PRO LOEWE NEWS

The LOEWE Research Initiatives report

SPECIAL: MAKING HESSE'S FORESTS FIT FOR HOT SUMMERS

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Title: Beech trees are the most common deciduous trees in Germany's forests and can be found in about one third of Hesse's state forest area. The genetic makeup of individual trees determines how well they will survive fairly long periods of drought. This is what researchers from the LOEWE Centre for Translational Biodiversity Genomics have discovered. Photo: Marc Guddorp

Photo below: The hot summers in recent years have also left their mark on beech forests in Hesse. In some places, almost half of the trees are damaged. Drone pilot: Volker Heymann Photo: Markus Pfenninger

WHICH TREES SURVIVE DRY, HOT SUMMERS AND WHICH ONES DO NOT? RESEARCHERS AT THE LOEWE-TBG IDENTIFY GENES FOR DROUGHT RESISTANCE IN BEECHES

Which trees survive dry, hot summers and which ones suffer severe damage? It is now possible to answer this question for beech trees using genome analysis. A team led by Prof. Dr Markus Pfenninger of the **LOEWE Centre for Translational Biodiversity Genomics (TBG)** and the Senckenberg Biodiversity and Climate Research Centre (SBiK-F) in Frankfurt/Main has studied damaged and healthy beech trees in Hesse and identified areas in their genome that are responsible for drought resistance. Based on these DNA segments, it is possible to say for each individual tree how well it will survive fairly long periods of drought. Thanks to targeted DNA tests, resistant specimens could therefore be selected for forestry work and beech forests could be made fit for climate change. The study has now been published in the „eLife" journal.

Anyone walking through Hesse's forests in summer will repeatedly see brown parched leaves and dead branches on trees. The long dry periods in 2018 and 2019 have left their mark. Prof. Dr Markus Pfenninger, who conducts research at LOEWE-TBG and SBiK- F and teaches at the Johannes Gutenberg University in Mainz, has observed this too. One detail in particular has caught his eye: „Not all trees suffer damage to the same degree in beech forests. Completely healthy trees are standing right next to badly damaged ones." These kinds of unequal pairs can be found throughout Hesse. But what lies behind it?

The answer lies in the genetic makeup of the trees, as a study by Pfenninger and colleagues on about 200 pairs of trees has now shown. The genome of the copper beech, i.e. its entire genetic information in the form of DNA, comprises 542 million building blocks. The copper beech (Fagus sylvatica) is widespread in Europe and is the most common deciduous tree in Germany's forests. Some of the building blocks in its genetic material are identical in all copper beeches. Others, however, differ from tree to tree. And this is exactly what happens in healthy or severely damaged beech trees, as the genome analysis shows: according to this analysis, around 100 DNA segments are crucial for drought resistance. In healthy trees, these sections contain, among other things, genes that are familiar from other plants and enable a kind of „survival response" to drought stress.

„The individual genetic makeup determines whether a beech tree will survive prolonged periods of drought well," Pfenninger says. Molecular ecologist Dr Barbara Feldmeyer (SBiK-F) explains, „If we classify individual trees, forestry workers can make use of particularly resistant trees, for example, for reforestation. Then beech forests will be equipped for climate change in the long term."

To make this possible, the researchers have developed a test based on their results and it can be used to detect drought resistance in the genetic material of beech trees – even in their seeds. Researchers from the Technical University of Darmstadt, the Justus Liebig University in Giessen, Geisenheim University and the Johann Wolfgang Goethe University in Frankfurt are also involved in the study.

The research scientists led by Pfenninger examined beech trees throughout Hesse in 2019 and 2020 for the study, from the Taunus area to the Rhine-Main region, the Odenwald and even the Westerwald and northern Hesse. At each of the 200 or so sites, they selected for analysis one healthy-looking tree and one tree nearby, on average five metres away, with severely withered leaves or none at all. In the laboratory, DNA was extracted from the leaves that were still green. Based on the genome data, the test was developed with molecular markers for the drought-resistant genes and experiments were performed on about 90 beech trees. The success rate was 99 percent.

„Our study has laid the scientific foundations for the sustainable management of beech forests; it provides support for the natural selection of resistant trees," says Pfenninger. „The task now involves putting the findings into practice, for example, by monitoring natural forests or selective logging and reforestation. In this way, we can help preserve a unique ecosystem that is already feeling the effects of climate change. After all, one thing is already certain: the next hot summer is bound to come."

Publication in 'eLife' by Markus Pfenninger, Friederike Reuss, Angelika Kiebler, Philipp Schönnenbeck, Cosima Caliendo, Susanne Gerber, Berardino Cocchiararo, Sabrina Reuter, Nico Blüthgen, Karsten Mody, Bagdevi Mishra, Miklós Bálint, Marco Thines, Barbara Feldmeyer.
„Genomic basis for drought resistance in European beech forests threatened by climate change".

Logo of the first emergenCITY Week, which was held on 14 – 17 June 2021 as a digital event. Copyright: emergenCITY

FIRST LOEWE-EMERGENCITY WEEK SUCCESSFULLY COMPLETED

The first **emergenCITY** WEEK since the LOEWE project was launched in 2020 focused on its main goal of conducting interdisciplinary research into the topic of resilience in digital cities; the event involved workshops, top-class lectures and discussions. Roughly one year after the start of research, **emergenCITY** brought together more than 70 scientists with partners from various private and public organisations and other international research scientists to share their ideas using digital means. Many of the events were explicitly open to the general public. The first event was the scientific conference entitled "Software and Resilience". International guest speakers offered daily insights into current research on various topics in a series of distinguished lectures: the spectrum ranged from machine learning to more resilient graphs and even communication technologies. Another cooperative event with the Schader Foundation, which was organised by the **emergenCITY** Professor Michèle Knodt, dealt with the scenario of a prolonged power blackout – and its consequences for a city like Darmstadt. There was also a workshop on "Responsible Digitalisation – from Ethics to Law?" led by Prof. Petra Gehring in conjunction with the Hesse Centre for Responsible Digitalisation.

However, the week was also extremely fruitful for sharing ideas internally and coordinating the scientific progress achieved in the project to date. In cooperation with partners from industry, public authorities and the centre's scientific advisory board, **emergenCITY** scientists discussed five ongoing research missions in different fields: the current projects range from resilient smart homes to a neighbourhood app and even using drones to safeguard local connectivity and another project – on the topic of "digital twins" – is now set to be launched with the German Aerospace Center (DLR).

The highlights of the extremely full week not only involved taking a look at the successes and research results already achieved, but also presenting the first **emergenCITY** Collaboration Award for three interdisciplinary publications written by young scientists at the LOEWE Centre. You can discover more at: www.emergencity.de.

THREE NEW LOEWE CLUSTERS FROM JANUARY 2022 ONWARDS: INCLUDING A THEME-BASED PROJECT ON „SUSTAINABILITY" FOR THE FIRST TIME – AND TWELVE RESEARCH PROJECTS IN THE NEW „LOEWE EXPLORATION" FUNDING LINE

Three new LOEWE clusters involving pure research will receive research funding from the federal state of Hesse from 1 January 2022 onwards: **LOEWE "GreenDairy – Integrated Animal/Plant Agricultural Ecosystems"** on the topic of "Sustainability" **(led by the Justus Liebig University in Giessen)**. This cluster will examine how two dairy production systems work and how sustainable they are and the results will be used to provide new ideas for research into agricultural systems as well as deriving recommendations for practical action from theoretical ideas. The scientific coordinator is Prof. Dr Andreas Gattinger and the academic partner is the University of Kassel. **LOEWE "FLOW2W FOR LIFE" (led by the Technical University of Darmstadt**). The focus of this research cluster is on drug development. Organs artificially produced in a laboratory will test the effectiveness and toxicity of active substances on human cells outside the body. The scientific coordinators are Prof. Dr Ulrike Nuber and Prof. Dr Jeannette Hussong. **LOEWE "ACLF I - Pathogenetic Mechanisms in Acute-to-Chronic Liver Failure" (led by the Goethe University in Frankfurt/Main)** will deal with the disease pattern of liver cirrhosis and the acute organ failure that often occurs as a result of this (ACLF, acute-to-chronic liver failure). Various mechanisms and the interaction of individual organs in the development of ACLF will be examined and new diagnostic tests and therapeutic approaches will be developed within the framework of the LOEWE funding. The scientific coordinator is Prof. Dr med. Jonel Trebicka. The partners are the Fraunhofer Institute for Molecular Biology and Applied Ecology IME in Giessen, the Georg Speyer House in Frankfurt and the Paul Ehrlich Institute in Langen. The key areas of focus that have been selected will receive funding totalling EUR 18 million for a period of four years.

"Our society is facing great challenges. In order to guide it [...] into the future so that it is able to change, we need the thoughts and solutions of many bright minds – and this includes cutting-edge research; we're encouraging this through our [...] LOEWE programme, which is unique in Germany," says Science Minister, Angela Dorn.

Twelve scientists will receive state funding for their innovative and bold research approaches in the new "LOEWE Exploration" funding line for unconventional innovative research. The research projects selected will receive funding totalling more than EUR 3 million for a period of two years.

The decision about which research projects were to receive funding from Hesse was made by the LOEWE Administrative Committee on the basis of assessments by outside experts and the recommendations of the LOEWE Programme Advisory Board.

STEPHAN BECKER, SPOKESPERSON FOR LOEWE-DRUID PARTICIPATES IN A PROMINENT ONLINE EVENT ORGANISED BY THE IGH

"Why we can no longer ignore 'neglected diseases'." was the central issue discussed at an online event organised by the Initiative Gesundheitsindustrie Hessen (IGH or the Hesse Health Industry Initiative). Entitled "MOSQUITOS, WORMS AND CO. ... WHAT WILL HAPPEN AFTER CORONA?", Minister of State, Tarek Al-Wazir, Prof. Dr Klement Tockner (Director General of the Sencken-

berg Nature Research Society), Prof. Dr Jochen Maas (Head of Research & Development at Sanofi-Aventis Deutschland GmbH) and Prof. Dr. Stephan Becker (Head of the Institute of Virology at the Philipps University in Marburg and the spokesperson for the **DRUID LOEWE Centre**) discussed a pressing topic at this time. The session focused on so-called "neglected diseases", zoonoses and the question of why these issues are steadily becoming more important for temperate latitudes too, particularly because of climate change.

This was followed by a lecture by Prof. Dr Stephan Becker. He used this to introduce the **DRUID LOEWE Centre** and its research into neglected tropical diseases, which are also associated with poverty. The 25 research groups involved in **DRUID** have been working intensively on the development of innovative drugs and diagnostics to combat tropical infectious diseases since 2018. Stephan Becker is also coordinating the "Emerging Infectious Diseases" research field at the German Center for Infection Research and the DFG-funded "SFB 1021" special research field on RNA viruses (DFG = German Research Foundation).

21 STAGES TO THE FINISH: THE PROLOEWE SCIENCE RALLY LAUNCHES A BIG SUMMER HOLIDAY QUIZ ON 2 AUGUST

It will soon be time for the summer holidays in Hesse. This poses a challenge for many families because of Covid-19, as the pandemic makes it hard to plan a vacation. Is boredom therefore inevitable? Not with the **ProLOEWE Science Rally**: it starts on **2 August at proloewe.de and provides a new science puzzle** for people to solve every day in 21 stages. **There are 21 puzzle videos from the Hesse LOEWE projects to solve by 2 September 2021 at the very latest.**

Children and young people aged 10 and upwards can take part and the whole family is invited to join in the fun. The best thing about it is that there are some great prizes to win for each LOEWE project; and anyone who manages to solve all the tasks correctly will be entered into the final draw for one of the three main prizes.

LOEWE scientists use the 21 puzzle videos to introduce young people to the world of pure research and show them how exciting and varied it is.

Whether experimenting, painting, crafting or discovering previously unknown things in nature, the puzzles are as varied as the prizes. For example, the prizes include guided tours around research institutes and laboratories that are normally off limits, museum visits, experiment boxes and a great deal more.

The solutions will be published as short films at proloewe.de on 21 September and the winners will be informed. Detailed rules for participation and further information will be available at proloewe.de from July 20 onwards.

One of the protagonists of the „Robot Scout" ProLOEWE Science Rally trains to assist first responders in a crisis. Photo: ProLOEWE

ERC ADVANCED GRANT FOR JOST GIPPERT – FOUNDING SPOKESPERSON OF THE „MINORITY STUDIES: LANGUAGE AND IDENTITY" LOEWE CLUSTER

The founding spokesperson of the **„Minority Studies: Language and Identity" LOEWE cluster**, Professor Jost Gippert, has managed to obtain an **ERC Advanced Grant** for the **„The Development of Literacy in the Caucasian Territories (DeLiCaTe)"** project. Starting in 2022, the scientists will study the emergence of literacy in the Caucasus region. The development of alphabetic scripts within the context of conversion to Christianity in the early 5th century AD marked the beginning of literacy and was a crucial step towards independent statehood for three ethnic groups in the Caucasus area: Armenians, Georgians and the so-called „Caucasian Albanians."

While the written language of the first two peoples has continued to develop until the present day and represents an important foundation for the emergence of the independent states of Armenia and Georgia, that of the „Albanians" ended with the Arab conquest of the eastern Caucasus region in roughly the 8th century, so that only little evidence of their language and writings has survived; the most important of these are two palimpsest manuscripts discovered at St Catherine's Monastery on Mount Sinai. Only a few original texts have survived from the „early" centuries for Armenian and Georgian, too, i.e. the period between the 5th and 10th centuries, and most of them are also hidden in palimpsest manuscripts.

Considerable progress has been made in analysing the writings preserved in palimpsest form during the last 20 years and this has provided substantial new insights into the historical development of the three languages and their literature. The DeLiCaTe project will now, for the first time, bring together these findings, which have so far been limited to the individual languages, in order to shed new light on the emergence and spread of writing and literacy in the region, focusing on the interrelationships between the three languages and the Christian cultures that they represent, as well as the influence of external religious and linguistic factors.

LEGAL NOTICE

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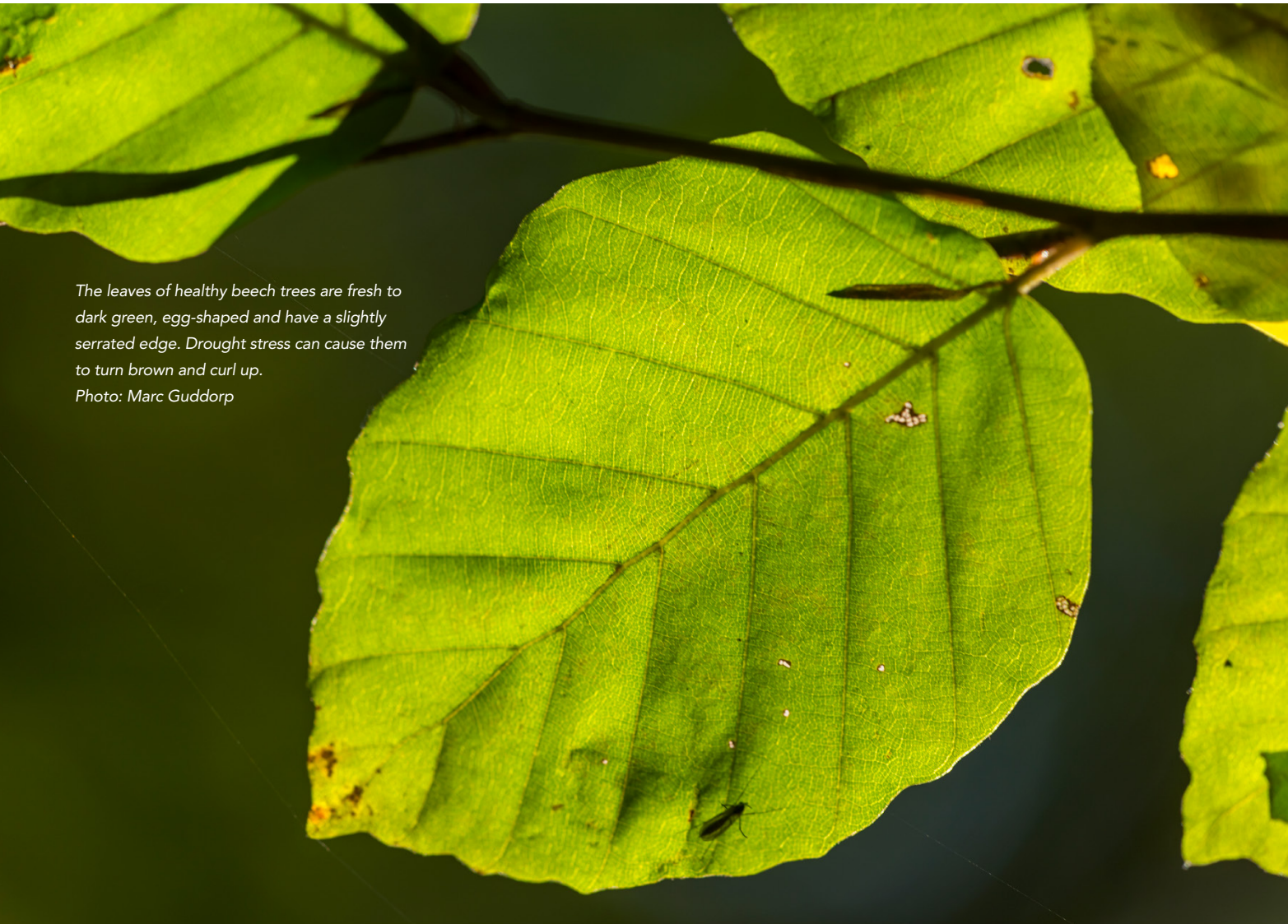
An unequal pair: beech trees standing next to each other in Kelkheim-Eppenhain, Hesse. While one of the trees is healthy (right), the other has suffered severe drought damage (left).
Photo: Markus Pfenninger



The leaves of healthy beech trees are fresh to dark green, egg-shaped and have a slightly serrated edge. Drought stress can cause them to turn brown and curl up.
Photo: Marc Guddorp

Professor Miklós Bálint heads the Functional Environmental Genomics programme area at the TBG LOEWE Centre in Frankfurt/Main and teaches at the Justus Liebig University in Giessen. Photo: Sascha Mannel, visualbrander.com

Prof. Dr. Miklós Bálint
Pioneers of biodiversity genomics

Prof. Bálint, you have been working as Head of the Functional Environmental Genomics programme area at the LOEWE Centre for Translational Biodiversity Genomics (TBG) at the Senckenberg Nature Research Society in Frankfurt/Main since October 2020. Can you tell us something about your work? *What I'm particularly focusing on in my research is how ecological communities adapt to their environment. Ecological communities are species that live together in an area at the same time and often interact with each other. The most important question for us here is how these communities change as a result of human influence and what this change might mean for us in future.*

Climate change, environmental pollution and the introduction of exotic species are some of the most important influences that we can observe in relation to ecological communities.

Soil is particularly interesting for my research group and me because it is essential for food production and has a strong influence on the quality of the food. It is important for us to manage soil to maintain its ability to contribute to human well-being. This is closely related to the wide variety of organisms found in soil. There is an enormous number of tiny mites, worms and springtails living under our feet, interacting with each other and contributing to soil health. Experts believe that there are more than one million species of mites on our planet. In the past, it was impossible for us to identify all the species because of their enormous diversity. We can now use molecular tools to study the DNA of these creatures and find out how their communities are changing due to human impact. This enables us to understand the effects of environmental changes on soil communities much better than in the past.

Why is it important to conduct pure research in the field of biodiversity genomics? What are the benefits for society? *Research in general improves our understanding of the world and enables us to make more accurate predictions about the consequences of events. It is not really easy to separate pure research from applied research. A great deal of pure research work focuses on phenomena that are important for people and therefore for society too. For example, we are decoding DNA from Baltic Sea sediments that were deposited at the bottom of the lake a long time ago as part of the PhytoArk research project, which is being funded by the Leibniz Association. Based on their composition, we can understand which species lived there hundreds or thousands of years ago. If we now relate these historical communities to their historical environment, we can use them to predict ecological consequences for the environment. For example, they allow us to draw conclusions about the ecological effects of climate warming at this time based on changes to our climate in the past. Although you could say that this is actually pure research, one of the partners is the Helsinki Commission and its main interest is to discover whether the sediment DNA results can improve its biomonitoring activities to protect the environment in the Baltic Sea, which have been continuing for decades.*

What do you think you can achieve through LOEWE research funding, which would not have been possible without it? *Biodiversity genomics is a very young and very rapidly growing field at the same time. Many organisations recognise the enormous economic and scientific potential of information from the genomes of the millions of species that populate the earth. Thanks in part to our LOEWE funding, we are now one of the "pioneers" in biodiversity genomics and "are operating right at the cutting edge." The number of biodiversity genome experts conducting research in Hesse has also increased to a number that is internationally relevant through TBG. Thanks to this "pool" of different kinds of expertise, we can work on complex issues that individual scientists could not handle. For example, my research on soil animals is providing important input for colleagues who are interested in biologically active natural products encoded by the microbiomes of these creatures. In turn, without the help of laboratory colleagues and bioinformaticians, I would not be able to sequence and analyse the genomes of hundreds of these species etc. So LOEWE research funding has enabled us to establish a vibrant, collaborative and internationally relevant scientific culture related to biodiversity genomics.*

And we have only just begun to reap the fruits of this cooperation work.

Read the whole interview at proloewe.de