NEWS FROM CRH

September 2018

CENTRE OF THE REGION HANÁ
FOR BIOTECHNOLOGICAL AND
AGRICULTURAL RESEARCH

INTERVIEW

IVO FRÉBORT — Director of CRH

Readers are holding the first issue of CRH newsletter. Why have you decided to publish it?
CRH has quite a lot of scientific, educational and other activities. It is good to summarize these and present the most important accomplishments within the institute as well as to the expert and laic public.

The newsletter will bring information once per semester. How would you assess the past period?
We have achieved a number of solid scientific results. However, finishing and publishing the reference wheat genome sequence is the clear highlight. At 17 billion nucleotides and over 100,000 genes it is the most complex organism on Earth yet sequenced. It brings a huge amount of new information to our field for both understanding the basic functions of monocular cultural crops as well as for breeding new varieties with better properties. I would also like to mention our first major success in the field of molecular farming, namely the development of a technology that can lead to high capacity production of human peptide cathelicidin in modified barley.

What changes have occurred due to two important OP VVV projects - Plants as a means of sustainable global development and Pre-application research in the field of nano- and biotechnology?
Both projects are absolutely crucial for CRH and they demonstrate that we can succeed in very strong competition. Regarding the project within Excellence Research call, we are currently in the so-called start-up phase. We put together a management and implementation team, we purchase equipment, so there are a lot of tenders, we are gradually recruiting new workers. The research will fully begin in January next year. Research in the second project began in July, we have been transferring gained knowledge to be used in practice.

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Can you zoom in on some of the research intentions from which you have the greatest expectations?
I have great expectations in the area of barley genome editing. So far, we have succeeded in shutting down some genes and now we will focus on searching for those related to adaptation of plants to stress. These genes could be turned off, in order to find out their functional context and to suggest a way to help the crop deal with adverse environmental impacts. In the long term, we want to develop a technology which will enable us not only to turn off the gene but actually edit it.

You yourself deal with genetic modifications of plants. What are you currently working on?
I consider the production of antimicrobial peptides via molecular farming very promising. We have achieved solid results with cathelicidin, but we will also focus on other substances. I set up a research group, I dedicate a lot of my time and effort to this topic, and enjoy it very much.

GMOs are framed by a myriad of myths that you are trying to refute for example at popularization events for the public. Do you see a shift in public opinion?
The Czech Republic is relatively liberal in this respect. However, I see that people know very little about this issue. They do not have information that genetically modified bacteria or yeast is being used or that traditional breeding commonly uses chemical and radiation mutagenesis. On the other hand they have negative attitude towards herbicides. We are still lagging behind, e.g. the US or Western Europe in keeping the public informed. I see potential for CRH in this area. We need to get more involved in public education.

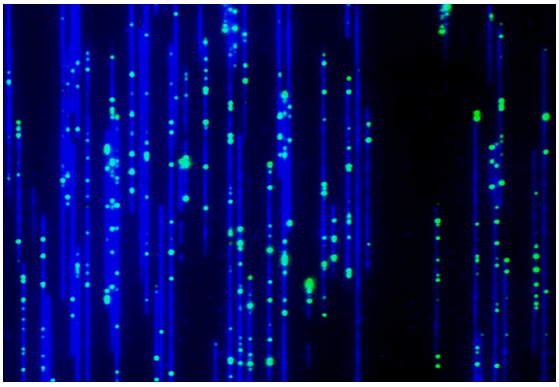
The European Court of Justice recently restricted the use of the method CRISPR and other similar techniques. Was it a black day for science? Does this affect research in CRH?
The thing is that the same regulation as on GMOs will be imposed on the products created by CRISPR method, which effectively means that they will be subject to complex, excessive and costly approval process. While in the US or Canada, for example, all products are assessed in the same way, In Europe they are judged based on the method of preparation; those generated by genetic modifications are de facto at the same level as pharmaceuticals. But for instance crops created by irradiation are not evaluated this way, which is a big paradox. In the Czech Republic, and therefore at CRH, basic research will stay unaffected. We are still use the technique to turn off genes in barley or alfalfa. But it can have an impact on applied research and, above all, on creating products of biotechnology in all areas, not only in agriculture. Development and production will move out of Europe, and the old continent will become even more dependent on importing these products.

SCIENCE AND RESEARCH

GENETIC CODE OF WHEAT HAS BEEN BROKEN ALSO THANKS TO OLOMOUC SCIENTISTS

The genome of common wheat, one of the most important agricultural crops, has been resolved. International Consortium for Wheat Genome Sequencing (IWGSC) informed about it in Science. An important role in this research has been played by Olomouc scientists of the Institute of Experimental Botany (IEB) of the Academy of Sciences, which is part of the Center of the Region Haná for Biotechnological and Agricultural Research (CRH).

It took thirteen years of work and 200 scientists from 20 countries. Research was based on chromosome sorting method using flow cytometry developed and used only by Olomouc scientists. "This procedure allowed for dividing large and complex genetic information to smaller parts - chromosomes, which simplified the reading of DNA and the subsequent arrangement of read sections. Our laboratory thus supplied the DNA of chromosomes to collaborative laboratories in different parts of the world. We have obtained complete and very accurate text of genetic information of wheat," said the head of the Center for Structural and Functional Plant Genomics of IEB and Scientific Director of CRH Jaroslav Doležel. According to him, scientists now know the sequences of all 21 wheat chromosomes, exact location of 107,891 genes and more than four million molecular markers.



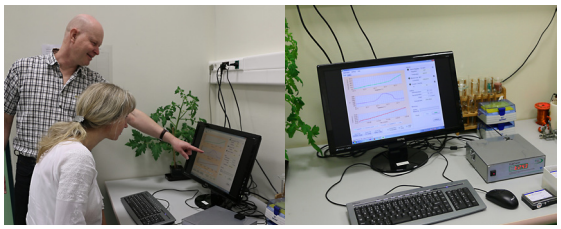
Another benefit of the workplace was the preparation of so-called BAC libraries, thanks to which it was possible to read longer sections of the genetic information text. Last but not least, the researchers successfully devoted themselves to sequencing three out of 21 wheat chromosomes. Other methods, such as optical mapping, have been involved in research.

With detailed knowledge of genetic information, breeders can now faster identify genes responsible for yield, grain quality, resistance to disease and pests and genes crucial for better overcoming periods of drought. In the future, this achievement will be of great importance in using new genetic modification methods.

The International Wheat Genome Sequencing Consortium (2018) Shifting the limits in wheat research and breeding using a fully annotated reference genome, Science 361. IF = 41.058.

BIOPHYSICISTS HAVE DEVELOPED A DEVICE FOR FAST MEASUREMENT OF HIGH-TEMPERATURE RESISTANCE OF PLANTS

Device for measuring plant resistance to higher temperatures has been developed by Biophysics team at CRH. PlanTherm determines general thermostability of cells and at the same time the thermostability of photosynthetic apparatus that scientists used to have to find out separately. The measurement is faster, easier and more complex than previous techniques.



"This is a universal thermostability measuring device of any cells that we primarily developed for plant cells. It is actually a heating system in which the temperature must be increased linearly. The whole measurement takes about 25 minutes," said the head of the Biophysics Department, Petr Ilík. Scientists developed the device in cooperation with a Czech company Photon Systems Instruments and offer it for commercial use. Plant thermostability has been studied not only in basic research, but it can also help breeders, e.g. when selecting varieties resistant to higher temperatures.

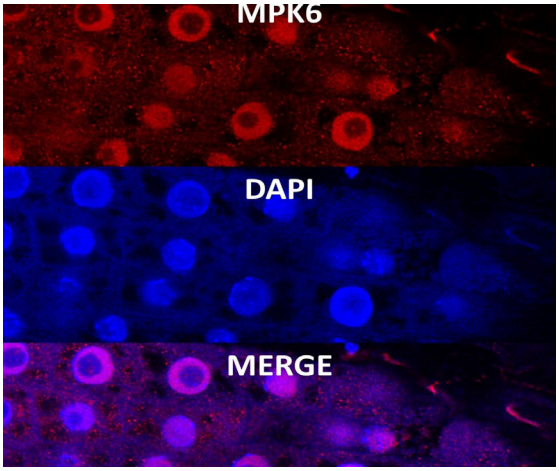
For the measurement, scientists need only a small part of the plant, the leaf at best. They then put it in a small apparatus in which there is a beaker with deionized water. Scientific community can get acquainted with the new methodology in an article in New Phytologist journal.

Ilík P, Špundová M, Šicner M, Melkovičová H, Kučerová Z, Krchňák P, Fürst T, Večeřová K, Panzarová K, Benediktyová Z, Trtílek M (2018) Estimating heat tolerance of plants by ion leakage: a new method based on gradual heating. New Phytol. 218, 1278-1287. IF = 7.433.

LONG-TERM RESEARCH HAS EXCITED EDITORS OF THE PRESTIGIOUS ANNUAL REVIEW OF PLANT BIOLOGY

Scientists from Department of Cell Biology, CRH have tapped into the most prestigious magazine in the field of plant science, Annual Review of Plant Biology. In a review article they summarized their research of mitogen-activated protein kinases (MAPK) and described the role of these important enzymes in plants.

"In this journal, scientists can only publish based on invitations and they will do so twice, exceptionally three times in a lifetime. The top authors always summarize their own research in fifteen to twenty years. That is why we were very pleased to have been invited. We have published a very comprehensive article, its preparation took more than a year. It is a milestone in the career as well as appreciation of the whole laboratory," said the head of the department and the lead author Jozef Šamaj. He and his colleagues have been studying the topic for a long time. Knowledge gained from model plants of Arabidopsis thaliana are used by scientists who research alfalfa or barley.



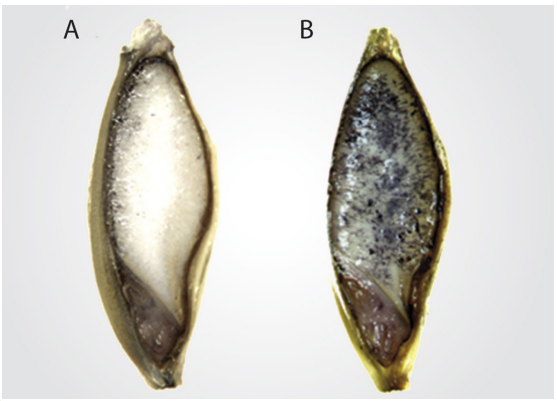
MAPKs are phosphorylation enzymes involved in a wide range of processes in plant, animal and human cells. They are involved in plant developmental processes starting with the development of seeds, embryos, pollen, blooms to leaf, stem, root or tuber development. On the other hand, they can react very quickly to environmental changes and various types of stress, such as diseases, pests, drought or other climatic influences.

Komis G, Šamajová O, Ovečka M, Šamaj J (2018) Cell and developmental biology of plant mitogen-activated protein kinases. Annu. Rev. Plant Biol. 69, 237-265. IF = 18.712.

SCIENTISTS HAVE FOUND A WAY TO CREATE HUMAN PEPTIDE IN BARLEY

Scientists from the Department of Molecular Biology have developed a unique technology that can be the basis for large-scale production of cathelicidin. The human peptide, which acts as a natural antibiotic, can be "produced" in genetically modified barley grain. The new method could also be used for preparation of other pharmaceutically important substances in plants.

Cathelicidin is one of the most famous antimicrobial peptides of human skin, it is part of its defensive function before infectious micro-organisms. Cathelicidin can be used in medicine for example in the treatment of chronic wounds and skin diseases. One of the main obstacles to commercial use of cathelicidin is its high manufacturing cost. This is why CRH researchers have decided to create this peptide in plants, even though they had to overcome various difficulties. Peptides have only limited stability, moreover may be toxic to the host plant.



"First we tested the effects of different protein or peptide molecules on the aforementioned factors. Then we proposed various types of genes for human cathelicidin and brought them first into tobacco leaves where hybrid molecules originated. After selecting the most efficient production strategy we imported the genes into barley. Developed transgenic plants produced cathelicidin only in caryopsis," said CRH Director Ivo Frébort. Scientists isolated the peptide and subsequently tested its antimicrobial activity. They have proven that cathelicidin obtained this way or its variants do not have negative effect on the plant itself. Now their goal is to increase the quantity of produced cathelicidin in a plant and minimize the costs associated with its production and isolation.

Holásková E, Galuszka P, Mičúchová A, Šebela M, Öz MT, Frébort I (2018) Molecular farming in barley: development of a novel production platform to produce human antimicrobial peptide LL-37. Biotechnol. J. 13. IF = 3.507.

BRIEFLY

In August, CRH presented its research at summer edition of flower exhibition and garden market Flora Olomouc. One of the pavilions of the exhibition center has been turned into a plant research laboratory. While Biophysicists showed through experiments that plants can shine, communicate with each other and some of them even move, a team of Molecular Biologists introduced the possibilities of genetic transformation of plants and their benefits not only for plants themselves but also for humans.

CRH had a significant presence at this year's Congress of Federation of European Biochemical Societies (FEBS), which took place in Prague in July. Two of the program sections were chaired by the head of the Department of Biochemistry of Proteins and Proteomics Marek Šebela, and Jozef Šamaj, head of Department of Cell Biology, took charge of another symposium and also performed a lecture called Advanced super-resolution and light-sheet microscopy bioimaging of plants. FEBS Congress takes place annually and is attended by several thousand participants.

New knowledge needed for faster development of methods that can help resolve the imminent food crisis have been discussed by the world's leading experts in research of wheat and banana at Advances in Plant Genomics for Crop Improvement symposium. It was held in July by IEB of Academy of Sciences within the research program Food for the Future AV21 strategy IEB of the Academy of Sciences.

CRH Scientific Council met again after six months in June. The agenda included information on two new OP VVV projects: Plants as a means for sustainable global development and Development of pre-applied research in the field of nano- and biotechnology.

Changes in the Career Code and the Partnership Agreement have been approved in June by participants of the 20th meeting of the Board of Directors of CRH. They also discussed the new Constitution of CRH, the purpose of which is future cooperation and coordination of all partners, Palacký University, Institute of Experimental Botany of the Academy of Sciences of the Czech Republic, and Crop Research Institute.

What a "stone" lettuce looks like, what is maral root or an earthworm tea. Answers to these and other questions were given at the traditional field sermon held in the middle of June at Olomouc worksite of the Crop Research Institute. More than 70 visitors had an opportunity to look into preparations of genetic material for the local gene bank of vegetables, aromatic, root and medicinal plants.

COOPERATION WITH BUSINESSES

SMART FERTILIZERS INCREASE YIELDS OF CEREALS AND OTHER CROPS

Researchers from CRH have reaped the benefits of their experience from years of study of plant hormones and developed new smart fertilizers. Besides the necessary nutrients, they contain the original cytokinin derivatives that have not been used in agricultural practice so far. Liquid preparations are very effective, gentle to the environment and easy to apply. Farmers, who should be able to get them on the market this year, will be ensured higher yields of cereals, oilseeds and other crops. CRH scientists collaborated with Chemap Agro, whose original preparations served as the basis of new stimulators.

The preparations are unique in the Czech Republic and probably in the world. It is a combination of macro and micro elements and plant hormones that we have developed over years of research. After application, the crops are easier to root, deal better with adverse climatic conditions, and create more offshoots and grains," said one of the authors Radoslav Koprna.

Aucyt Start fertilizer contains a synthetic derivative of cytokinins, which promotes the formation of strong offshoots, hence the cobs and grains in cereals and branching in oil plants. Application is done in the fall or spring directly by spraying plants. On the contrary Primseed fertilizer is designed for seed priming of spring or winter cereals such as rape, poppy, sunflower, legume and other crops. It contains a cytokinin antagonist, which reduces the plant's ability to perceive cytokinins. It has a positive influence on its initial development and ultimately on its yield.

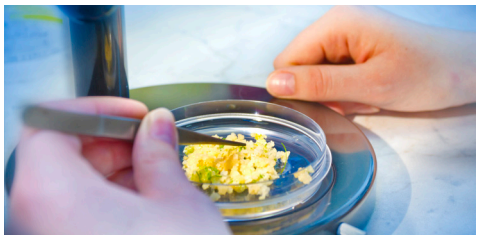
Fertilizers are the result of roughly a decade of joined effort of a number of chemists, plant specialists, biologists and physiologists. The products were registered as herbal preparations - combined stimulation fertilizers and are mainly intended for agricultural companies.

GRANTS

PRE-APPLIED RESEARCH WELL UNDERWAY

Project called Pre-applied research in the field of nano- and biotechnology, which started in July, creates a link between excellent research and eventual technology transfer. Researchers from both CRH and partner Regional Center of Advanced Technologies and Materials (RCPTM) are concerned with the development of new technologies usable, e.g. in agriculture, food industry, environmental protection or medicine.

"Scientists can complete their research, verify if they are suitable for commercial use, and also set the correct legal protection in relation to terms of future license or other means of transfer to practice," said the project´s principal investigator Lucie Plíhalová.



Three out of eight teams are engaged, for example, in the development of fertilizers of new generation, isolation and preparation of plant substances with antimicrobial and disinfectant effects or substances usable in cosmetics or hygiene products.

Another team will focus on gene engineering to breed a special variety of barley that should produce peptides with antibacterial effects suitable for application in cosmetics or medicine. Project with subsidy of CZK 125.8 million from the Operational Program Research, Development and Education - Pre-application Research for ITI (Integrated Territorial Investment) will run until the end of 2022.

CRH PICKS NEW REINFORCEMENTS AND EQUIPMENT FOR EXCELLENT RESEARCH

Getting new knowledge and developing techniques to enable breeding of economically significant crops with higher yields and greater resistance to adverse climatic conditions is one of the main goals of a project called Plants as a means of sustainable global development, which started in March. In grant call Excellent research of the Operational Program Science, Research and Education, CRH ranked seventh among 15 best applicants.

"The goal of the project is to gain knowledge about growth and yield regulation, property and sign formation, and stress adaptation of plants that are the main food source of mankind. We are capable of quite fast verification of laboratory research results from genetics, molecular biology, and biochemistry in growth chambers, greenhouses and then directly in the field," said CRH Director Ivo Frébort.

The project will bring new instrumentation including DNA sequencer of the latest generation, fluorescence microscope with super-high resolution for studying plant cell nucleus or unmanned helicopter with an air scanner that evaluates speed and extent of growth of biomass in field conditions. The purchase of new equipment and recruiting staff is a crucial part of the first phase of the project. Research part will fully start in January 2019.

CONGRATULATIONS

RESEARCH OF CLIMATE CHANGE IMPACT ON PLANTS HAS ATTRACTED WORLD EXPERTS

A scientist of the Olomouc worksite of IEB of the Czech Academy of Sciences, Pranav Sahu, has impressed experts from The Society of Experimental Biology (SEB) based in London with his research of climate change impact on plants. In vast international competition, he was selected among three finalists of the prestigious prize YSAS (Young Scientists Award Session) in the research section of plant cells and he presented his work at SEB conference in Florence in July.

CRH HAD A STRONG PRESENCE AT THE EUROPEAN CONGRESS ON BIOTECHNOLOGY

Researchers from Olomouc contributed by a total of five lectures to the scientific program, which is addressed to academics, representatives of public research institutions, and participants from the business sphere. In addition, CRH's Director Ivo Frébort and Head of Department of Cell Biology, Jozef Šamaj, chaired several program sections. The findings of their own research were shared by Tomáš Takáč, Miroslav Ovečka and Despina Samakovli, in addition to Professor Šamaj, who belonged to the invited speakers. Doctoral student Alžběta Mičúchová experienced her premiere performance at a large-scale international forum.

The meeting in Geneva was also the starting point for the forthcoming Plant Biotechnology: Green for Good V Conference, which will be organized by CRH in Olomouc in June next year. "The conference is strongly supported and co-organized by EFB. We also discussed cooperation with the Asian Federation of Biotechnology, which promised to contribute to the scientific agenda of the conference. In this context, a higher number of participants from Asia can be expected to participate in the event," said Michaela Holecová, member of the organizing committee.

Congress was attended by 700 delegates, with South Korea having the largest representation, indicating a growing interest in cooperation from Asian partners. Next year a Congress of the Asian Federation of Biotechnology will take place in Taiwan.

PLANNED ACTIVITIES

In November CRH will join the Science and Technology Week of the Academy of Sciences of the Czech Republic. On November 7-9, CRH will organize guided tours for school children and the general public called "We are looking for ways to benefit plants as well as people". Inside laboratories, scientists will explain to those interested why it is important to research economically important plants, such as barley and wheat. They will learn about genetic plant transformations and other research intentions. They will see cutting edge technology, including state-of-the-art microscopes which enable researchers to look at living plant cells.

On Wednesday, November 8, the Stronghold of Knowledge will host a lecture by CRH´s Director Ivo Frébort entitled "GMO and genome editing - Possible challenges, risks, and opportunities". In his performance he will introduce to high school students the essence of evolutionary changes and processes of natural and targeted genetic selection of organisms. Practical examples of techniques that enable imprinting desired properties to plants will be presented, such as gene insertion (GMO) or new methods of genome editing.

Centre of the Region Haná for Biotechnological and Agricultural Research

CRH brings together research groups from Palacký University and Olomouc worksites of Institute of Experimental Botany, AS CR, and Crop Research Institute. CRH is a Regional Branch Office of EFB.

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