Newsletter
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CzechGlobe
Global Change Research Centre AS CR, v. v. i.

CZECHGLOBE HOTCHPOTCH

When taking over editorial responsibility for bulletin called CzechGlobe Newsletter, I was a little worried what I'll write all the editorials about. The initial uncertainty has been suppressed for the time being, simply because one could say, „there is always something going on". After we had officially launched the atmospheric station in Košetice just before the summer holidays, another „opening event" followed. This time it was the grand opening of Experimental ecophysiological station along with a training center in Domanínek in Bystřice nad Pernštejnem. On 12th July 2013 we introduced a complex of 24 „open top chambers" (OTC), which is used by plant physiologists when conducting multifactor field experiments. These chambers allow growing plants in elevated CO_2 concentration and possibly also in other gases such as ozone and nitrogen oxides, as well as regulating the incident precipitation and temperature. Doing this, they enable us to simulate the impacts of future climate on the physiology, growth and plant production. Plant production and related food production and food quality is one of the most essential social problems that the global change brings about, and whose solution can CzechGlobe contribute to. The significance of the experimental equipment is evident judging by the guests present at the grand opening. They were representatives of the Academy of Sciences, Czech Agrarian Chamber, Mendel University in Brno, state administration and local government. As for some other CzechGlobe happenings, which are more or less kept under wraps, we can highlight the fact that the Department of biogeochemical and hydrological cycles succeeded in launching an analytical laboratory, which has already been awarded the quality certificate. The completion of tenders and signing contracts for the last costly investment of the CzechGlobe project, which are a large-scale photobioreactor and a system of hyperspectral sensors, can also be considered a great success. With regards to the fact that on 20th November Cessna 208, fully modified for airborne imaging, landed at the airport in Brno-Tuřany, we can say that the Airborne Laboratory for Remote Sensing is coming true.

There is still one piece missing in the mosaic called the CzechGlobe infrastructure. It is the completion of the laboratory pavilion in the premises of the GCRC in Brno. Even this last piece of work is soon coming to an end. Construction workers disappeared a few weeks ago and the only thing that hasn't been finished yet is the installation of apparatuses, laboratory equipment and furniture. Many employees will be moving to their new premises as part of their New Year's gift.

When listing the celebratory events, however, we mustn't forget the daily hard work of our talented researchers. They have launched promising bilateral projects along with joint measurement campaigns. We can name, for instance, the Czech-Italian project focused on the determination of volatile substances emission or the Czech-Spanish project focusing on metabolomics.

Thanks to the resolved ECOP projects, there have been four summer schools aimed at drought issues, systems biology, emissions of

volatile substances and ecophysiological measurements. Another summer school focusing on project management took place thanks to a project within the EUPRO II programme. There is also a significant ECOP project HYDAP, under whose auspices three workshops have been organized within the last six months. They are focused on the use of airborne remote sensing in the „soil science", in the landscape energetics and thermography and on the airborne and ground-based laser scanning.

Considering the list of events that took place in CzechGlobe over the year 2013, it is clear that it has been a very successful year. We can only hope that the year 2014 will be at least as successful!

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OUR GOAL IS TO BREED SUPER-ALGAE
AND A COMPUTATIONAL MODEL OF CYANOBACTERIA

Says Ing. Jan Červený Ph.D, the Head of the Department of adaptation biotechnologies in the Global Change Research Centre AS CR. Mr. Jan Červený was awarded his doctoral degree from the study programme of Technical Cybernetics at the Czech Technical University in Prague. His scientific career began when working for the Center for Applied Cybernetics, CTU, where he was engaged in mathematical modeling and regulatory mechanisms of biological processes.

If I'm not wrong, your department was established at the same time as CzechGlobe, wasn't it? Can you tell us what was the impetus behind it?

Our department began to take shape already at the former Institute of Systems Biology and Ecology. At that time we were starting doing systems biology, which basically means that we were trying to grasp the idea of biological processes – photosynthesis especially – through a comprehensive description of interactions between the components of the investigated system using advanced experimental methods and mathematical modeling of such systems.

Then the CzechGlobe project was launched which was the actual impetus for the development of the Department of adaptation biotechnologies.

The concept of biotechnology is quite broad. Can you tell us specifically what you are engaged in?

You are right that biotechnology is perceived as a really broad term. We are engaged in bioproduction of pharmaceutical substances, such as antioxidants and various omega -X fatty acids, up to the production of a wide range of interesting bioactive molecules. Another area of our interest are industrial biotechnologies, such as production of third generation biofuels, bioactive cleaning of remediation wells and using algae and cyanobacteria in wastewater treatment plants.

The key part of our Department is the reference and optimization laboratory for the research of photosynthetic organisms, primarily for the research of algae and cyanobacteria, but also for the research of plant cell cultures. The laboratory is based on a series of photobioreactors, of which we currently have ten. Using the photobioreactors, we are able to describe and optimize cultivation conditions of selected organisms in order to streamline the production of valuable substances. The selection of suitable organisms is based both on the experience of the research team as well as on the cooperation with foreign scientific institutions which possess a large number of exotic organisms. The selection and identification of potential candidates for biotechnological applications is very often a lengthy process of choosing from tens of thousands of potential organisms. The identified organisms are subsequently cultivated and characterized in the bioreactor, which is basically something like the intensive care unit, where we are able to provide well-specifiable conditions of cultivation and also to monitor a wide range of parameters such as the concentration of CO_2 and O_2, pH and temperature of the cell suspension. Bioreactors are also significant for their built-in fluorometer, which is a device allowing the measurement of fluorescence response of the studied organisms. That provides us with additional information on the capacity of the photosynthetic system.

However, everything doesn't revolve just around bioreactors, does it?

You are right, it doesn't. A bioreactor is a piece of equipment where organisms are cultivated and subjected to basic physiological measurements, particularly through the use of the already mentioned automatic noninvasive monitoring. For more comprehensive analyses we also use methods involving standard manual sampling for various analyses, such as analyses in molecular laboratory, and of course, the image analysis of cells. Therefore, part of our department consists in the laboratory of flow cytometry, where we use the most advanced flow cytometers. These devices excite one cell at a time in a continuous fluid flow of cells through the use of precisely defined light source and they measure the characteristic fluorescence response which is defined by the fluorescent dye used or by another „marker". The advantage of this method is its high-volume nature which allows us to analyze thousands of cells per second and obtain other valuable, in this case also visual, information on the level of individual cells from a statistically significant sample of a heterogeneous population.

Based on these extensive characteristics, we are further able to apply the methods of controlled selective pressure leading to targeted breeding of organisms with desired characteristics. We choose this approach because we do not want to use the method of genetic engineering, which is often approached controversially these days. Moreover, thanks to this directed evolution, we can achieve a comprehensive adaptation of an organism which then serves as a suitable specimen for possible differential genetic analysis.

Your goal is breeding organisms. Within the structure of the Institute you are ranked in the application section. Are you heading towards a particular product then?

Yes, we are mostly perceived as a workplace of applied research, but what we have been talking about so far relates primarily to basic research. Obviously, we are still interested in applied research as well.

First, however, we need to focus our resources on the development of optimization algorithms and methods for breeding photosynthetic organisms. Then we can subject our results to the requirements of applied research and offer our proprietary algorithms and new organisms – „super-algae" – for the use in industrial applications, biotechnologies.

Does your assignment end with the development of super-algae? Or are you going to do something with it?

The super-algae and its breeding is just the first step. The actual super-algae itself may be interesting from the application point of view and it can be offered to companies that will deal with it in their own environment. However, ideally, we will use it ourselves and further develop its potential, including the above mentioned characterization and optimization of a new organism and a detailed analysis at the molecular level. In order to be able to work on the super-algae more intensely, a new laboratory of molecular biology is being developed at the moment. This is a place where we are going to carry out a detailed molecular analysis (metabolomics, proteomics, transcriptomics, etc.) and examine how the super-algae differ from the original type. This comprehensive information on super-algae may serve genetic engineers for their further work.

Not to forget other focuses of the Department, we are attempting to create a model of cyanobacteria „*in silico*" – which is basically a computational model of cyanobacteria, which will allow us to deeply understand the mechanism of processes occurring in the cell and when responding to changes in its environment. If we succeeded, such a model would allow us to do virtual experiments. In contrast to real experiments lasting weeks to months, these virtual experiments will be carried out much faster. If, using the model, we succeed in finding the optimal conditions for the production of an interesting substance, we will only have to verify the conditions in reality and validate the model results. Otherwise, the results of real experiments will serve as an impulse for modifications to the existing model. Apparently, this is a very ambitious project requiring coordination at the level of international multidisciplinary cooperation.

That's right, it seems quite ambitious, and what is more, it also probably requires a broad professional focus of your staff, doesn't it?

I am originally a mechanical engineer, so I am more a technician than a biologist, but throughout the years of cooperation with biologists and other bio-disciplines, I have adapted to the

requirements of interdisciplinary cooperation. I think that the interconnection of engineering approaches and sciences is just necessary to achieve any major breakthroughs in the field of science these days. I studied control theory at the department of applied cybernetics and one of the ideas is that through the use of sophisticated control algorithms in conjunction with a series of laboratory photobioreactors, we can achieve our goals within a time frame relevant to today's generations.

The composition of our team is really diverse – from bioengineers, bioinformatics, through biophysicists, biochemists to biologists. Most of us have had a relatively short scientific career so far, but in my opinion, we have a great potential to achieve the above mentioned objectives.

At the beginning you mentioned the genesis of the Department of adaptation biotechnologies in connection with the CzechGlobe Centre. Nevertheless, I have to ask you, how do your activities relate to the global change?

In our research, we focus on algae and cyanobacteria, which are mostly found in the oceans, and the oceans are very significant participants in terms of influencing the global climate and the atmosphere. In general, people are aware of the role Amazon rainforest plays, but in terms of the greenhouse gases regulation, oceans play a much more significant role. Thus, within the Centre, we provide the missing part of ecosystems – the oceans. We aren't oceanographers, but for our research we use simulated environment in the bioreactors. So we can observe what happens to specific populations of photosynthetic organisms in response to environmental changes, such as increased ocean temperature and pH. Based on our results, we can verify the predictions of climate models and we can contribute to making them more precise.

We are also engaging in joint activities with other departments at the Centre. We explore common topics, for instance, with ecophysiologists, with the metabolomic laboratory or with climate modelers.

The CzechGlobe project has been turned into a unique and costly infrastructure. Hence, I am wondering if your research follows the current world trends, and how unique the research actually is.

Generally, the concept of breeding is nothing really new in terms of global scale. There have been breeding endeavors of grains, domestic animals, etc. However, I am not aware of anyone that would have actively bred cyanobacteria and algae. In this regard, we are developing unique methods and applications.

No one is pursuing the development of optimization algorithms for photosynthetic organisms at a similar level and finally, the complete mathematical model of cyanobacteria, as we have conceived it, is also very unique as is evidenced by a strong interest in these outcomes abroad.

Our team is at the core of the newly establishing international consortium called CyanoNetwork, where we cooperate with institutions in Israel, Germany, Austria, the Netherlands, England, Russia, the USA and Canada. Most of the mentioned workplaces represent the world leaders in photosynthetic research.

DEPARTMENT OF ADAPTATION BIOTECHNOLOGIES

Department of adaptation biotechnologies belongs among new teams established in the CzechGlobe Centre. Within the Centre's structure, it is incorporated in the Division of innovation and adaptation techniques. There are a total of 12 employees out of which there are eight researchers. It engages in both basic and applied research.

The department runs a reference and optimization laboratory for the research on photosynthetic organisms, a laboratory of flow cytometry and a laboratory of molecular biology. These workplaces, together with a series of bioreactors are supposed to contribute to finding organisms that are either genetically transformable or their metabolic pathways lead directly to the production of energy-rich substances.

Currently, the Department is addressing a project of the Czech Science Foundation and an EC OP project called „CYANO-TEAM" that is aimed at establishing a research team and an international consortium for a computational model of a cyanobacteria cell.

WE ARE OPENING UP TO THE WORLD

It has already been three years since the development of a new research CzechGlobe Centre was launched on 1st December. Meanwhile, the initially small scientific institute, in terms of staff, research teams, size of infrastructure as well as instrumentation, has become a significant modern research institution. Apparently, also the prestige of the Centre of Excellence CzechGlobe is rising, both at the national and international level.

This is proved, among other things, by the signature of the Memorandum of cooperation with a major American consortium NEON (National Ecological Observatory Network, Inc.) – analogic to European research network ICOS, which CzechGlobe is an integral part of since its very foundation in 2008.

The impulse to sign the Memorandum was the visit of the Director of Strategic Development in NEON Henry Loescher in April. Dr. Loescher was introduced to CzechGlobe research activities related to the global carbon cycle and visited the atmospheric station in Košetice and the Laboratory of adaptation biotechnologies in Drásov.

Likewise, in September the same year, the representatives from the Department of substances and energy fluxes visited NEON headquarters in Boulder, Colorado (USA), where they introduced CzechGlobe and prepared specific themes for future cooperation. Besides visiting the NEON network, they also went to see the Earth System Research Laboratory in the David Skaggs Research Center, which is part of the National Oceanic and Atmospheric Administration (NOAA). The Director of the Global Monitoring Division, James Butler, is planning to visit the CzechGlobe Centre very soon. The visit, which

is already being arranged, could be another great opportunity for further cooperation in the area of CO_2 monitoring.

In addition to the fact that CzechGlobe is becoming an equal partner to the world's top institutions, it is also proposing the imaginary helping hand to institutions in Third World countries. The mentioned cooperation is mainly offered for the measurement of substances and energy fluxes between ecosystems and the atmosphere, for which CzechGlobe can provide its first class infrastructure as well as the necessary know-how. The first result in this regard was the establishment of cooperation with the Institute of Tropical Biology in Saigon (Vietnam). This cooperation set the basis for an ongoing project of bilateral cooperation and, in addition to that, one of the CzechGlobe PhD employees is just being trained to be able to build a joint ecosystem station in Vietnam. A similar agreement on bilateral cooperation was successfully signed when visiting the University of Panama in Panama this year. Likewise, this institution also has its PhD student available in the CzechGlobe Centre.

DANGEROUS CLIMATE CHANGE WILL PROCEED UNEVENLY

GOT OUR ATTENTION

Camilo Mora et al., Nature vol. 502, October 2013

We are often confronted with the question: „When will the climate change become dangerous?“ The new scientific paper by the authors Mora et al. (2013, Nature) partly provides answers to this question. A borderline for the „dangerous“ proceeding climate change is considered the period when each subsequent year is more extreme than any of the previous years over the period from 1860 to 2005. According to the authors, various regions of the world will be affected by the proceeding changes at different times, yet almost all areas will be under the influence of dangerous climate change by around 2050. Provided that we limit the release of greenhouse gases into the atmosphere, we can delay these permanent changes by another 20 years.

In this paper, using climate models, the authors evaluated seven key environmental parameters, including temperature, precipitation, evaporation, transpiration or acidification (pH decrease) of oceans. We have long been familiar with the fact that global warming is now proceeding, and going to proceed faster in colder climate areas and higher latitudes. However, significant changes will first occur in tropical areas. This is due to the fact that the current climate variability in these areas is lower rather than in regions towards the poles, and thus even a relatively slower process of climate change will result in earlier excess of the absolute thresholds of variability that were determined in the past. The impacts will be even more noticeable, since plants, animals and after all also people living in these areas are not accustomed to such changes. The most vulnerable are coral reefs and the unprecedented living conditions will be experienced by people living in some cities in tropical areas at the beginning of the next decade. Southern Europe will be affected earlier followed by the northern parts of Europe, the Czech Republic can expect the threshold to be exceeded in about 2056 (see the Figure).

The paper states that current conservation efforts that are supposed to protect ecosystems from other effects of human activities are unable to protect these areas from climate change, and furthermore, the efforts on the expansion of conservation areas will be complicated by the fact that these changes will impact the low-income countries first. By 2050, approximately one billion people (provided that the growth in emissions will keep on rising, it will be even up to 5 billion people) will have been affected by the dangerous climate changes. It will be mostly people who caused the smallest share of its occurrence. The authors of the study point out that their results stress the urge of reducing greenhouse gas emissions if we want to prevent large-scale changes in human societies and global biodiversity.

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References: *http://www.nature.com/nature/journal/v502/n7470/full/nature12540.html*

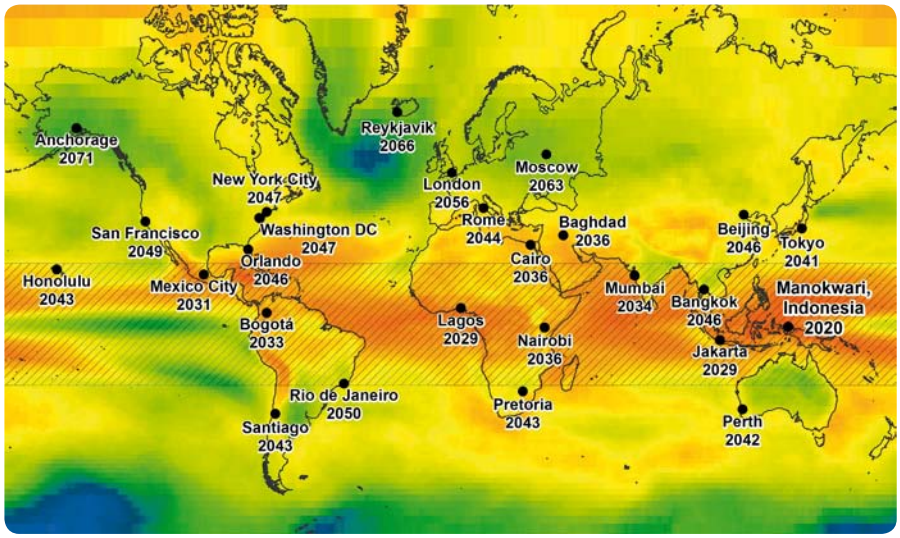

Figure: Uneven progress of the global change considering the scenario of growing greenhouse gas emissions. According to the authors, some tropical regions will exceed the climate variability thresholds determined over the last 150 years, as early as at the beginning of the next decade. Our latitude awaits dangerous climate change a little later, around the year 2056. (Source: the author's website *http://www.soc.hawaii.edu/mora/PublicationsCopyRighted/Cities%20Timing.html*)

WHAT´S NEW

A visit to the Ambassador of Bhutan

On the 18th September the director of the CzechGlobe Centre, Michal Marek, together with the scientific secretary, Jiří Kolman, accepted the invitation of the Ambassador of Bhutan in Brussels. The purpose of the meeting with the Ambassador was to discuss and prepare conditions for scientific activities of CzechGlobe experts in Bhutan, namely for the research of the global change effects.

Researchers‘ Night

On 27th September 2013, the traditional Researchers‘ Night, which is the largest showcase of scientific disciplines intended for general public, took place across EU countries. This ninth year's motto was “Energy for knowledge”. Also the GCRC got involved by organizing the Open day at the Experimental Station Bílý Kříž as well as a night sky observation of the dark-sky preserve in the Beskydy area. The event was accompanied by expert presentation, debate, demonstrations of measurements and screening of the film called „What if the world got switched off“.

Open Day

The workplaces of the Academy of Sciences traditionally devote the first half of November to popularizing science via organizing the Science and Technology Week. This year's event was driven by the motto „Fascinated by the world“. On 8th November, as part of this event, GCRC organized the Open Day at its Brno premises. General public visitors were offered thematic tours around selected laboratories and a series of four lectures under the following titles: How forest breathes, Photosynthesis – why is forest green, View of the ecosystems from the bird's-eye perspective and The global change and sustainable development.

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