cycle 12/12 h, temperature 23/20°C with a constant humidity of 30%. The density of the culture of *A. variabilis* before starting the experiment was 10 million cells/ml. The *A. variabilis* colonies were cultured in the presence of the following steroid hormones: E1, E2, EE2, E3, PRO, PRE, LNG and TST (individually and mixed). The control samples were cultured on the same medium and in the same conditions, but without the presence of steroid hormones. Each tested compound was first dissolved in methanol and then, the dissolved form was added to the 100 ml culture of cyanobacteria in the concentrations: 0.1, 1, 10, 25, 50, 75 and 100 ppm respectively. The same amount of methanol was added to the control sample. Number of cells, biomass and chlorophyll a content, in *A. variabilis* after 1, 2, 3, 7, 8, 10, 13 and 14 days of exposure to the analysed chemical compounds and in control samples cultured in the same conditions were monitored.
Natural and synthetic hormones had a strong inhibitory effect on *A. variabilis*. Progesterone, 17-α-ethinylestradiol and mixed hormones had a toxic effect on the tested cyanobacteria; the incubation in their presence led to the inhibition of the colony growth, while the 17-β-estradiol, 5-pregnen-3b-ol-20-one and testosterone affect the colony growth only to a small extent.

The relationship between presence of brown bear (*Ursus arctos*) and diversity of airborne algae and cyanobacteria in the Głowoniowa Nyża Cave, Tatra Mountains, Poland

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Bears bones represents one of the most frequently encountered paleontological remains from the Pleistocene in Europe. Of the big mammal taxa, the brown bear (*Ursus arctos*) is one ofa few surviving species and one of the two largest terrestrial carnivorans that have successfully exploited caves. Airborne microorganisms (algae and cyanobacteria) growing on tree twigs and granite cave walls represent a unique natural habitat. Overall, 24 species were found using direct LM and TEM microscopy in the pseudokarstic Głowoniowa Nyża Cave in the High Tatra Mountains, southern Poland. The highest number (10) of documented species belonged to cyanobacteria, among which the genus *Gloeocapsa* was the most diverse. We also identified 10 Chlorophyta species. Only four taxa of diatoms were found. No correlation between species diversity and physical parameters (temperature and humidity) was found. Interestingly, there was a general trend of increasing diversity with the presence of the brown bear.

Evidence for the phosphatase regulatory effect of cylindrospermopsin on an insensitive green algal species

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Cylindrospermopsin (CYN) is the most studied cyanotoxin after microcystins. CYN has many negative effects to photosynthetic and heterotrophic organisms, although there is only a little information on its possible roles in the producing organism, in algal assemblages, moreover on the biological factors, which influence its production. According to the few literature data, it is presumable that one possible role of cylindrospermopsin is forcing other phytoplankton species in the environment to produce alkaline phosphatase. Then, the cyanobacterium can take up the enzymatically liberated phosphate. In the present study the planktonic green alga *Scenedesmus obtusus* (Chlorophyta, Sphaeropleales) cultures were treated with CYN-containing and non-toxic *Chrysosporum* (Cyanobacteria, Nostocales) crude extract. Responses of the green alga at the phosphate limited conditions were also investigated. The results showed that cylindrospermopsin-containing crude extract induced the alkaline phosphatase activity in the treated cultures of the studied cosmopolitan green alga, which otherwise was not sensitive either to the relatively high cylindrospermopsin concentration or to phosphate limitation.
Nowadays, CYN producing cyanobacteria show wide geographical distribution, including temperate and arid regions, therefore knowledge on the possible roles of CYN in the algal assemblages, and the biological factors, which regulate its production are important and reasonable.

Diatom Index for Polish Lakes and Shorezone Functionality Index in lake management

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The Diatom Index for Polish Lakes (IOJ) and Shorezone Functionality Index (SFI) are used for water quality analysis as well as their direct catachment. They are useful tools for lakes management, especially SFI with its algorithmic construction. The SFI analysis of the lakes in e.g. Wigierski National Park, showed a good state of functionality of the coastal zone of Białe Pierciańskie Lake. Lakes, where functional state of the shore has been estimated as moderate or poor in at least 30%, are Okrągłe and Krusznik Lakes. In the lakes, in sites with the worst functionality of the coastal zone, diatoms considered to be indicators of weak water quality were found. They are also included in the Diatom Lake Index, e.g. *Nitzschia supralitorea* or *Cymbella tumida*. The results of analysis of Diatom Index and Shorezone Functionality Index allow to determine changes that occur in lakes and their surroundings. In addition, they help to find the most effective measures to improve the quality of water and ecological status of the lakes. After shorezone analysis, especially endangered parts of shorezone were indicated and some directions of lake management were proposed.

Potential anti-cancer activity of peptides synthesized by the Baltic cyanobacterium *Lyngbya aestuarii* CCNP1324

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Cyanobacteria belong to the oldest organisms living on Earth; they inhabited our planet approx. 3.8 billion years ago. To survive in changing climatic conditions, cyanobacteria have developed advanced strategies of adaptation. These include thesynthesis of various secondary metabolites, including peptides. Today, the ecological significance of these compounds still remains unknown. However, due to their diverse biological activity, they are being widely explored as potential drug candidates.

In this study, the structure and biological activity of peptides produced by the Baltic cyanobacterium, *Lyngbya aestuarii* strain CCNP1324 was explored. The organism was isolated from Puck Bay (Southern Baltic Sea) and grown for biomass in culture. Crude cyanobacterial extract was fractioned using flash chromatography and preparative chromatography with DAD and ELSD detectors. The activity of the collected fractions was tested against breast cancer cell lines (T47D). The content of samples which showed cytotoxic activity was determined using a LC-MS/MS system. The isolated compounds were identified to be ribosomal peptides called aeruginozamides. In the MTT assay, cytotoxic activity of the compounds was revealed.

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Factors accompanying the appearance of the expansive and nuisance flagellate species *Gonyostomum semen* in European humic lakes

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The mass appearance of the raphidophyte alga *Gonyostomum semen* in European freshwaters has been a well-known phenomenon since the end of 20th Century. However, knowledge about its distribution and factors determining its occurrence is still scarce, especially in lakes outside of Northern Europe, from where its expansion has started. To fill this gap, we initiated a research aiming to determine both abiotic and biotic factors (including bacterio- and zooplankton) accompanying the appearance of the species in humic lakes situated outside its initial range in Europe. Here we present preliminary results from the studies which cover seven humic lakes from six countries (Czech Republic, Denmark, Germany, the Netherlands, Poland and Portugal). All lakes were sampled in August or September, except the Portuguese waterbody which was sampled in November. In the case of the deeper stratified lakes, plankton samples were collected from 2–3 layers in the central part of each lake, while in shallow lakes, only one sample was taken. Our results, which have documented relations between *Gonyostomum semen* and biotic/abiotic factors, accompanying its appearance have provided essential knowledge for future research in other European countries.

New cyanobacterial taxa from radium-rich thermal springs with elevated radioactivity in Iran

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There are several places in the world where the level of natural radiation is unusually high, such as some regions of Ramsar and Abegarm-e-Mahallat in Iran. Such places are still insufficiently explored in terms of their species richness. We have studied 10 thermal springs with elevated radiation levels. The highest concentrations of ^{226}Ra in the soil and water were 13000 Bq kg^{-1} and 130 Bq l^{-1}, respectively. The microscopic analyses revealed over 60 cyanobacterial morphotypes. The dominant morphotypes in the benthos of most of the radioactive springs in Ramsar were *Leptolyngbya* spp. and *Nostoc* spp. Additionally, the soil with the highest radioactivity (13000 Bq kg^{-1}) was colonised by *Cylindrospermum licheniforme*. We have isolated and investigated several strains isolated from six geothermal springs. Morphological and molecular analyses did not enable the strains to be classified into any existing taxa; therefore, they are described as new taxa, not previously known to science, namely 4 new genera and 7 new species.

The role of photobiont – green algal species in shaping the distributional range of the members of the lichen genus *Solenopsora*

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With the aim to find out whether and how symbiotic interactions play a role in shaping lichen distributional range, we have been creating our dataset on the identity of primary photobiont and potential presence of secondary photobionts constituting lichens of the genus *Solenopsora* (Leprocaulaceae). The members of the genus have their distributional centre in the Mediterranean, but their overall distributional patterns differ. The algal material forming photobiont layers of four pilot taxa (*S. cesatii*, *S. candicans*, *S. grisea* and *S. olivacea* subsp. *olivacea*) was isolated and cultivated. Morphological and molecular data related to these photobionts from the lichen samples, as well as cultures, show a close relationship to coccoid green algae of the genus *Symbiochloris* (Trebouxiophyceae), most probably to *S. symbiontica* (Tschermak-Woess) Škaloud. This lichen alga was originally described as *Dictyochloropsis symbiontica* by Tschemak-Woess in 1980 from the lichen *Chaenothecopsis consociata*. To obtain the complete data across distributional ranges of the *Solenopsora* species the material from the Mediterranean Basin, Atlantic Europe, the Carpathians, Pannonia and Asia Minor will be analyzed.

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A new *Ceratium* species (Dinophyceae) from a tropical mountain lake (Papua province, Indonesia)

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Freshwater dinoflagellates of Indonesia are scarcely known. Almost all papers dealing with Indonesian dinoflagellates were published in the first half of the XX Century (Lemmermann 1905; Wołoszyńska 1912, 1923, 1930; Nygaard 1926; Lindemann 1931). Comparatively recently, Vyverman (2006) published a list of dinoflagellates recorded from lakes and swamps of the south-eastern part of Papua province (formerly Irian Jaya).

On the 15th September 2015 we revealed a mass development of the unusual *Ceratium* species in Lake Habbema (Papua province, Indonesia) which is situated at an altitude of 3200 m. This species was studied in detail by SEM. The tabulation of this *Ceratium* species is typical for the genus: 4′, 5′′, 5c, 5′′′, 2′′′′. The apical horn is straight without an apical pore and is composed of four apical plates two of which (1′ and 2′) do not reach the apex. The junction of plates 2′′and 3′′ near the cingulum contains an area of high pore density. The same pore pattern has been reported for *Ceratium cornutum* (Ehrenb.) Clap. et Lachm. by other authors (Bourrelly & Couté 1976; Happach-Kasan 1982; Vyverman & Compère 1991). The most unusual feature of this *Ceratium* is a reduced right posterior horn. The only known *Ceratium* species, which lacks both posterior horns, is *C. monoceras* Temponeras et al. (2000). This was described from Lake Doïrani in Greece and Macedonia. Based on our observations we propose that *Ceratium* sp. from Lake Habbema represents a new species to science and we will name it after the type locality, *C. habbemensis* sp. nov. prov.

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Disturbance of diatom community structure in high mountain streams -symptoms of threats to natural habitats

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Water environments of high mountains provide refuge for natural conditions being inhabited by many species with high ecological ranges. However, they are not free from threats. This situation is shown by diatom communities, which are very good indicators of environmental conditions. Long-term investigations were carried out in streams of the Tatra National Park (High Tatra Mts., altitude ca. 700–2000 m a.s.l., years 1962–2004) and the Swiss Alps (Swiss National Park, Macun Lakes: altitude 1668–2620 m a.s.l., years 2001–2010). Diatom communities in the Tatra Mts streams developed along an altitudinal gradient in association with vegetation zones: montane and alpine belts that formed characteristic assemblages. Over time, various disturbances in the development of diatom communities were observed. In 2001, *Diatoma mesodon,* being characteristic of the montane belt, developed abundantly in streams of the alpine belt (Dolina Pięciu Stawów Polskich Valley). This may have been related to dynamic changes in weather (droughts, floods) that are considered as symptoms of global climate change. The development of the *Nitzschia palea* population in 1971 in Rybi Potok stream (montane belt), a species that prefers highly eutrophic water, suggested anthropogenic threats in the region. These environmental changes were caused by domestic sewage froma tourist lodge. In 2003, the development of this species was not found, which indicateda positive effect of the construction of a sewage treatment plant. In the Alpine lake/stream network of the Macun Lakes region (alpine belt), the development of diatoms was moderate and the community structure was stable. However, studies carried out in 2015–2016 showed a strong degradation of diatoms that may be related to drastic changes in water physicochemistry over the past few years (increased acidification and increased silicate concentrations). Observations in both regions support the need for conducting systematic phycological studies in high mountain areas. This monitoring will help recognise threats and predict their effects, thus contributing to the protection of these extremely valuable ecosystems.

Influence of low temperatures on the growth of Ice and arctic microalgae

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A group of students from the III Liceum Ogólnokształcące is preparing the stratospheric mission within the 3-SAT project (http://3inspace.com/). In this study, the influence of low temperatures simulating stratospheric conditions on the growth of ice and arctic microalgae was examined.
For the experiment 6 strains of green algae and 2 strains of diatoms were selected. They were isolated and established as monocultures from rocks, macroalgae and bryophytes collected in Svalbard and from snow in the Tatra Mountains (strain CCALA 970).
The strains were grown on agar-F2 medium plates for 2 weeks in a temperature-controlled growth chamber at 12°C. Then 10 mm diameter discs were cut out and transferred into 5.0 ml Eppendorf tubes. For each strain, four tubes were placed for two hours (the estimated duration of the stratospheric balloon flight) at -80°C, four at -20°C and four were left as a control. Subsequently, to all tubes 2 ml of the F2 culture medium were added and then they were returned to the growth chamber. Quantitative analysis was made in a Bürker chamber after 8 and 12 days following standard procedure.
The reactions of strains to low temperatures were various. For one diatom strain only the temperature of -20°C induced its growth but for the other one both temperatures increased the number of cells (-80°C even two fold). For three strains of green algae, a temperature of -20°C stimulated their growth, even nearly two-fold, whereas -80°C had a limiting effect or no effect. For two strains the temperature of -20°C limited their growth, while -80°C doubled the number of cells. For the remaining strain only the limiting effect of -80°C was observed.
The results of the experiments suggest that the studied microalgae would survive in a stratospheric temperature gradient. However, to assess their survival potential, the influence of additional environmental variables such as ultraviolet radiation and pressure should also be tested.

Exploring the potential of Baltic green algae in biogas production through changes in biochemical profile in response to nutrients limitation

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The search for an algal strain suitable for mass culturing using local biological and water resources has reached the Southern Baltic region. Among the biofuels possible to be produced from algal biomass, biogas fulfils the conditions of a most attractive fuel in the region. It is easily convertible into electrical energy, the basic power supply for modern technologies. Anaerobic digestion by means of which biogas is produced depends on the biochemical composition of the substrate used. As such, the aim of our research was to compare the growth rate and lipids, proteins and carbohydrates content in the biomass of 15 Baltic green algae strains and, secondly, to observe the range of their change caused by depleting nutrients, which is a natural inducer of accumulation of energy substances in cells. With the help of the Stoichiometric Methane Potential index, it was possible to indicate the strain and the phase of cultivation in which the biomass has theoretically the best biogas yield per biomass unit value. The materials used in the experiments were the Baltic strains of green algae that were isolated from natural waters of the Gulf of Gdansk. Currently, these strains are held as monocultures in the Culture Collection of Baltic Algae (CCBA) located at the Institute of Oceanography at the University of Gdansk (Latała 2003; Latała et al. 2006).
Based on the results, it was inferred that there were significant differences in the biochemical composition of individual green algae. Furthermore, the later the growth phase at which cells were harvested, the more reserve substances characteristic for a given strain were accumulated. For example, in *Monoraphidium contortum* BA-5 lipids and carbohydrates accounted for 40% and 20% of its biomass, respectively. This was also the strain producing the highest amount of lipids. In *Chlorella vulgaris* BA-2, on the other hand, the highest amount of carbohydrates accumulated, which constituted almost 50% of its dry weight. However, maximum biogas yield calculation indicated the strain *M. convolutum* BA-17 (lipids – 32%, carbohydrates – 33%, proteins – 11% of dry weight) as the most suitable for biogas production – 0.7 L CH_4 g VS^{-1}.

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Species diversity in the genus *Muelleria* in different habitats on the Ecology Glacier Forefield (King George Island, Maritime Antarctic Region)

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The genus *Muelleria* is one of the most species-rich genera in the Antarctic Region. Together with *Humidophila*, *Luticola* and *Hantzschia*, it dominates the Antarctic diatom flora of wet to semi-dry terrestrial habitats (Van de Vijver et al. 2014). At present, 42 taxa are described worldwide within the genus *Muelleria*, most of these restricted to the Antarctic Region. The Ecology Glacier Forefield (EGF) is located on King George Island (South Shetland Islands), in the northern part of the Antarctic Specially Protected Area 128. During the deglaciation period (documented from 1979), a large part of the land was exposed with irregular glacial deposits. Several temporary pools and small creeks, very often modifying their riverbeds, are formed on this newly uncovered areas. Part of the forefield, especially close to the recessional moraine ridges, are overgrown mainly by mosses and lichens (Angiel & Dąbski 2012). A total of 78 samples from different habitats: soil (60 samples), pools (13 samples) creeks (5 samples) were collected from the Ecology Glacier Forefield for diatom analysis. During the survey of the diatom flora from the EGF, twelve *Muelleria* taxa were identified, nine at species level and three only on the genus level due to the rarity of the taxa. In aquatic samples, several *Muelleria* taxa: *M. aequistriata* Van de Vijver & S.A. Spaulding, *M. australoatlantica* Van de Vijver & S.A. Spaulding, *M. kristinae* Van de Vijver, *M. nogae* Van de Vijver, Zidarova & Kopalová, *M. olechiae*, *M. pimpireviana* Zidarova, Kopalová & Van de Vijver, *M. sabbei* Van de Vijver & S.A. Spaulding were found in small temporary pools, filled with stagnant water during early summer and gradually drying out towards the end of the austral summer, located on the ridge of EGF. The diatom communities in this pools are dominated by *Nitzschia gracilis* Hantzsch and *N. homburgensis* Lange-Bertalot together with a large number of aerophilic taxa. The highest diversity of the *Muelleria* taxa was observed in soil samples with a rather circumneutral pH and low organic matter content collected from different sites on the elevated ridge (oldest moraine deposits): *M. aequistriata* Van de Vijver & S.A. Spaulding, *M. australoatlantica* Van de Vijver & S.A. Spaulding, *M. kristinae* Van de Vijver, *M. nogae* Van de Vijver, Zidarova & Kopalová, *M. olechiae* Kochman-Kędziora, Noga, Van de Vijver, Stanek-Tarkowska, *M. pimpireviana* Zidarova, Kopalová & Van de Vijver, *M. rostrata* Van de Vijver & S.A. Spaulding and *M. sabbei* Van de Vijver & S.A. Spaulding.

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Water usage and seasonality as primer drivers influence epiphytic diatoms in the basins of the Kisköre reservoir (Hungary)

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The Kisköre reservoir (Lake Tisza) created by damming of the Tisza River is the second largest (after the Lake Balaton) standing water in Hungary, also of Carpathian Basin. It is divided into four basins (from north to south: Tiszavalk-, Poroszló-, Sarud- and Abádszalók basins), differently affected by several manner of water use. This artificial water body plays an important role in water management and recreation. The total amount of its water is artificially regulated. Special environmental conditions, due to annual water-level fluctuations, create unique habitats which represent high nature conservation value. Epiphytic diatom samples were collected in each of the basins from reed, one of the characteristic plants of the reservoir, twice a year from 2014 to 2017. We studied the taxonomical and morpho-functional characteristics of diatom assemblages in terms of seasonality, spatiality and water usage. We hypothesised that (i) compositional similarities of diatoms in basins will be affected by spatial and water usage factors rather than seasonality; (ii) effects of water management on diatom composition will increase in time; (iii) water usage will affect significantly the water quality of basins. In contrast to our first hypothesis, our results highlighted that seasonality influenced epiphytic algal composition more conspicuously than other factors. But the effects of additional factors on diatoms such as water management, connection with external inflow and the extent of open water surface increased in time. Surprisingly, there were opposite relation between the diatom based water quality and the protection level of basins.

Biological activity of secondary metabolites produced by selected phytoplankton species

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Phytoplankton species produce a wide variety of compounds which play an important role in aquatic environmental ecology and the biogeochemical cycles of elements. Microalgal and cyanobacterial exudates contain primary metabolites (carbohydrates, amino acids, lipids) and bioactive secondary metabolites (pheromones, siderophores, allelochemicals, antibiotics, feeding deterrents and attractants). These compounds are released into the environment during cell growth and cell lysis. The production of bioactive compounds is highly specific or even strain-dependent and is a subject of screening studies worldwide.

Therefore, the main goal of this study was to investigate the biological activity of phytoplankton exudates, collected from environmental samples as well as from laboratory-grown monocultures. Seawater samples were obtained during r/v 'Oceania' research cruises and from the coastal sampling stations in the southern Baltic Sea. Ten species from three different taxonomic groups: dinoflagellates (*Alexandrium ostenfeldii*, *Heterocapsa rotundata*, *Prorocentrum minimum*), diatoms (*Chaetoceros wighamii*, *Skeletonema marinoi*, *Thalassiosira pseudonana, Phaeodactylum tricornutum*) and cyanobacteria (*Dolichospermum lemmermannii*, *Aphanizomenon flos-aquae*, *Planktothrix agardhii*), isolated from the Baltic and grown in monoculture were selected. Marine water samples and monoculture growth media were filtered through glass-fiber filters. Cell-free filtrates containing produced secondary metabolites were then extracted with nonionic resin, washed with organic solvents and concentrated by vacuum evaporation. The extracts were used in chemical and biological assays to investigate their bioactive properties.

We confirmed the presence of siderophore-like compounds in the majority of the environmental and monoculture extracts. Many samples demonstrated allelopathic activity towards target species. Moreover, some of the investigated crude extracts revealed bacteriostatic, bactericidal and anticancer properties.

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Cyanobacterial water blooms in a small, restored lake

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Konin Lake is located in Lubuskie Province (Western Poland). It is a lake with a small surface (88 ha), characterized by an oval shape, with a poorly developed shoreline. Its maximum and mean depth are 4.2 m and 3.1 m respectively. The restoration of the lake was based mainly on the introduction of probiotic preparations into its waters and sediments.

Cyanobacterial research was conducted in the period of 2011–2015 (from April to October). Changes in taxonomic composition and abundance of phytoplankton were analyzed in the period before and during lake restoration. Since July, cyanobacteria predominated in the phytoplankton, causing intense water blooms. The most numerous species were *Aphanizomenon gracile* Lemmermann and *Cylindrospermopsis raciborskii* (Woloszyńska) Seenayya & Subba Raju in Desikachary. Other numerous species of cyanobacteria were: *Dolichospermum viguieri* (Denis & Frémy) Wacklin, L. Hoffmann & Komárek, *Cuspidothrix issatschenkoi* (Usachev) P. Rajaniemi, Komárek, R. Willame, P. Hrouzek, K. Kastovská, L. Hoffmann & K. Sivonen, *Planktothrix agardhii* (Gomont) Anagnostidis & Komárek and *Planktolyngbya limnetica* (Lemmermann) Komárková-Legnerová & Cronberg.

Effect of changes in light intensity on the growth, photosynthetic activity, and fatty acid profile of the green-yellow alga *Eustigmatos magnus*

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The aim of the study was to assess the effect of changes in light intensity on the growth, photosynthetic activity, lipid content, and fatty acid profile of *Eustigmatos magnus* (Eustigmatophyceae). Eustigmatophyceae is a class of yellow-green unicellular coccoid algae living mainly in soils and freshwaters. Some of them are a potential source of valuable bioactive compounds: saturated and unsaturated fatty acids.

The experiments were performed at the following light intensity: low light (30 μmol photons m^{-2} s^{-1}), medium light (60 μmol photons m^{-2} s^{-1}), and high light (400 μmol photons m^{-2} s^{-1}) at the photoperiod 16h light : 8h darkness and temperature 20 ±1°C.

During algal growth (9 days), analysis of the growth kinetics and measurements of the photosynthetic activity were carried out. *Eustigmatos magnus* growth was estimated by means of daily measurements of changes in the optical density of the culture at 650 nm with UV/Vis spectrophotometry. Chlorophyll fluorescence was determined using a Pulse Amplitude Modulated fluorometer. Crude lipid content was determined with a modified version of the Bligh and Dyer method (1959) and fatty acid composition was determined by means of gas chromatography.

The highest specific growth rate of *E. magnus* was observed at the highest light intensity applied. The maximum photochemical yield (Fv/Fm) significantly decreased with increasing light intensity, although the Fv/Fm value recorded at each light intensity was similar at 6th and 8th day of algae cultivation. The crude lipid content and the composition of fatty acids were influenced by the light intensity; C16–18 accounted for over 69 % of all fatty acids.

The highest content of eicosapentaenoic acid was observed in *E. magnus* cells cultured at the highest light intensity used.

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Mixotrophic algae as an indicator species in some types of water bodies

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The plankton community is composed of different types of microorganisms: autotrophic, heterotrophic and mixotrophic. Mixotrophy is a combination of various types of nutrition (phototrophy and heterotrophy) within a single organism. Mixotrophic species effectively compete for light energy with obligatory autotrophic organisms and for sources of nitrogen, carbon and phosphorus with heterotrophic species. Quick changes in the type of nutrition cause changes of the position in the trophic network. In our studies we define mixotrophy as the ability of a mobile species (with flagella) to use various types of nutrition (phototrophy and phagotrophy or osmotrophy). To the group of mixotrophic species we included: dinophytes, euglenophytes, golden brown algae, cryptophytes and some motile green algae. The aim of our studies was to determine if they belong to any group/cluster of 'characteristic' ('indicator') species in the studied water bodies. Considering their potential importance in eutrophic aquatic ecosystems, our hypothesis was that mixotrophic algal species are present in clusters of characteristic species of shallow, eutrophic water bodies.

The studies were conducted in six eutrophic water bodies: four oxbow lakes formed by the Vistula River and two ponds supplied by the Rudawa River. All the studied reservoirs were shallow, had a relatively small area and their trophic status was from low eutrophy to hypertrophy.

The classification of indicator species in the selected water bodies was performed using the indicator value (i.e. the IndVal method). Indicatory species (species linked to specific ecosystems) were found for five out of six of the studied water bodies. Mixotrophic species (euglenophytes and dinophytes) were present in clusters of indicatory ('characteristic') species only for two oxbow lakes classified as eutrophic, with cyanobacterial blooms present as natural summer phenomena. We found mixotrophic species (golden-brown and dinophytes) present in low eutrophic water bodies, however they were not present in indicatory clusters. We did not find any mixotrophic species in high eutrophic and hypertrophic water bodies.

Bioaccessibility of phenolic and indole compounds from *Arthrospira platensis* preparations

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Arthrospira platensis (also known as *Spirulina platensis*) is a one of the most popular species of microalgae that is used as dietary supplement according to the rich content of proteins (up to 60% of dry mass) and biological active substances which exhibit antioxidant activity.
The aim of the study was to determine content of phenolic and indole compounds using RP-HPLC method in commercial preparations containing *Arthrospira platensis* after extraction with methanol (as a control group) and after incubation with artificial digestive juices (artificial stomach and intestinal juices) using *in vitro* model of human digestive tract (using Gastroel-2014 apparatus). The selected dietary supplements differed in preparation form and derived from different manufacturers – due to this fact, evaluation of the quality of these preparations was performed according to *European Pharmacopeia 8th ed.*
Phenolic compounds identified in the examined extracts are as follows: gallic acid; protocatechuic acid; 3,4-dihydroxyphenylacetic acid; *p*-hydroxybenzoic acid; syringe acid; cinnamic acid; and quercetin. Furthermore, indole compounds identified were 5-hydroxy-L-tryptophan, 5-methyl-L-tryptophan, L-tryptophan, tryptamine, and 5-methyltryptamine.
Quality assay of the preparations showed that *A. platensis* distributed in the form of tablets does not disintegrate in artificial digestive juices. Among the examined preparations, only hard capsules met the requirements of the *European Pharmacopeia 8th ed.*

The effect of weather conditions on phytoplankton composition in selected shallow lakes of temperate zone

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During five years of this study (2010–2014) in four small, shallow and eutrophic lakes of the Western Polesie region in mid-eastern Poland, we investigated the effect of different weather conditions (i.e.,precipitation totals, temperature, type of winter) on the phytoplankton community (i.e. phytoplankton biomass, chlorophyll *a* concentration) by means of determination of physicochemical parameters of water (i.e. soluble and total nitrogen and phosphorus, electrolytic conductivity, water transparency). Water samples for biological and physicochemical analyses were collected fortnightly in vegetation season, from May to the end of August. We hypothesised that the changes in precipitation totals, temperature and the presence of mild or cold winters can influence the physicochemical parameters of water and thus change the conditions for the development of phytoplankton community. The concentrations of soluble and total nitrogen, the TN: TP ratio, as well as chlorophyll *a*, total phytoplankton biomass and biomass of Cyanoprokaryota and Cryptophyceae in the lakes were considerably higher, whereas the concentration of soluble and total phosphorus and water transparency were significantly lower after mild winters (2011 and 2014) compared with cold winters (2010, 2012 and 2013). No differences were found in water temperature, reaction and electrolytic conductivity. Lower phytoplankton biomass linked with lower concentration of chlorophyll *a* after cold winters resulted in increased water transparency and decreased light attenuation coefficient. We found the effect of increasing mean air temperature over the periods of 14 days before sampling on the increase of the phytoplankton biomass, the biomass of Cyanoprokaryota and chlorophyll *a* concentration in the studied lakes. We also stated the effect of raising precipitation totals over the periods of 14 days before sampling on the increase in soluble nitrogen and decrease in water temperature. No differences were found in other physicochemical, as well as biological parameters. Our findings show that the weather conditions (i.e. warmer winters, higher air temperatures) affected by climate warming can change the physicochemical properties of water environment and thus change the phytoplankton community in shallow eutrophic lakes.

Germination of charophyte oospores and use of iron and aluminium coagulants in lake restoration - laboratory experiments

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Findings of the monitoring surveys conducted in 2013–2014 by the Chief Inspectorate of Environmental Protection indicate that approximately 40% of the Polish lakes which constitute natural habitats 3140 (Habitats Directive 92/43/EEC) are in an unsatisfactory or poor condition. In the public view, such a state of affairs is approached from the standpoint of diminished attractiveness for potential bathers, divers and tourists. For this reason restoration measures are being employed increasingly often. In order to re-establish the balance of ecosystems, it is necessary to regenerate submerged vegetation, particularly its subsurface *Chara* meadows. As for restoration methods, a variety of these are available. However, aiming for a prompt clear water effect, iron and aluminium coagulants are utilised. Recently there have been reports of the toxic impact of iron and aluminium compounds on certain macroalgae (e.g. Rybak et al. 2017). It has been demonstrated that aluminium penetrates into cells and aggregates, thereby causing cell damage. If restoration is to proceed correctly, it is vital to examine the environmental condition of oospore germination in particular charophyte species and determine the size of the oospore bank.

Our study aimed to (1) obtain an insight into environmental factors affecting germination of stonewort oospores, such as temperature, light and biogenic abundance and (2) determine whether iron and aluminium coagulants have an impact on their germination capacity. Laboratory experiments in controlled conditions (in phytotrons) were conducted using oospores of three species: *Chara hispida, C. tomentosa* and *C. virgata*. The results indicate that in the presence of Al and Fe coagulants, *C. virgata* demonstrates the highest germination capacity, while a limited quantity of germinating oospores was observed with the other two species.

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Analyses of benthic algal colonization processes in the light of single traits and combined trait groups

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Functional approach in ecology enables better understanding of community dynamics in relation to environmental factors. It is based on the analyses of changes in trait composition of the assemblages influenced by environmental circumstances.
In our work, colonization processes of benthic algal assemblages were studied in a small lowland stream in Hungary. We primarily focused on the changes in single morphological and behavioural traits (STGs) and combined groups (CTGs) during colonisation. We hypothesised that (i) morphological features (life forms and cell size) will be mainly affected by environmental disturbances and algal settlement characteristics; (ii) changes in behavioural traits (mobility) composition will be strongly connected to disturbances and the risk of drying out of the stream; (iii) CTGs can emphasize the functional changes of the community more pronouncedly than STGs could. Our results proved these hypotheses: proportion of colonial and filamentous groups were high at the beginning of colonisation due to their fast settlement. In contrast, increasing physical disturbances caused significant increase in proportion of unicellular group with time. Changes in cell size groups were mainly affected by the strength of disturbances. Proportion of small sized groups increased with the increasing disturbances. The risk of drying out of the stream positively influenced the presence of mobile group in assemblages. Despite the strong relationship between environmental factors and STGs, analyses of changes in CTGs enabled the better understanding of compositional changes of benthic algae in biofilm.

Morphotypes of *Cryptomonas* species from water bodies in Kraków

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Periplasts surrounding the cell of crytophytes are one of the features characteristic to this group of algae. They consist of two proteinaceous layers sheathing the plasma membrane in between. Surface periplast component (SPC) can be composed of fibrilous material, discrete plates or rosulate scales, while the inner periplast component (IPC) is either smooth and sheet-like or covered with plates of various shapes (polygonal, hexagonal or rectangular). The IPC was considered a taxonomically important feature since electron microscopy has begun to be widely used as a research technique. However, later studies have shown that some clonal cryptophyte cultures produce cells with both types of periplasts i.e. plated and sheet-like – called cryptomorphs and campylomorphs, respectively – in *Cryptomonas* species.

To determine the morphotype of several clonal *Cryptomonas* strains isolated from the water bodies in Kraków, they were subjected to different fixation protocols, varying with a range of centrifugation conditions for cell harvest, fixative composition and concentration, and examined with the use of scanning electron microscopy (SEM). The methods that produced the best overall results and the differences between different treatments will be presented.

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Assessment of water quality of the Warta river based on phytoplankton indicators

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The assessment of water quality is based on biological, hydromorphological and physicochemical parameters. Among them, biological indicators – including phytoplankton – play the main role in determining the ecological state/potential of waters. In Poland, according to the current law regulation, IFPL is the phytoplankton index used for rivers and the other watercourses. Another method evaluating water quality is the analysis of functional groups of phytoplankton (Reynolds et al. 2002, Borics et al. 2007, Padisák et al. 2009). The aim of the study was to compare the results of water quality assessment of the Warta River based on the IFPL metric and on the functional groups of phytoplankton. Samples for chlorophyll *a* and phytoplankton analyzes were collected once a month – during the growing season (from March to October) in 2009, 2010 and 2016 from the Warta River in the center of Poznań. IFPL metric indicated good ecological potential of water in 2010 (IFPL=0.64), but moderate in 2009 (IFPL=0.58) and in 2016 (IFPL=0.52). The mean values of chlorophyll *a* amounted: 45.6 $\mu g \cdot l^{-1}$ (in 2009), 27.4 $\mu g \cdot l^{-1}$ (in 2010) and 67.4 $\mu g \cdot l^{-1}$ (in 2016). In all investigated years, the largest percentage share (>10%) in the total phytoplankton biomass had the following functional groups: A-B-C-D (small centric diatoms from groups A, B, C, D), H1 (e.g. *Anabaena* spp., *Aphanizomenon* spp.) and J (e.g. *Desmodesmus/Scenedesmus* spp., *Pediastrum* spp.). In 2009 such a large share was noted also in case of groups: M, Td, X1; in 2010 for groups: P, Td, Y, X2 and in 2016 for groups: P, Lo, C, D, X2. The structure of the phytoplankton based on the functional groups shows significant importance of taxa typical for eutrophic water bodies.

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The sensitivity of epiphytic diatoms to freshwater *Cladophora glomerta* (L.) Kütz. allelopathic metabolites

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A high allelopathic potential of macroalgae and water plants can be a result of high concentrations of total phenolic compounds (about 12% of dry matter), which are released into surrounding medium. Limited information on the functioning of epiphytic communities on the surface of *Cladophora glomerata* (L.) became the impulse for authors to undertake a detailed analysis. The aim of the research was to assess the seasonal differences in periphytic communities on *C. glomerata* in order to elucidate the role of phenols' content in the diatom species structure formation.
Macroalgal biomass was collected from the Oporzyńskie Lake. All samples of *C. glomerata* thalli were randomly selected from the mat (10 cm below the water surface) during the weekly sampling from May to October 2015. The diatom samples were prepared according to standard methods and permanent slides were used in order to estimate the abundance of particular taxa. Algae have been subjected to two types of extraction: MAE (microwave assisted extraction) and SFE (supercritical fluid extraction). Total phenols content (TPC) in the obtained extracts was determined spectrophotometrically using the Folin–Ciocalteu method with some modifications.
Concentration of polyphenols was generally steady during vegetative period, with the exception of July and August, when the concentration of polyphenols increased significantly. The decrease in polyphenol concentration in algal extract was strictly correlated to the increase in their concentration in water samples. Polyphenols excretion to water caused by dense mats of the filamentous green algae caused significant reconstruction of taxonomic composition (reduction in diversity) within the communities of epiphytic diatoms. The polyphenol-resistant species were *Epithemia sorex* Kütz., *Achnanthidium minutissimum* (Kütz.) Czarnecki, *Ulnaria ulna* (Nitzsch) Compère, *Amphora ovalis* (Kütz.) Kütz. Cosmopolitan diatoms (*Fragilaria*, *Ulnaria*, *Navicula*, *Gomphonema*) seem not to be inhibited as intensively as planktonic species, but more data are needed for a generalization.

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What's your favourite way to travel? Raccoon ears may foster long-distance spread of microorganisms

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Raccoons *Procyon lotor* can stay in the water for many hours and, when on land, are capable of covering distances of more than 250 kilometres. It means that they are very efficient dispersers, and at the same time, they may provide dispersal corridors for microorganisms, such as microalgae, cyanobacteria, water fungi, or microinvertebrates.

We used highly conservative PCR primers to amplify V4 hyper-variable region of the 18S ribosomal RNA gene of microscopic organisms that could be possibly present on the raccoons bodies. We have recorded 14 different microorganisms (mostly water fungi) and 2 dinoflagellate species: *Borghiella tenuissima* (Lauterborn) Moestrup, Gert Hansen et Daugberg and *Woloszynskia pascheri* (Suchlandt) v. Stosch in DNA extracts obtained from the tips of raccoon ears. The animals come from Poland, where racoon is an invasive alien species. Similarly, its expansion in Europe is still ongoing and the raccoon is extending its range extremely fast.

Here, we show for the first time that large or medium-size mammals, and even more importantly, invasive alien species, are underestimated vectors of long-distance dispersal of microorganisms. Racoon is a very good example because the species lives both on land and in water. Apart from racoon, there are at least a few other mammals capable of spreading of such microorganisms (e.g. muskrat, otter, beaver, American mink). Moreover, taking into consideration a globalization of trade and travel, which facilitate the spread of alien species, such passive dispersal is possible also at the global scale.

Can cyanobacteria be a good biofertilizer for soils?

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Cyanobacteria are natural component of waters and they can photosynthesize similarly to plants, what is vital for ecosystem. Many cyanobacteria species are able to fix nitrogen using atmospheric N_2 as its natural source. They can find good life-conditions in variety of ecosystems, e.g. water, wetlands, soils. In rice culture, cyanobacteria can cause an important increase of rice productivity being consequently the economically-attractive and ecologically-alternative for other fertilizers especially chemical. Thus, the ability of nitrogen fixing species allow them to be very useful in enhancing the agricultural production by adding important components to soil and crops, such as organic matter, vitamins or even other substances which can promote the plant growth. The aim of study was to determine the fertilizer value of the nostocalean cyanobacterium *Gloeotrichia echinulata* J. S. Smith ex Richt with an ability to form persistent blooms in a temperate lake. Concerning its role in sediment-phosphorus translocation and covering its nutritional needs by N_2-fixation or TN uptake in the pelagic zone, it seems to be also one of the major factors affecting the reduction of phosphorus and nitrogen loads in lake. During persistent blooms at the end of July, the numbers of *Gloeotrichia*'s colonies in the surface waters (0–0.5 m) of pelagic zone ranged from 12 500 to 160 500 colonies dm^{-3}, whereas in littoral zone up to *ca* 770 000 colonies dm^{-3}. *Gloeotrichia* samples were then collected for chemical analysis of macro- and micronutrients. Among macronutrients nitrogen content was the highest, next phosphorus, calcium, magnesium, potassium and others, ranging from *ca* 97 g kg^{-1} up to below 1 g kg^{-1} of dry weight. The order of decreasing content of micronutrients (from 1.1 to 0.002 g kg^{-1} of dry weight) was as follows: iron > manganese > zinc > copper > others. Thus, in the search for new and alternative solutions to improve water quality, we highlighted the use of the cyanobacterium as soil fertilizer.

Removal of nutrients from post-fermentation sludge by *Auxenochlorella protothecoides*

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The post-fermentation sludge (digestate) collected after the methane fermentation of maize silage was used as a medium for cultivation of the green microalga *Auxenochlorella protothecoides*. Centrifuged and sterilized digestate was subjected to analysis of physicochemical properties such as total solids (TS), volatile solids (VS), ash, chemical oxygen demand (COD), biological oxygen demand (BOD) and macro- and microelements content. Before algae cultivation, digestate was diluted with deionised water to increase the transmission of light into the culture. *Auxenochlorella protothecoides* was cultured simultaneously also in the BBM medium with peptone, as a control. After cultivation, biomass was centrifuged, while supernatant was mineralized and subjected to analysis of its composition, in order to compare it with composition of the medium before the cultivation.
The results showed that the digestate contained much higher amount of nitrogen (N), potassium (K), manganese (Mn) and iron (Fe) and much lower amount of phosphorus (P), sulphur (S), magnesium (Mg) and copper (Cu) compared to BBM. *Auxenochlorella protothecoides* poorly removed organic carbon contained in the digestate. Furthermore, this species more effectively utilized N from the digestate than from BBM. It may be the result of its ammonium form, which is more preferred by microalgae than the nitrate form present in BBM (Xia & Murphy, 2016). On the contrary, the removal of P and S from digestate was significantly lower, what testifies to their low bioavailability.

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Xia A. & Murphy J.D. 2016. Microalgal cultivation in treating liquid digestate from biogas systems. Trends in Biotechnology 34(4): 264–275.

Distribution patterns and habitat requirements of some cold water dinoflagellates from lowland and mountain lakes (Poland)

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The general model of dinoflagellate diversity in lowland and mountain lakes suggests minimal diversity of phytoplankton in cold waters under the ice cover. We studied lowland lakes in the Wielkopolska and the Pomorze regions (NW Poland), in the Suwalszczyzna region (NE Poland) and mountain lakes located in the Tatra Mountains (S Poland). We took samples from the surface water in winter (under the ice) or early spring (immediately after the ice melting). In total, we tested 65 lakes (128 samples). In our studies we have found both low dinoflagellate diversity as well as high dinoflagellate diversity and abundance in cold waters, depending on the type of lake. The highest diversity of dinoflagellates was recorded in small lakes with organic matter and the lowest in some mountain lakes. Fifteen taxa were identified, especially from the following genera: *Palatinus*, *Apocalathium*, *Gyrodinium*, *Parvodinium*, *Peridinium*, *Gymnodinium*, *Borghiella*, *Kathodinium* and a few unidentified taxa. Among the most commonly observed species were those from the *Apocalathium aciculiferum* (= *Peridinium aciculiferum*) and *Palatinus apiculatus* (= *Peridinium palatinum*) and *Parvodinium* groups. The studied lakes can be divided into three groups based on the habitat characteristics and dinoflagellate diversity: lowland lakes with hard water (presence of *Apocalathium aciculiferum*, *Gyrodinium helveticum*), lakes rich in dissolved organic matter (*Palatinus apiculatus*, *Borghiella*, *Peridinium bipes*) and mountain lakes (*Parvodinium* spp.). The patterns of distribution were developed for more frequently noted species.

Use of functional groups for assessing the status of phytoplankton assemblages of lakes in the town of Chodzież (Wielkopolska Voivodeship, mid-western Poland)

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The purpose of this study was to assess the composition and diversity of phytoplankton in anthropogenically stressed lakes characterised by a high trophic level. Water samples were collected in late summer (September 2013) from the surface layer of three water bodies: Lake Chodzieskie (area: 115.6 ha), Lake Karczewnik (33.2 ha) and Lake Strzeleckie (16.6 ha). All these lakes are shallow (max. depth 4.0–6.7 m) and located in the town of Chodzież, 65 km north of the city of Poznań. Phytoplankton was counted according to the Utermöhl standard technique, using an inverted microscope and cylindrical chambers of 9 ml each. The biomass of phytoplankton taxa was estimated from microscopic measurements and cell volume. In total, there were 17 phytoplankton functional groups in the investigated lakes: A, D, E, F, H1, J, LM, Lo, M, MP, N, P, S1, W1, Xph, X2 and Y.

In the individual lakes there were 11, 13 and 15 groups. The phytoplankton of Lake Chodzieskie was dominated by dinophytes, and two functional groups (Lo, Y) contributed 99% to the total phytoplankton biomass. Cyanobacteria were recorded in this lake but they did not have a high biomass. In contrast, water blooms in Lake Karczewnik were formed mainly by filamentous cyanobacteria (mostly *Planktothrix agardhii*) and large cryptophytes, and three functional groups (Y, S1, H1) constituted almost 96% of the total phytoplankton biomass. In the phytoplankton of Lake Strzeleckie, filamentous cyanobacteria (*Pseudanabaena limnetica*) were the dominant group, and three functional groups (S1, H1, J) were the most important, accounting for 93% of the total biomass. In the formation of the dominance structure of the phytoplankton community, environmental differences between the lakes acted like a sieve, preferencing in each of them the functional and morphological forms best suited to the local conditions.

Assessing morphological congruence in free-living forms and their stomatocysts of *Dinobryon*, including a stomatocyst newly assigned to *D. pediforme* (Chrysophyceae)

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Dinobryon Ehrenberg is one of the most common and recognisable genera of the chrysophytes. The genus comprises 41 taxa which mostly occur in clean freshwaters in temperate regions, some of them also occur in arctic and tropical regions and a few species are also known from marine waters.
Like other chrysophytes, *Dinobryon* species have ability to produce siliceous resting stages called stomatocysts, which are formed endogenously within special membrane chambers. The encystment process may individually or collectively depend on several environmental factors, principally the population density of vegetative cells, but also on temperature, nutrient concentrations and endogenous factors. Stomatocysts range from 2 to 30 µm in diameter and are classified based on morphology, and height and diameter of the cyst body, collar and pore. They are species-specific and are classified independently of the free-living forms. Only 10–15% of stomatocysts are conclusively linked with living chrysophytes that produce them. It is caused by the problems with finding encysting chrysophytes in natural and culture conditions. Nevertheless, they play a very important role because they are used in paleoecological studies as well as in different biodiversity assessments in situations where living chrysophytes are not observed.
In this study, we compared the morphology of four *Dinobryon* taxa, for which stomatocysts have previously been assigned, as well as of *D. pediforme* (Lemmermann) Steinecke, for which the stomatocyst 127 Duff et Smol in Duff et al. 1992 is newly assigned here, based on mass encystment observed in two *in situ* populations. We also analysed the congruence in morphology between free-living colonies of five *Dinobryon* taxa and their stomatocysts. Additionally, we mapped the morphology of free-living forms and stomatocysts on the phylogenetic tree and discussed the obtained results.

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Duff K.E., Douglas M.S.V. & Smol J.P. 1992. Chrysophyte cysts in 36 Canadian high arctic ponds. Nord. J. Bot. 12: 471–499.

Biodiversity of Baltic microphytobenthos: testing V4-V5 18S rDNA and plastid 23S rDNA barcodes for species identification

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Barcoding is the most reliable and popular technique to investigate the biodiversity of algal communities. Despite growing barcode reference databases, the search continues for the ideal barcode to identify microalgae. In this study, Baltic microphytobenthos molecular diversity was investigated.
The samples were collected during three seasons, i.e. spring, summer and autumn, at the station in Władysła-wowo (Puck Bay, Baltic Sea). Three pairs of primers allowing for PCR amplification of two nuclear (V4 and V4-V5 18S rDNA) and one plastid (23S rDNA) loci were tested. In addition, bacterial 16S rDNA was used in order to evaluate the amplification efficiency of plastid 23S rDNA for cyanobacteria identification. The obtained amplicons were sequenced using Ilumina MiSeq platform and subsequently analysed using QIIME2 software. In order to pick out OTUs, sequences were clustered at the similarity level of 97%. For taxonomic annotations, multiple reference sequences alignment was used (based on GenBank sequences).
The PCR, for three out of the four used markers (i.e. V4 18S rDNA, 23S rDNA and 16S rDNA), showed high amplification efficiency. The amplification of V4-V5 rDNA was successful for half of the samples only. Miseq sequencing generated 1 899 287 raw reads, of which (after trimming and quality check) 558 564 were clustered into OTUs. The highest number of OTUs was obtained for V4 18S rDNA (1 671) and 16S rDNA (1 624). V4-V5 18S rDNA barcode allowed clustering sequences in only 72 OTUs, which is not surprising regarding its poor amplification. The highest number of OTUs (ca. 98%) was identified, at least to the phylum level for V4 locus, which was due to the fact that the 18S rDNA database is the most extensive. On the other hand, only ca. 40% of plastid 23S rDNA OTUs were taxonomically annotated, which could be explained by the low number and diversity of reference sequences.

Landscape planning and diversity of diatom flora

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The territory of the Podkarpackie Voivodeship in Poland is a very diverse area in terms of landscape planning; the dominant feature of this region are rural areas. Agriculture is based mainly on small family farms and the natural values of many regions favour agrotourism and organic farming. Studies on the diversity of diatom assemblages were conducted in the years 2013–2015 in two research seasons – spring and autumn. The studied sites were determined on forestry soils in the buffer zone of the Magura National Park in the Lower Beskids (Polish: Beskid Niski) and on two farmlands in the Przemyśl and Rzeszów Foothills.

The aim of this work was to show the species differentiation of diatoms growing on soils of various types of management. On forestry soils, 37 taxa in total were indicated, while on agricultural ones – ca. 20 taxa. Among every identified taxa the most common were: *Hantzschia amphioxys* (Ehrenb.) Grunow and *Mayamaea atomus* (Kütz.) Lange-Bertalot, which can be considered as indicator species for soil habitats and were the most often given from the farmlands. Beside these, three other species occurred abundantly: *Luticola mutica* (Kütz.) D.G. Mann *sensu lato, Humidophila contenta* (Grunow) Lowe, Kociolek, J.R. Johansen, Van de Vijver, Lange-Bertalot & Kopalová and *Sellaphora atomoides* (Grunow) Wetzel & Van de Vijver. *Luticola mutica* (Kütz.) D.G. Mann *sensu lato* seems to be a typical species for habitats with variable humidity. The latter two species are known as aerophitic taxa and were often identified in the forest habitat (Ettl & Gärtner 1995; Hofmann et al. 2011).

Ettl H. & Gärtner G. 1995. Sylabus der Boden-, Luft- und Flechtenalgen. Gustaw Fischer, Stuttgart – Jena – New York.
Hofmann G., Werum M. & Lange-Bertalot H. 2011. Diatomeen im Süsswasser-Benthos von Mitteleuropa. Bestimmungsfl ora Kieselalgen für die ökologische Praxis. Über 700 der häufigsten Arten und ihre Ökologie. In: H. Lange-Bertalot (ed.). A.R.G. Ganter Verlag K.G., Königstein/Germany.

Species of *Ulva* (Ulvaceae, Chlorophyta) as indicators of salinity

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Salinity is one of the main determinants of species diversity in macroalgae. This study analysed the occurrence of 16 species of the genus *Ulva* in the salinity gradient. *Ulva* populations originated mainly from shores and estuaries, with a minor number occurring in ocean lagoons, coastal lakes, canals and rivers. *Ulva* species were found in waters where salinity ranged from 0–49 PSU. Most species were most commonly found in euhaline waters. It was observed that *Ulva* species with tubular thalli were present in a very wide range of saline waters (from fresh to hyperhaline). *Ulva* species with leaf-shaped thalli, however, were encountered chiefly in euhaline waters, while being present least often in hyperhaline waters. It has been shown that the morphotype of the thallus (leaf-shaped or tubular) is correlated with water salinity levels. *Ulva* species with leaf-shaped thalli are not found in fresh (<0.5 PSU) and poorly saline (<10 PSU) waters, whereas tubular species are recorded in freshwater, brackish and marine ecosystems (from 0–39 PSU).

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Diversity of aerophytic diatoms inhabiting terrestrial mosses in the Rio de Janeiro region, south-eastern Brazil

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The aim of the study was to investigate the species diversity of diatoms developing among the terrestrial mosses of the tropical zone in comparison to the communities composition from various habitats and substrates, as well as to determine the dominant taxa. Samples for diatom analysis (clumps of bryophytes) were collected in Rio de Janeiro and a rain forest neighbouring the city at the turn of March – April 2015. For every site, a number of environmental parameters were determined: the geographic coordinates, elevation (m a.s.l.), type of substrate and type of habitat (urban or natural). Cleaned diatom material was analysed using both light and scanning electron microscopy. A total of nearby 70 diatom taxa were observed. Most of these taxa are typical for terrestrial habitats such as wet or moist soils and mosses. The dominant species are *Humidophila contenta* (Grunow) Lowe, Kociolek, J.R. Johansen, Van de Vijver and Lange-Bertalot & Kopalová followed by *Luticola moreirae* Straube, Tremarin & T. Ludwig and *Achnanthes* sp., which cannot be identified using currently available literature. Moreover, for *A. mauiensis* R.L. Lowe & A.R. Sherwood it is the first report from Brazil, whereas another species – *Luticola clagesii* Moser, Lange-Bertalot & Metzeltin – was never previously reported from South America.

Photosynthetic life of limestone

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Aerophytic algae can be easily found 'with the naked eye' at the surface of different substrates. They are widely distributed in almost all climatic zones. Different taxonomic groups have different ecological preferences, therefore the taxonomic diversity may vary depending on the environmental conditions. In the temperate zone biofilms are mostly formed by chlorophytes, while in warmer regions of the temperate zone and in the tropical climate – by cyanobacteria.

In May 2017, at the 36th International Symposium of the Polish Phycological Society in Kazimierz Dolny in Poland, a small piece of limestone with pale green biofilm was collected. The biofilm was an unialgal community of a green algal species from the *Chlorococcum* genus. The limestone was placed in a climatic chamber, where a relative humidity of 60–75%, 25°C temperature, artificial light of 5.2 W/m^2 and 16h/8h day/night illumination cycle were sustained. Every 3 months the samples of biofilm were analysed using traditional methods and isolated on the agar plates with media: BB for green algae and BG-11 for cyanobacteria.

The growth activation in the climatic chamber increased the diversity of photosynthetic microorganisms growing on the limestone. In such conditions an intense growth of cyanobacteria was observed. The communities were mainly formed by heterocytous types, e.g. *Nostoc*, *Calothrix*, and some simple trichal froms e.g. *Phormidium*. The coccal forms of cyanobacteria were not found. However, after six months of further incubation, the composition of species have been changed and mostly coccal green algae and filamentous *Klebsormidium* sp. were observed.

Allelopathic activity of the picocyanobacterium *Synechocystis* sp. on cyanobacterial and algal monocultures and on natural plankton community

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Picocyanobacteria of the genera *Synechocystis* have been recognised in the last few years as important components of phytoplankton in most of the world's oceans. Despite the ecological importance of marine *Synechocystis*, very little is known about their allelopathic effects on phytoplankton organisms. In this study, the allelopathic activity of the picocyanobacterium *Synechocystis* sp. on cyanobacterial and microalgal monocultures growth and photosynthesis performance and on natural plankton community growth, expressed as chlorophyll *a* (Chl *a*), chlorophyll *b* (Chl *b*) and chlorophyll *c* (Chl *c*), as well as total abundance was investigated. We demonstrated that both the addition of *Synechocystis* sp. cell-free filtrate inhibited the growth and photosynthesis of cyanobacterium *Kamptonema animale* and diatom *Fragilariopsis pseudonana* in monocultures. In contrast, the green alga *Chlorella minutissima* was unaffected by picocyanobacterial filtrate. Our results also indicated that picocyanobacterium *Synechocystis* sp. filtrate had generally an inhibitory effect on phytoplankton community; however the degree of inhibition was different for each species, causing a change in the phytoplankton abundance and dominance during the experiment. To our knowledge this is the first report of the allelopathic activity of *Synechocystis* sp. in the Mediterranean Sea, the first study on the interaction of *Synechocystis* sp. on the natural phytoplankton community and one of the few works suggesting allelopathic properties of picocyanobacteria on coexisting phytoplankton species.

A new record diatoms from the Tigris-Euphrates River System (Turkey)

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The Tigris and Euphrates originate in south-eastern Anatolia in Turkey and the catchments are the largest basins in Turkey. The aim of the study was to reveal the distribution of diatoms in the Tigris-Euphrates river catchment. For this purpose, samples were collected from 20 different flowing waters in 2014; they were taken by brushing from submerged stones. As a result, the 32 diatom taxa included: *Amphora alpestris* Levkov, *A. copulata* (Kützing) Schoeman & Archibald, *A. liriope* Nagumo, *A. lange-bertalotii* var. *tenuis* Levkov & Metzeltin, *Brachysira neglectiformis* Lange-Bertalot, *Cymbella excisa* var. *procera* Krammer, *C. excisa* var. *subcapitata* Krammer, *C. exigua* Krammer *C. peraffinis* Tynni, *Cymbopleura lange-bertalotii* Krammer, *C. vrana* Krammer, *Encyonopsis falaisensis* (Grunow) Krammer, *E. krammeri* Reichardt, *E. thumensis* Krammer, *Gomphonema aequale* Gregory, *G. exilissimum* (Grunow) Lange-Bertalot & E. Reichardt, *G. jadwigiae* Lange-Bertalot & Reichardt, *Gyrosigma kuetzingii* (Grunow) Cleve, *Luticola hlubikovae* Levkov, Metzeltin & Pavlov, *Navicula exilis* Kützing, *N. lacuum* Lange-Bertalot et al., *N. lundii* Reichardt, *N. simulata* Manguin, *N. vandamii* var. *vandamii* Schoeman & Archibald, *N. vandamii* var. *mertens* Lange-Bertalot, *N. wildii* Lange-Bertalot, *Nitzschia denticula* Grunow, *N. dissipata* ssp. *oligotrophenta* Lange-Bertalot, *N. pumila* Hustedt, *N. rosenstockii* Lange-Bertalot, *N. subtilis* (Kützing) Grunow and *Stauroneis separanda* Lange-Bertalot & Werum – a 'new record' status for Turkish freshwater diatom flora.

Diversity of diatoms and yield of winter wheat under different tillage systems

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The aim of this research was to compare the effects of conventional tillage (CT) and reduced tillage (RT) on the diversity of diatoms, on some soil properties and on the grain yield of winter wheat in grown monoculture. The diatoms were chosen for the study of biodiversity for several reasons: (1) they are naturally-occurring and ubiquitous; (2) different taxa can be identified under an optical microscope; and (3) incidences of the different taxa are countable. Diatoms are one of the major groups of microalgae. Because they require light, they occur mainly at or near the soil surface.

The experiments were conducted at the Krasne Research Station near Rzeszów, Poland. CT involved soil inversion, whereas RT was a non–inversion system. The content of organic carbon in the top soil was greater in RT than in CT. RT also showed greater soil water content and bulk density, especially in the top layers (0–5 cm and 5–10 cm), than in CT. The soil under RT had a greater diversity of diatoms (139 taxa) than that under CT (102 taxa). Biodiversity was found to be greater under RT than CT. In the soil samples from both treatments, a total 197 taxa of diatoms were identified. RT was richer in species (139 taxa) than CT (102 taxa). The higher SOC and SWC increased the number of different diatom taxa (by 37 taxa or 36%) under RT in comparison with CT, as found by Stanek-Tarkowska et al. (2015). The dominance in diatom communities under RT and CT were similar. RT improved the quality of the surface soil as shown by the greater content of SOC and diversity of diatoms. In the dry years under RT, dominant species exceeded 20%, but under CT were less than 20%. Comparable results were obtained by Stanek-Tarkowska and Noga (2012a, b) in RT and CT systems under maize.

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Lipid composition of cold adapted microalgae and their perspectives as commercial species

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The lipid composition of microalgae is one of the very important features in their commercial application. Whereas for biodiesel production the quantity and rate of biodiesel precursors produced is the most important, for more fine products, e.g. human food supplements or aquaculture hatcheries feed, the quality of the algae lipids appears to be more important. Temperature has a strong effect on fatty acid composition in lipids, but according to our data there is also a relationship between the geographic origin of the algae and its fatty acid composition. Cold adapted algae from the polar regions generally have a higher content of valuable long chain polyunsaturated fatty acids, even if they are cultivated in the same conditions as their non-polar relatives. Polar algae also have a shifted temperature niche, which means that they can maintain good growth rates in colder conditions. This ability could be used in temperate regions to grow this species over the winter period.

In a recent study, we examined several species of green algae from the family *Selenastraceae* from different regions of the planet. We compared their abilities to grow in different temperatures, the dynamics of lipid production and fatty acid composition. To determine if the observed pattern can be found across large taxonomic groups, we performed similar experiments also with benthic pennate diatoms isolated from various geographical regions.

The diversity of algae and macrophytes communities in different spring types from the Apuseni Mountains (Transylvania, Romania)

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Springs are one of the most singular, diverse and understudied habitats that provide important ecosystem services and numerous microhabitats for their aquatic biodiversity. The hydrochemistry and geomorphological characteristic of the springs offer an environment for a high number and density of organisms in comparison to the small area they occupy. Numerous endangered, rare and new to science diatom species have been found in the few studies conducted (Cantonati & Van de Vijver 2009; Cantonati et al. 2010). Even though springs are considered hotspots of diversity, and periodical monitoring should be applied, they are mostly neglected in the legislation (European Union Water Framework Directive 2000), especially in Romania. This study will be the first of its type, since no previous studies were recorded in the Apuseni Mountains (in Romanian: Munții Apuseni) in north-western Romania, regarding the algal and aquatic macrophytes communities from different spring types. The only similar study – including several types of communities specific to these unique habitats: algae, macrophytes and invertebrates – was made during the years 1959 and 1961 on 70 springs located in the Romanian Plain, southern Romania, by Motaș et al. (1962).
Algal communities, particularly diatoms, are the most frequently used organism in evaluating natural habitats. The keen response of algal assemblages to the changing conditions or human impact, determines their importance in evaluating the water quality. Diatoms often display distinct preferences for specific substrate and microniches (Cantonati et al. 2012). A particular relationship has been observed between diatoms and some aquatic macrophytes, specifically bryophytes, which represented an almost exclusive substrate for some diatom species (Poulíčková et al. 2004). The main objectives in the ongoing study are the following: 1. providing reference diatom assemblages for the spring types found in Apuseni; 2. comparing the epilithic and epibryon communities and determining if bryophytes are a neutral substrate; and 3. assessing the influence of hydrochemistry and geomorphological characteristic of the springs on the studied organisms. The diatom assemblages identified on bryophytes have shown a significant increase in number of species compared to the epilithic communities, mostly in limnocrene springs (in one spring 53 diatoms; dominant taxa: *Amphora pediculus, Cocconeis placentula, Diadesmis contenta, Eunotia exigua*, *Pinnularia* sp. and *Planothidium lanceolatum*). These preliminary findings correspond with the results from several studies conducted in the Alps (Cantonati 1998; Cantonati & Lange-Bertalot 2006).

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Peryphythic flora of the Gulf of Gdańsk

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Microalgae are one of the most important functional groups of organisms in water environments. They can be found on all types of substrates e.g. sands, muds, underwater plants and artificial substrates. We present the summary of studies on peryphytic flora conducted in the Gulf of Gdańsk, Poland between 2008 and 2016 on natural and artificial surfaces.

Altogether 23 taxa of microalgae were identified on macrophytes and 56 on artificial substrata such as plastic and glass surfaces. The diatom *Rhoicosphenia abbreviata* was the most abundant species on both studied natural and artificial surfaces. On the plants surface, among the most abundant microalgae was the diatom *Fragilaria fasciculata* and cyanobacteria *Heteroleiblienia* sp. On artificial substrata diatoms, both adnate (mostly *Cocconeis* spp.) and erect growth forms (e.g. *Rhoicosphenia abbreviata* and representatives of *Fragilaria, Gomphonema* and *Licmophora*) were the most numerous. Free-living motile forms (e.g. *Bacillaria paxilifer*, tube-dwelling *Berkeleya rutilans* and *Navicula ramossimsima*) were also well represented. The cyanobacteria (e.g. *Anabaena flos-aquae, Lyngbya* sp., *Merismopedia* sp., *Microcystis* sp., *Oscillatoria* sp. and *Spirulina* sp.) were the second most important group of microalgae in terms of richness.

The highest primary production of microalgae (1.681 mg $C \cdot m^{-2}$) was observed on *Potamogeton pectinatus* surface, and the lowest on *Ulva* sp. (0.467 mg $C \cdot m^{-2}$). On artificial substrata, the highest biovolume of 581.729 mg $C \cdot m^{-2}$ was measured on panels exposed for 12 months.

In the experiment conducted on substrates exposed over different bottom sediments (sands and muds), no differences in the colonisation process were observed between the sites. Generally, the differences between communities developing on plants were determined by the specific structure or functionality of their surface, e.g. representatives of *Ulva* sp. use exfoliation to reduce populations of microorganisms developing on them. On the other hand, on the artificial surfaces no differences in matured communities were observed.

The influence of bisphenols on the cyanobacteria *Microcystis aeruginosa*

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Endocrine disrupting compounds (EDCs) are pollutants with estrogenic or androgenic activity at very low concentrations and are emerging as a major concern for water quality. These chemicals arise from many different sources including pesticides, industrial chemicals, pharmaceuticals and phytochemicals. They are widely distributed in the environment and are able to mimic or disrupt the biological functions of natural hormones. Increasing concern over bisphenol A (BPA) as an endocrine-disrupting compound and its possible effects on human health have prompted the removal of BPA from consumer products, often labelled 'BPA-free'. Some of the chemical replacements, however, are also bisphenols and may have similar physiological effects in organisms. The aim of this work was to study the effects of bisphenols on the blue-green algae.

The *Microcystis aeruginosa* strain was obtained from the Faculty of Biology, University of Lodz. The tested cyanobacteria were cultured in the photoperiod: 12 h light (the temperature was kept at 23°C) and 12 h dark (the temperature was kept at 20°C) at a constant humidity of 30%. The measured algal concentration before exposure to terpenes was 10^7 cells mL^{-1}. The *M. aeruginosa* colonies were cultured in the presence of selected bisphenols. The control samples were cultured on the same medium and in the same conditions but without the presence of bisphenols. Each tested compound was first dissolved in methanol and then the dissolved form was added to the 100 ml colony of cyanobacteria in the concentrations doses: 0.1, 1, 10, 25, 50, 75 and 100 ppm, respectively. The same amount of methanol was added to the control sample. The studies monitored the number of cells, biomass and chlorophyll *a* content in the cells of *M. aeruginosa* after 1, 2, 3 and 7 days of exposure to the analysed chemical compounds and in the control samples cultured in the same conditions.

This research has demonstrated that bisphenols have a strong inhibitory effect on *M. aeruginosa* cells. Currently, present concentrations of bisphenols in surface waters can cause a potential ecological risk to aquatic organisms. Considering the constantly increasing consumption of industrial raw material for polycarbonate and epoxy resins, pollution of surface waters with bisphenols undergoes continuous growth, and for this reason further testing using test systems with various aquatic species and endpoints are needed to provide additional information about the toxic impacts of bisphenols on aquatic biota.

Structure of the winter microorganism communities in an urban stream and lake (Poznań, Poland)

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Urban rivers and lakes play an important role in shaping the landscape and modifying local weather conditions. In summer, residents use these water resources for recreational purposes and then the quality of these waters is of great interest to users, scientists and managers. In turn, in winter, lakes and rivers do not receive much attention. Therefore, the aim of this study was to determine the quality of water and communities of microorganisms in Strzeszyńskie Lake and its tributary, the Rów Złotnicki, in the middle of winter. Water samples were taken in January at two stations: at the inflow of the stream to the lake and from the surface layer of the lake near the bathing area. Both stations are located within the administrative borders of the city of Poznań, in its western part. Water temperature, conductivity and pH were measured in situ and the total suspended matter, chlorophyll *a* and nutrients were analysed in the laboratory. Due to the fact that the stream is considered to be the main source of lake pollution, sanitary parameters in water quality assessment were also taken into account.

The differences between the two stations were clear. The stream water was characterised by more than twice the suspended matter content found in the lake water. The nitrate nitrogen concentration was over seven times higher and soluble phosphorus almost three times higher in the stream than in the lake. Both in the stream and in the lake, the phytoplankton was characterised by low species richness but different taxonomic groups predominated: cryptophytes in the stream and diatoms in the lake. Despite the low temperature of the water, the stream carried 137 mesophilic bacteria per 1 mL of water, including 5 cells of faecal bacteria (*Escherichia coli*). The number of psychrophilic bacteria exceeded 300 cells per mL in the stream. The lake water contained no faecal bacteria and a much lower number of psychrophilic and mesophilic bacteria. A comparison of the water parameters and microorganism community between this lake and stream in winter and summer showed that the differences are smaller in the cold than in the warm period.

Baltic-derived *Anabaena* as a source of metabolites with biological activity

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It was estimated that approximately 24% of marine natural products commercially available for biomedical research are of cyanobacterial origin; they were mainly identified in organisms from tropical waters. However, recent studies have also revealed that cyanobacteria from temperate regions, such as the Baltic Sea, can be explored as a source of metabolites with potential biotechnological application. Due to their diversity in structure and function, they can be used in many areas including industry, agriculture and medicine. Special efforts have been made to discover new natural products that could effectively treat diseases of affluence, including cancer. Another important area of research is screening for new compounds with antibacterial activity especially effective against drug resistant strains.

Our aim was to assess the anticancer and antibacterial activity of metabolites produced by the Baltic-derived strain of *Anabaena* sp. (CCNP1406, isolated in 2005 from the Gulf of Gdańsk). To achieve this, we tested chromatographically separated fractions (flash chromatography) of methanol extract against breast cancer cell line T47D using MTT assay. Fractions which revealed cytotoxic effect were further separated with preparative chromatography, aimed at obtaining pure active compounds or groups of compounds. In parallel, the effect of active fractions on Gram-positive and Gram-negative antibiotic resistant bacterial strains was tested using the broth microdilution method.

Our results revealed that metabolites isolated from the Baltic *Anabaena* have antibacterial activity and significantly inhibit the proliferation of T47D breast cancer cells. Active fractions were subjected to LC-MS/MS analyses for the preliminary characterisation of compounds responsible for the toxic effect of the extract. Current work is aimed at the identification and characterisation of compounds produced by the tested strain.

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River versus lake: seasonal differences in periphytic communities on *Cladophora glomerata* (L.) Kütz. thalli

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Research was conducted on periphytic diatom communities in the small lowland Nielba River and Opo-rzyńskie Lake in the Wielkopolska Voivodeship, Poland. The focus was on the communities living on the surface of *Claddophora glomerata* (L.) Kütz. which occurs in different forms: in the river ecosystem it creates threads, while in the lake ecosystem it grows into dense mats. The aim of the research was to show the seasonal differences in periphytic diatom communities on different morphological forms of *C. glomerata* in both river and lake ecosystems.
Thalli of *C. glomerata* were collected from May to October 2015. The samples were taken to the laboratory, weighed to ascertain the mass of both *Cladophora* and diatoms, and then prepared for the identification of diatoms. For diatom analysis, a part of each sample was oxidised according to Battarbee procedures. Permanent slides were mounted with NAPHRAX.
The results point to diversification of both periphytic communities. Some of the common diatom species, belonging to the genera *Cocconeis*, *Fragilaria*, *Ulnaria*, *Navicula*, and *Gomphonema*, were noted in all the examined sites. However, in the Nielba River the dominant species is *Cocconeis placentula* Ehr. (reaching 75% of domination) while in Oporzyńskie Lake it is only one of the dominants (reaching only ca. 15% of domination), but the main dominants are species from other taxa such as: *Epithemia sorex* Kütz., *Achnanthidium minutissimum* (Kütz.) Czarnecki var. *minutissimum*, *Ulnaria ulna* (Nitzsch) Compère and *Amphora ovalis* (Kütz.) Kütz. The observed seasonal changes are connected with the tolerance of certain species to seasonal changes in the environment.

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Monitoring research of algal species diversity in the high-mountainous Nesamovyte Lake (East Carpathians, Ukraine)

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The diversity of algae in reservoirs of the East Carpathians is characterised by the limited number of studies to date and the lack of monitoring supervisions. Information in relation to the algae of the high-mountainous lakes of this region is limited and fragmentary. The investigational lake (N 48°07'21.7", E 24°32'22.1"; 1748 m a.s.l.; surface ~ 0.43 ha (~ 88 x 45 m); depth <2.0 m), one of largest lakes of the region (massif of Czarnohora), is of glacial origin and characterised by the atmospheric type of water-supply. The history of floristical study on algae dates back ca. 100 years with the periodicity of supervisions close to a half-century. The presence of such periodicity in the study of the variety of water-plants in this reservoir provided an opportunity to conduct monitoring supervisions, as well as to offer conclusions in relation to the change of specific composition of water-plants during the marked period and credible reasons for this process. The species diversity of algae in the lake at the beginning of the 20th century was presented by J. Wołoszyńska and showed taxa from 6 taxonomical groups: Cyanoprokaryota – 3, Chrysophyta – 1, Dinophyta – 2, Bacillariophyta – 17, Chlorophyta – 4, Charophyta – 15 (according to the modern taxonomical representations). The taxonomical structure and species composition allowed for characterising the lake as an oligotrophic alpine reservoir that was considerably distinguished from the lakes of analogical mountain regions of Europe (The Alps, Tatra Mountains, Sudety Mountains).
The research work of Z. Asaul and G. Palamar-Mordvintseva in the 1960s–1970s witnessed the specifics of the species composition of algae in this lake, sorted by types of rarity and denoted the general taxonomical structure of algal diversity and presence of rare forms. Along with it, a certain change in specific composition of the algal communities was noted. Original research work on Nesamovyte Lake (mineralisation of water – 5.1–6.0 ppm, conductivity – 8.2–9.8 μS, oxygen saturation – 10.7 mg/l, pH – 6.4–8.3) in the last few years (2013–2016) showed the increase of a specific variety of Euglenophyta, Chlorophyta, Charophyta and Cyanoprokaryota, the appearance of Cryptophyta and Xanthophyta, and an insignificant increase of species composition of Desmidiales for the accounted commonly widespread taxa and the disappearance of specific high-mountainous alpine taxa. There was a marked change of algological complexes of dominant-taxa and a mass development of individual species (e.g. 'blooms' of *Botryococcus terribilis* Komarek et Marvan). The change of structure in algal associations and the presence of specific composition, the disappearance of rare specific taxa and the mass development of individual widespread species indicate a clear transformation of the Nesamovyte Lake's ecosystem, moderate biocontamination and an increase of the trophic level – a transition from oligotrophy to mesotrophy.

Does *Spirulina* from the Baltic Sea have biotechnology potential?

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Cyanobacteria are important components of the phytoplankton community. Under favourable conditions, they can develop into blooms whose impact on aquatic fauna and flora is still the subject of research and discussion. On the other hand, cyanobacteria are known as producers of compounds with possible medical applications. Screening of the extracts from the Baltic cyanobacteria revealed the ability of *Spirulina subsalsa* CCNP 1310 to produce metabolites active against important metabolic enzymes and several bacterial strains. The aim of our current work was to identify the agents responsible for the observed activity. Fractions from *S. subsalsa* CCNP1310 obtained using flash chromatography and preparation chromatography were analysed with liquid chromatography tandem mass spectrometry (LC-MS/MS) optimised for the detection of peptides. The samples were also tested for their cytotoxic effects on cancer cells (breast cancer cell line T47D) and for their inhibitory effects on serine proteases. Several of the fractions showed a significant decrease in relative viability of cancer cells. In the tested material we identified several groups of compounds which share the same fragment ions and are possibly linked with the observed activity. The results confirmed the biotechnological potential of the Baltic *S. subsalsa* CCNP 1310.

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The diatom analysis of sediments from the ore mine cessation in the Chechło River area (S Poland)

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Lead and zinc (Pb, Zn) mines are a common occurrence worldwide but the vast majority have been abandoned for decades. Abandoned mining wastes describe a serious hazard, as Pb, Zn and associated metals are continuously released into the environment, threatening ecosystem functions. For almost 60 years, until 2009, the Chechło River have been experienced by a serious pollution from the lead-zink ore mine. Currently, the river is recovering to its natural conditions, but many channel and floodplain locations still preserve the sediments that were accumulated during the mining era. However, remediation of the metal waste is costly and complex process.
The results are based on the reconstruction of changes of diatom (Bacillariophyta) assemblages (qualitative and quantitative) as well as physical characteristics and chemistry of sediment stored in the mining area. The diatom ecology and their compositional patterns provided important, indirect information about changes in a water state. The diatom analysis exhibit rapid response to the mining cessation. Differences in species composition depends also on hydrology of the particular subsidence basin studied. In the samples originated from the most polluted sites the dominant diatom species found were e.g., *Achnanthidium minutissimum*, *Eolimna minima* and *Staurosira venter*, whereas in the least polluted locations next to them also dominated *Gomphonema parvulum*, *Planothidium lanceolatum* and*P. frequentissimum*. All of them are well-known species from metal-polluted waters. Moreover, the results show that the metal content of sediments mobility can be a function of pH. In some sites, originally colonized by oligosaprobic and acidophilous diatoms e.g. *Eunotia incisa* and *Frustulia saxonica*, there arecurrently only alkalophilous, mesotraphentic and eutraphentic species e.g. *Staurosira venter*.

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The importance of microalgal cell wall for the evaluation of lipids using fluorescent dyes

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Lipids from microalgae are important both as low-value products suitable for biofuel production and as high-value products used as nutritional additives. Nevertheless, algae can accumulate neutral lipids up to 80% of their biomass, the quantity varies among species and depends on algae growth stage and culturing conditions. Thus, there is a real need to develop a rapid, inexpensive and reliable methodology of their evaluation that will allow fast screening of strains, as well as to define the best suitable periods for biomass harvesting. The evaluation of free lipids in the algae cells by measuring fluorescence intensity of Bodipy dyes seems a very promising screening technique. However, the weak correlation of relative fluorescence intensity and amount of lipids determined by conventional methods was sometimes observed, possibly due to cell wall structures that limit penetration of the dye. Therefore, the aim of our study was to assess the importance of cell wall for the evaluation of lipids using fluorescence spectrophotometry and to determine Bodipy dyes optimal staining conditions suitable for quantification of *lipids* produced by various microalgae species.

Eight species of cyanobacteria (*Microcystis viridis*) and microalgae (*Gonyostomum semen, Nitzschia palea, Haematococcus pliuvialis, Ankistrodesmus fusciformis, Synura* sp., *Peridinium* cf. *cinctum* and *Cryptomonas curvata*), differing by taxonomy and complexity of cell surface structures, were selected for analysis. The amount of lipids was investigated in the culture at stationary phase by conventional gravimetric method following Axelsson & Gentili (2014). Simultaneously, the accumulated lipids were stained with Bodipy dyes and visualised using an epifluorescence microscope Nikon Eclipse N*i* equipped with Nikon DS-Ri1 camera, and fluorescence intensity was also assessed using a GloMax®-Multi Microplate Multimode Reader. For the determination of lipids suitability as biocompounds, total fatty acid content was analysed by direct esterification/transesterification and consequent gas chromatographic determination. The data of various lipid analysis methods will be discussed in relation to the cell wall structure of cyanobacteria and microalgae species. A preliminary optimised protocol for free lipids evaluation by fluorescence spectrophotometry using Bodipy dyes will be suggested.

Axelsson A. & Gentili F. 2014. A single-step method for rapid extraction of total lipids from green microalgae. PlosOne 9(2), https://doi.org/10.1371/journal.pone.0089643

Allelopathic effect of *Chara aspera*, *C. baltica* and *C. canescens* on the bloom-forming picocyanobacterium *Synechococcus* sp.

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The role of allelopathy in aquatic systems has been receiving increased attention asa potential means of controlling cyanobacterial blooms. Additionally, allelochemicals isolated from different macroalgae are suggested to have growth inhibiting effects on selected cyanobacteria. Three laboratory experiments were conducted to investigate allelopathic activity of extracts of *Chara aspera*, *C. baltica* and *C. canescens* on the growth, effective quantum yield of photosystem II (PSII) photochemistry (ΦPSII) and photosynthesis parameters such as the initial slope of photosynthesis-irradiance (P-E) curves (alpha) and 16 photosynthetic capacity (Pm) of the picocyanobacterium *Synechococcus* sp.
In this study the monoculture of picocyanobacterium was exposed to three concentrations of extracts originating from charophyte cultures. Dry matter of macroalgae were extracted in solvent and the initial picocyanobacteria inoculum – derived from unialgal culture media – was used. After the seventh day of the experiment, we observed a significant negative effect of all the tested macroalgae on the growth of *Synechococcus* sp., with the strongest effect produced by *Chara baltica*. It was also demonstrated that extracts from *C. aspera* caused a significant decrease in the ΦPSII and Pm value of picocyanobacterium. On the other hand, the addition of extracts from *C. canescens* stimulated ΦPSII, Pm and alpha of the target picocyanobacterium. In contrast, no effect of the *C. aspera* extract was evident on the alpha value of *Synechococcus* sp. Our results suggest that some allelopathic macroalgae have the potential to mitigate harmful cyanobacterial blooms in systems dominated by *Synechococcus* sp.

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