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YEARBOOK 2021



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Fabric pattern made by Jūlijs Madernieks. 1920s. Paper, watercolour, Indian ink. 26.6×24.5 cm. Collection of the Latvian National Museum of Art, acquired in 1932

On the back cover:

Textile pattern "Dragons" made by Jūlijs Madernieks. 1924. Paper, Indian ink. 36×35cm.

Collection of the Latvian National Museum of Art, acquired in 1955



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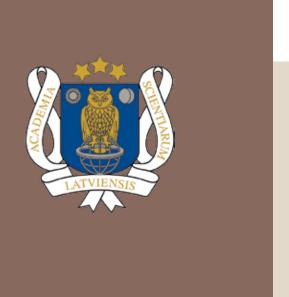
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IVARS KALVIŅŠ

PRESIDENT, LATVIAN ACADEMY OF SCIENCES

2020-2021: A TIME OF CHALLENGE AND OPPORTUNITY

The year 2020 will undoubtedly be remembered in world history as the year of the COVID-19 pandemic, which will leave its mark on all spheres of daily life. Many governments have been forced to introduce drastic restrictions in order to limit the spread of the virus, and these have been ambiguously taken up by the public. Global economic growth has slowed, and, in many places, recession has set in, leading to a fall in living standards.

At the same time, we have seen global consensus emerge in efforts to pool intellectual and financial resources to fight this virus, and to mitigate the consequences. It was particularly fascinating in regard to the way scientists from many countries, and even private-sector actors, worked together to create effective vaccines, as well as to carry out basic research. The public sector invested huge sums in projects carried out by private companies such that vaccines be developed within one year and be made available to the public. And the results have been really fantastic! Not just a one vaccine was created and mass vaccinations begun in many countries around the world. Scientists focussed on investigating many fundamental issues, both in terms of the virus itself, and in explaining the effectiveness and impact of the new vaccines on the human body. New technologies and principles have been developed that allow rapid adaptation of vaccines as needed to SARS-Cov2 mutants, as well as to achieve a high degree of immune response in people against new strains of the virus.

We are proud that members of the Latvian Academy of Sciences are at the forefront of scientists working on the development of new types of vaccines based on the use of virus-like particles to enhance immune response. Our members are developing new approaches to the design of antiviral agents, have developed new disinfectants, and explored the possibility of repurposing the existing drugs by studying their effects on COVID-19-induced changes in the human body. We have worked on creating personal protective equipment effective against SARS-Cov2. Thanks to the excellent performance of our scientists, a specialised national high-security biosafety laboratory is being set up appropriate for work with live infectious viruses. LAS members are studying changes in COVID-19 genes and their effect on viral properties, to explain the spread and development of COVID-19 in different age groups, including among children. These and many other studies, including engineering solutions to combat COVID-19, have been done in the framework of a special state-sponsored research programme dedicated to timely forecasting of the spread of infection.



Photo: Jānis Brencis

In 2020, we began extending the range of activities of the Latvian Academy of Sciences from the creation of knowledge, the evaluation and promotion of scientific achievements, to more active engagement in innovation processes. In like manner as many other national academies, we are actively assisting Latvian decision-makers to improve the education, research, development and innovation ecosystem, and science policy, so that Latvian industry can increase its global competitiveness. In small economies such as that in Latvia, it is important to increase public sector investment in the development of knowledge-based products and technologies, while keeping in mind the priorities of a green economy, with digitalisation and robotisation as preconditions for sustainability.

In 2020, Latvian scientists took a significant step to move closer to leading EU countries in the fields of education, science, research, and, also, innovation. In order to achieve this goal, the National Academies of Sciences of the Baltic Sea region have been addressed by the LAS seeking enhanced cooperation in developing an innovation platform. And we are determined to continue along this path.

The Latvian Academy of Sciences continues to strengthen its activities in regard to the humanities and social sciences, solicitous of advances in culture and art in Latvia. This is one of the nationally recognised missions of the LAS - to cultivate our mother tongue, to study the history of our country, to promote cultural advances of the titular nationality and, also, minority culture in our country, for the sake of social cohesion and spiritual growth. We are convinced that active participation not only of the Full Members, but also of the Honorary Members and Honorary Doctors of our Academy in promoting science contributes to spiritual growth of society and cohesion of its various groups, strengthening thereby the sustainability of our country and nation. Latvia is and will continue to be a country where rights are respected of every individual to live and work in conditions of democracy and harmony. Therefore, the Latvian Academy of Sciences will continue to do its best such that nothing might interfere with the spiritual development of all. In this regard, we are appreciative for the opportunity of strengthening international cooperation with other National Academies of Science, as well as for the unity of contemporary Europe and the way forward for ever closer cooperation. And we are convinced that together we shall succeed!

Translated by Eduards Bruno Deksnis

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When the first academies and learned societies were created in the Age of Enlightenment, they became gathering places for those who were actively engaged in the pursuit of knowledge, be it in answer to practical needs or simply knowledge for its own sake. In this they differed from the universities of the 17th and 18th centuries, where theology and religious doctrine still ruled, and disciplines based on reason and empirical observation were treated with severe reservations. As time went on, and universities started not just admitting scientific disciplines in their curricula, but taking research institutes under their wing as well, they came ever closer to the ideal proposed by von Humboldt communities of scientists and scholars engaged in the creation of knowledge as well as its transmission. Next to such stronger and revitalised universities, academies were then left with a variety of different models for their special mission. One thing, however, remained common to them all, and that was the criterion of excellence and exclusivity. This meant that being an academician brought with it various privileges, sometimes of a material sort but always in terms of conferring prestige – that of belonging to a highly elitist group of people considered to be of exceptional merit.

Because of the brutal series of historical transitions that Latvia as a country has gone through within

living memory, the Latvian Academy of Sciences has had to follow different structural models and serve somewhat different purposes during its early decades under Soviet occupation and the recent decades as the National Academy of a country once again independent. During the Soviet era, being an academician brought with it both research funds and facilities and material compensation in the form of exceptionally high salaries. The downside was the need for strict adherence to communist ideology and unquestioning obedience to the directives deriving from Moscow and transmitted by the local Party Central committee. This was undoubtedly less of a problem for researchers in the physical and biological sciences, but imposed an extremely heavy ideological burden on the humanities. As for the social sciences, many were not even recognised or accepted, their very existence being considered alien to Marxism-Leninism ("who needs such a thing as demography in a socialist system?"). After renewed independence, everything was turned on its head. Research funds and institutes moved over to the universities, salaries for academicians became drastically reduced and the intellectual and ideological freedom gained came at a heavy price in material security. The limitations in state support for science and scholarship as a whole have been a chronic problem for the past three decades.



Photo: Jānis Deinats

Successive governments have paid lip service to it and successive Presidents of the Republic have militated for it, but other priorities have always taken precedence over research funding.

How then is excellence to be achieved in conditions of severe deficiencies in the infrastructures and resources available for research? First of all, through the ingenuity of scientists and scholars and their devotion to their respective quests. These qualities have served them equally well under the yoke of ideological strictures and the scarcity of funds under a democratic regime. Thus, back in the 1980s, I was told by a famous US physicist how much he had been impressed by the work of Latvian physicists in purely theoretical physics at a time when they had neither access to the latest Western scientific publications nor to the experimental facilities available in the Russian SSR. While individual talent and commitment remain the sine qua non of excellence to this day, researchers are no longer dependent on state support alone. Membership in the European Union has opened up a broad range of opportunities to engage in common projects with colleagues in other European countries as well as the possibility of applying to various sources of research funding of an international nature. In addition to that, the public-private partnership between business and industry, on the one hand, and academies and

centres of higher learning, on the other, has become a significant source of research support for totally free basic research as well as for applied research of a more targeted nature. An especially happy union has been the long-lasting collaboration between UNESCO and l'Oréal, with its broad programme of special support for women in science. I have had the honour of being the patroness of the Latvian part of this programme, which in recent years has been extended to our neighbouring countries Lithuania and Estonia as well. The Latvian Academy of Sciences became the instrument by which candidates were evaluated and selected for these fellowships, and parallel programmes are now in place in all three Baltic countries.

As in previous years, the 2021 yearbook of the Latvian Academy of Sciences, by presenting a broad overview of the structure and function of research activities in Latvia, becomes a showcase for current and future projects and accomplishments in a variety of disciplines. While the year 2020 will enter history as the *annus horribilis* of the COVID-19 pandemic, let us hope that the world-wide vaccination programmes of 2021 will illustrate the crucial role played by science and research in the very survival of the human race.

NATIONAL CONTRIBUTION FOR FUTURE EDUCATION AND SCIENCE

VIZIUM – VENTSPILS SPRINGS INTO SCIENCE

Elīna Kroņkalne, Master of Computer Science, Director of Ventspils city municipality institution "Ventspils Digital Centre"

Today we are at the dawn of an age of unprecedented technological change. Rapidly changing trends of industry compounded by issues of the skills gap in the labour force are putting pressures on education and learning systems to act on 21st century skills. Scientific literacy is one of the skills required in the digital age. This means knowledge and understanding of the scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity.

From 1 September 2020, schools in Latvia gradually started introducing curricula and approaches in accordance with the new standards of primary and general secondary education. The number of lessons in subjects has been made much more flexible, the total number of lessons in a subject is set for three years, not a week, as has been the case before. Students in upper-secondary school will be able to devote about 30% of their study time to those subjects that are of particular interest to them - so it is essential to adjust education content and learning approach to focus on bringing 21st century skills and literacies to educators and students. The concept of competency in the 21st century implies more than just the acquisition of knowledge and skills, it also involves 21st century literacies and mobilisation of knowledge, skills, attitudes and values to meet complex demands.

The report to the European Commission of the expert group on science education [1] highlights: "As the world becomes more inter-connected and competitive and as research and technological know-how expands, new opportunities along with more complex societal challenges arise. Overcoming these challenges will require all citizens to

have a better understanding of science and technology if they are to participate actively and responsibly in science-informed decision-making and knowledge-based innovation." Collaboration between formal, non-formal and informal education providers, academia and industry should play a vital role in the increasing interest in science and science careers.

To establish a first-class learning resource for children and adults, Ventspils Municipality has decided to build a modern and capable science and innovation centre. Named VIZIUM - portmanteau of the words "Ventspils Inovāciju un ZInātnes centrUM" (Ventspils Science and Innovation Centre) - the centre will occupy a 6300 sq.m. building and a territory of 22 950 sq.m. The construction started in October 2019 and the centre was scheduled to open doors after 24 months - in the beginning of 2022, a truly formidable speed. The centre will be equipped with exhibition halls, hands-on labs, auditoriums and interaction spaces for the purpose of nurturing visitors to have the attitude and aptitude in science, technology, engineering and mathematics (STEM).

The centre is set to become a highly visible and trusted hub of activity, promoting interest, learning and creativity in science and technology, through imaginative and enjoyable experiences, facilitating discussion about science and technology, and a key strategic partner to academia, the public sector and industry to develop, promote and embed our "Inspire and Challenge" approach to science education working in partnership with local authorities, schools, teachers, academia, NGOs and industry.

VIZIUM vision is to promote and link high-quality formal, non-formal and informal science education



Visualization of the Ventspils Science and Innovation Centre VIZIUM building, author: Audrius Ambrasas Architects

opportunities with outstanding relevant and meaningful experiences in science to people of all ages and backgrounds, to inspire, motivate and encourage learning and deeper engagement. To achieve this vision, in parallel to the construction of the building, exhibits are being designed and 20 curriculums are being developed for smart technologies, geography, information and communication technologies, natural science, physics, mathematics, human anatomy and self-knowledge.

To stimulate interest in science activities, enable students to carry out self-directed activities in various disciplines of science and to provide opportunities for students to develop initiative and creativity, the Young Researchers Centre is being established in close cooperation with Ventspils University of Applied Sciences. The Young Researchers Centre, as a pre-academic framework, aims at strengthening the potential of school students in order to encourage them to pursue higher education, with an emphasis on science and tech-

nology studies. The centre provides students with hands-on laboratory experience and computerised learning environments not available in their schools. The cooperation with an academic and research institute creates an opportunity for meetings with experts as role models in science. The activities encourage educational continuity in order to promote excellence in science and technology that will naturally encourage students to continue their education, in general, and to specialise in the sciences, in particular.

The science centre will provide a source of highquality and attractively packaged information about science and issues of relevance not only to young people, but specially designed curriculums and workshops for both teachers (training them in the use of the exhibit) and students are being developed to complement formal schooling and to extend school science teaching. These workshops will also focus on creating content that will support teachers in the classrooms and help them communicate science to children to provide an approach to teaching and learning that incorporates co-creation, 21st-century learning, innovation and design thinking.

Although it may sound as a revolution, Ventspils City Municipality has a long history of using information and communication technologies and providing high-quality formal, non-formal and informal science and digital skills education opportunities. Since the year 2000, when the first Information Technology Development Strategy of Ventspils was accepted and implemented, and a dedicated municipal institution, tasked to foster development of information society – Ventspils Digital Centre, was established in 2003, a new era of informal learning started.

Growing gradually, Ventspils Digital Centre now constantly runs various educational events for adults and children. In 2020, more than 1500 people have acquired knowledge both at the professional level and for home use in topics such as spreadsheets, digital photo and video processing, computer graphics, computer drawing, programming, internet security and use of e-signature and e-services.

Since September 2015, the Operational Programme for the Acquisition of Computer Skills in Ventspils City General Education Schools has been implemented in three main directions:

- 1. Computer skills acquisition programme developed by Ventspils Digital Centre;
- 2. Approbation and implementation in schools of the curriculum "Computer Science" developed by the State Education Content Centre;
- 3. Classes developed by schools for the development of digital skills.

The objectives of this programme are:

- To provide students with the opportunity to acquire knowledge, skills, abilities and attitudes necessary for meaningful use of technology;
- 2. To promote students' interest in information and communication technologies (ICT) and to promote students' desire to study technology after school;
- 3. To provide an opportunity to use ICT in the learning process for all students.

Classes last a full school year: from September to May. Participants are divided into groups according to age and classes are held once a week, except for robotics classes for the middle age group, where



Visualization of the exhibition hall, author: Didzis Jaunzems Architecture

students work twice a week and one lesson lasts 90 minutes (two academic hours with a break).

In the first school year, 298 participants in ten programmes participated in interest education classes, but with every year students' interest in learning technologies has increased. Currently, 704 participants participate in technology classes, which is 236% of the initial number of students.

All curricula are based on professional software and technology, for example, digital home economics, computer graphics, digital photo, and video learning programmes use professional Adobe software (Adobe Photoshop, Adobe Illustrator, Adobe Premiere, etc.) that is used in printing and advertising companies and skills and knowledge acquired in this way can be practically used in students' professional development.

Ventspils Digital Centre has also developed a curriculum for teachers, "Towards digital competencies", to demonstrate the principles of operation of latest digital technologies covering topics such as technology, the humanities, the exact and social sciences to facilitate their use in the school teaching process.

This work has led to major results – opportunities to learn a broad spectrum of digital skills are available for everyone in Ventspils and are hugely popular, emphasising the need to provide access for 21st century skills for everyone. The Ventspils Science and Innovation Centre, scheduled to open in spring 2022, is being set up to provide major boost and bring the availability of 21st century skills to the next level.

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PROJECT INTERFRAME-LV AS A PROVIDER OF SOLUTIONS TO CURRENT PROBLEMS IN LATVIA

Baiba Rivža, *Dr. habil. oec.*, Professor, Full Member of the Latvian Academy of Sciences **Maiga Krūzmētra**, leading researcher Latvia University of Life Sciences and Technologies

INTRODUCTION

In 2018, the Cabinet approved the national research programme (NRP) "Latvian Heritage and Future Challenges for the Sustainability of the State" (2019–2021), with the main goal of developing guidelines for further sustainable development of the State of Latvia, outlining the main operational models in the context of global change-driven processes. The NRP includes five research projects, including "Challenges for the Latvian State and Society and the Solutions in International Context – INTERFRAME-LV". As this is a report on the results of work in 2020, it should be taken into account that they reflect not only the continuation of trends, but also the impact of the COVID-19 pandemic on the economic system.

RESULTS

Information on the research results achieved in 2019 is available in the 2020 Yearbook of the Latvian Academy of Sciences (https://www.lza.lv/images/publikacijas/YearBook_2020.pdf, pp. 72–74). During 2020, research on performing the tasks of the research project having started in the previous year was continued.

First, the scientists continued their analyses of the latest statistical data for 2019 and of changes in economic processes in 2020, as well as expanded an in-depth examination of some problems and the most urgent problems researched by students (in their doctoral dissertations and master and bachelor theses).

The structural changes observed in the national economy continue confirming a conclusion that economic activity playing an increasingly important role in the segments of the economic system is expanding. An analysis of data on net turnover for 2010, 2018, and the first nine months of 2020 reveals quite significant changes in the composition of the national economy: net turnover in agriculture, forestry and fishing ((A) + 0.4 percentage points), manufacturing ((C) + 0.8%-points), wholesale and retail trade ((G) + 3.9%-points) and information and communication ((J) + 0.4%-points), which increases the proportions of these segments in the national economy. The changes were observed at regional level too, i.e. in the regions, with only a few nuances: different growth rates and different geographical locations. The economic systems of the regions that make up the country have their own specific features, which are significantly affected by the specifics of the particular region's natural resources. Therefore, a research study "Innovative Business Opportunities for Regional Economic Growth" that analysed the processes of structural change in Kurzeme Region (D. Stefenberga, Latvia University of Life Sciences and Technologies, LULST) and a research study "Territory Competitiveness for Smart Business Development in Pierīga Region" (L. Āzena, LULST) that performed an in-depth analysis of the situation in Pierīga Region were conducted within the research programme. The structural changes largely related to expansion of digitalisation processes in the country, which is observed globally and significantly affects everything that occurs in the world.

In 2020, emphasis on the digitisation of economic activities was placed on fostering e-commerce and contributing to the development of artificial intelligence (AI). According to the 2019 indicators of the Digital Economy and Society Index (DESI) developed by the European Commission, connectivity and digital public services in Latvia were given the highest ratings among the key five dimensions (above the European average); but integration of digital technology or business digitisation, incl. Internet use for e-commerce (below the European average), as well as human capital (not enough specialists are prepared) lagged behind. High-speed and ultra-high-speed fixed and mobile broadband networks are widely available in Latvia, and an increasing number of individuals use e-services on a daily basis. However, a large segment of the Latvian population lacks basic digital skills, and the growing demand for ICT specialists in the labour market is unfortunately not satisfied – not enough ICT specialists are prepared. At the same time, companies should make more efforts to build up the digital skills of their current employees through their own participation in lifelong learning, which would provide more opportunities for the growth of e-commerce. At present, in Latvia, only 10% small and medium-sized enterprises (SMEs) sell online, compared with the EU average of 17%, and half less sell online across borders. Therefore, the following specific research studies were conducted under the national research programme regarding opportunities for e-commerce expansion for small and medium-sized businesses: "Analysis of E-commerce Utilisation Factors in the Latvian Small and Medium-sized Enterprise Sector" (I. Gudele, LULST) and "Opportunities for Blockchain Technology Adoption in the Economy of Latvia in the Context of Baltic States Region" (N. Kostrikova, LULST).

At the same time, scientists have focussed on the continuous development and application of artificial intelligence in the country. Machine translation and the extent and also the quality of its application, as well as the performance of virtual assistants that are already exploited by such important companies in Latvia as the Register of Enterprises, the State Revenue Service, the Rural Support Service, Tele2 Ltd and Tet Ltd were ana-

lysed. The current use for Al involves machine translation: 64.9% translation by the company Tilde corresponds to human translation, for Google it is 52.1%, which is a high figure in both cases; a virtual assistant (chatbots or bots) - a company should assess whether the flow of customers and incoming questions are so large that a virtual assistant is needed, yet at a certain number of questions, it saves a lot of working hours and, over time, financial savings; image analysis; robotics; an analysis of large amounts of data and forecasting based on it; decision making automation and support. Almost ten national companies already have virtual assistants, e.g. Toms for the State Revenue Service, Varis for the Rural Support Service, Ieva for Tele 2 Ltd etc. The Cultural Information Systems Centre has launched an innovative virtual assistant-sharing platform for public administrations. The project is implemented by using the initial designs and resources of the public administration language technology platform Hugo.lv. Therefore, each institution does not have to create its own virtual assistant from zero. As the importance of AI grows in Latvia, an action plan has also been developed; the plan stipulates that public sector investments in AI should reach EUR 25 million by 2030. Researchers are tasked with preparing proposals for the NRP in the field of ICT, integrating the AI component into the NRP. National or sectoral policy documents, as well as municipal development plans should include an assessment of automation and of use of Al. In the field of Al. several master and bachelor theses have been produced at LULST, e.g., on the application of deep machine learning methods for detecting wood damage, developing a prototype of a face recognition system, which is expected to have a practical application.

Second, there was an exchange of views and discussion among scientists from various institutions and countries, as the development of any country is affected not only by what occurs in the country but also by global processes – climate change, digitalisation and restructuring in society and, as a result, changes in the system of needs.

On 13 December 2019, a working meeting on all the five projects of the NRP was held at the Ministry

of Education and Science (MES) as the administrative institution of the NRP (Latvian Heritage and Future Challenges for the Sustainability of the State), including the INTERFRAME-LV project implemented by the Latvian Academy of Sciences (LAS). At the meeting, the project directors reported on the achievements of the first year and outlined further opportunities for cooperation between individual projects, incl. production and publication of a joint monograph during the implementation of the NRP (2019-2021). Academician Baiba Rivža presented the project "Challenges for the Latvian State and Society and the Solutions in International Context - INTERFRAME-LV" implemented by the LAS (cooperation partners: Latvia University of Life Sciences and Technologies, the main research direction – business digitisation; the University of Latvia (UL) - economic consequences of public radicalisation; the Institute of Agricultural Resources and Economics – climate change mitigation and adaptation; Rīga Stradiņš University – the influence of personality and social structure factors on capacity and perceptions of security). Overall, it was an analysis and a forecast of structural change processes in the world, the European Union, the Baltic States and an in-depth analysis of the economic and social system of Latvia. Analysis of the processes was the focus for all the scientists in order to assess Latvia's position in these changes.

On 27 October 2020, a mid-term conference on the NRP "Latvian Heritage and Future Challenges for the Sustainability of the State" was held in the Ziedonis Hall of the National Library of Latvia (LNB) to report on the results achieved during the past year and a half and the work to be done in the remaining project period. The main idea that was expressed in all the reports and discussions was that Latvia faced the same challenges as the rest of Europe. The digital environment was relatively advanced, yet it was underused, especially in terms of integration of technologies into business operations in order to modernise them and raise productivity. Proposals were made to help SMEs that could not afford using global technology solutions with local solutions. Digital technologies need to be used more in lifelong learning. New motivations need to be considered to engage citizens in business. It is

necessary to ensure the flow of inclusive information, e.g., when administrative institutions communicate with potential service users, they need to come up with offers to the users and not only meet their demands.

CURRENT PROBLEMS IN THE PROCESS OF GLOBAL CHANGE WERE ALSO DISCUSSED FROM AN INTERNATIONAL PERSPECTIVE

On 6 May 2020, an online seminar was held by the LAS, Division of Agricultural and Forestry Sciences, and the NRP project INTERFRAME-LV in cooperation with the Nordic Association for Agricultural Science, Department of Economics. The seminar was attended by representatives from Finland, Denmark, Iceland, Sweden, Norway, Lithuania and Latvia. The association has long research traditions, it has existed for 100 years, and its main goal is to develop research in agricultural economics in the Nordic and Baltic countries. There was an exchange of views on the use of digitisation to foster economic activity in all the countries represented in the seminar and identify opportunities to learn from positive experience in order to reduce the disparities between the countries as shown by the DESI index. The second online seminar was held on 3 June. Kristina Holmström, a student from the Swedish University of Agricultural Sciences, participated in the seminar and reported on her research "From Small to Large Pastures - Improved Profitability in Swedish Mammalian Meat Production", while Latvia was represented by a doctoral student Aija Pilvere-Javorska from Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development who reported on her research "Sustainable Economic Growth in the Baltic and Nordic Countries".

There were discussions and exchanges of views between scientists and practitioners (entrepreneurs, businesspersons, national and municipal institution employees, stakeholders) on what was presented by scientists as well as what was observed in real life and in the particular region of the country. **Regional forums** were useful events, in which scientists had the opportunity not only to share their research results but also to get feedback on particular problems from entrepreneurs, businesspersons,

municipal employees and other interested individuals by listening to their opinions. The regional forums represented a proven way of exchange of ideas and cooperation among researchers, involvement of regional experts in discussions and dissemination of research results.

ZEMGALE FORUM

On 19 February 2020, a series of regional forums on business digitisation began in Jelgava, at the home producer shop Craftsmen House, under the project INTERFRAME-LV (NRP "Latvian Heritage and Future Challenges for the Sustainability of the State", 2019–2021) (Fig. 1). Researchers from LULST are involved in this project, including LULST doctoral student Ina Gudele, chair of the Board of the Latvian Internet Association, and LULST Professor Pēteris Rivža. The forum provided new valuable information not only to the present representatives of small enterprises but also to LULST students being

well-represented at the forum. The exchange of opinions resulted in the main conclusion that the technological infrastructure available in Latvia should be used more effectively in business.

VIDZEME FORUM

On 16 February 2020, the forum "Smart Economy: Science, Technology and Innovation" that aimed to analyse the economic situation in Vidzeme Region in the context of the present, as well as the near and distant futures, was held at Vidzeme University of Applied Sciences (Fig. 2).

A continuation of this forum was the INTER-FRAME-LV forum held on 26 February, which aimed to provide a more detailed exchange of opinions on an urgent topic entitled "Digitalisation: the Opportunities and Challenges for a Smart Economy". The forum focused on digitalisation in education and the experience of entrepreneurs in the use of digitalisation and concluded with an innovation in the



Fig. 1. Zemgale forum. 4th from the right, Baiba Rivža



Fig. 2. Vidzeme forum. Presentation by *Dr. hist*. Gatis Krūmiņš, Rector of Vidzeme University of Applied Sciences

"marketplace". One of the main conclusions of the discussion was that the view on digital skills needs to be broadened. The culture of digital behaviour needs to be developed. At present, digital communication lacks immediate feedback and an opportunity to ask questions. The discussion participants suggested a combination of face-to-face and distance learning as the most optimal option for learning. The participants of the forum were introduced to a unique product created in Latvia – the first virtual economics classroom. Edgars Čerkovskis, an economist and a teacher at Rīga Distance Learning Secondary School, introduced virtual reality in distance learning. He is the author of the innovative idea of the first virtual economics classroom in Latvia. It was created in cooperation with Vidzeme University of Applied Sciences (technical developer Eriks Līsmanis and graphic developer Armands Millers). This product will soon be available free of charge to teaching personnel and students to be used in the learning process.

LATGALE FORUM

On 29 June 2020, the third regional forum on digitalisation, "Digital Tools for Business Support in Latgale Region", was held at Rezekne Academy of Technologies. Opening the forum, the rector of the Academy, Professor Iveta Mietule, emphasised the great and important priorities for Latgale Region in the field of information and communication technologies (ICT) – to ensure comprehensive mobile network coverage and the transition of institutions to the digital environment. The leader of the NRP project INTERFRAME-LV, Baiba Rivža emphasised that being at the 1st stage of the 4th industrial revolution (Industry 4.0) - with drones, sensors and robots, as well as the still narrow and weak use of AI - we need to prepare for the 2nd stage, which is characterised by a wider use of smart digital tools and broader functionality of artificial intelligence, incl. its participation in decision-making. This means focusing not only on ICT studies and research but also advanced ICT courses in any university programme as well as shifting lifelong learning towards this field. Industry 4.0 is expected to affect all groups of society and all professions, and a new type of workforce needs to be developed and trained, incl. for business and entrepreneurship.

ICT skills, as well as learning and new knowledge-gaining skills are considered to be the most necessary in the future, as the role of manual labour gradually diminishes. Digitalisation is a huge challenge for education, science and industry. In Latvia, too few ICT specialists are being trained, the growing demand for them in the labour market is not being met, and a large segment of the population lacks basic digital skills. The EU Common Agricultural Policy 2021–2027 envisages the integration of rural areas into the digital economy. In each region, attention should also be paid to the access of small and medium-sized farms and enterprises to technology. This means that rural areas also need a closer link with the development of human capital, research and support for innovation should be improved, and this should be part of overall national policy.

KURZEME FORUM

The forum was held online on 14 August 2020, together with Project reCOVery-LV scientists. The ideas expressed in the Kurzeme forum focused on the need for digitisation not only in business but also in education. A report "Digital Environment and the Business Opportunities Therein" by the leader of the NRP project INTERFRAME-LV, Dr. habil. oec. B. Rivža, and a report "Artificial Intelligence in Business" by Dr. habil. sc. ing. P. Rivža were followed by an extensive discussion on topical issues such as whether young women's digital skills meet today's labour market needs, professional development courses for employees - distance learning opportunities and challenges, digital tools for remote work and training opportunities. The need for building up digital skills was also stressed by the forum participants with regard to Latvia's rankings in the Digital Economy and Society Index in the period 2014–2019.

PIERĪGA FORUM

The forum was held online on 26 August 2020, together with Project reCOVery–LV scientists. In the Pierīga forum, just like in the previous ones, the leader of the NRP project INTERFRAME-LV, LULST Professor, *Dr. habil. oec.* Baiba Rivža, described the

digital environment, while LULST Professor Pēteris Rivža reported on the development of artificial intelligence (AI), thereby arousing great interest among the participants and confirming that such issues need to be explained to the public. It is necessary to make more efforts to shape an understanding of an association between the use of digital opportunities and labour productivity, the advantages of business modernisation and the effects on prosperity, the need to build up digital skills for future professions etc. Al is increasingly entering business through cooperation between researchers and practitioners. For example, in wood-processing industry, a factory producing oak parquet uses the knowledge and technologies created by LULST specialists to find and prevent damage in wood; this is possible by means of convolutional neural networks. Similar examples could be found in crop farming and food industry. The more efforts are made by all generations concerning these issues, the more opportunities to use the advantages of technologies and AI and avoid disadvantages, thereby giving sustainability to these processes, which, according to President Egils Levits at the Saeima meeting on 3 September, is a force that lasts long.

Given the main objective to be achieved in 2021 – to produce and publish a monograph "Latvian Sustainability Perspectives: Challenges and Opportuni-

ties", which would summarise both the conclusions of the research and provide further guidelines for the balanced development of the country from the perspective of scientists, a draft table of contents of the monograph that further shapes the research work to successfully implement the national research programme and achieve the goals set has been developed.

Sixty-eight reports on the INTERFRAME-LV project have already been presented at international conferences, of which 34 were presented abroad; 88 research papers have been submitted and published, of which 39 were indexed by SCOPUS and Web of Science; five doctoral dissertations are being produced, while three have been defended. There was participation in international projects (Development Opportunities for the Securities Markets in the Baltic States, Meta Cluster for Attracting the Japanese Tourism Market), and new project proposals have been submitted for transnational projects (Horizon 2020 project on rural development; Assessment of EU Agricultural Policies – Domestic and Third Country Markets etc.).

Much has been told and written about the results of the project in the mass media – TV, radio and press publications, which informed the public about the findings of the research and provided an opportunity to discuss the findings.

STUDIES IN MEDICINE AND PHARMACOLOGY

INSTITUTE OF FOOD SAFETY, ANIMAL HEALTH AND ENVIRONMENT "BIOR" IS A CORNERSTONE TO STRENGTHEN SUSTAINABLE AND SAFE FOOD SYSTEMS

Aivars Bērziņš, *Dr. med. vet.*, PhD, Director of the Institute of Food Safety, Animal Health and Environment "BIOR", Professor at the Latvia University of Life Sciences and Technologies, Faculty of Veterinary Medicine, Vice-chair of the Management Board of European Food Safety Authority (EFSA), Full Member of the Latvian Academy of Sciences

On 30 January 2020, the Institute of Food Safety, Animal Health and Environment "BIOR" marked its 10th anniversary at the International Scientific Symposium "Science to Strengthen Sustainable and Safe Food Systems", with participation of around 250 participants from 15 countries (Figs. 1, 2). This was also an occasion where we acknowledged our scientific collaborators, colleagues from governmental agencies, industry and NGO's for cooperation and our common contribution to make safer and more sustainable food systems and environment in Europe.

Although the Institute has a long-accumulated professional experience over several decades in some areas, starting even in the 1920s, the last ten years can be characterised by a dynamic development to become one of the leading research institutes in the region. In 2010, the Institute of Food Safety, Animal Health and Environment "BIOR" was established by merging the existing National Diagnostic Centre (National Reference Laboratory in the areas of animal health and food safety) with Latvian Fish Resource Agency and National Aquaculture infrastructure. This was a significant step forward to establish the National Research Institute with a new strategy, clear vision and ambitious goals.

Alongside significant scientific achievements, the Institute has built-up as a centre of best available research infrastructure in the respective fields of science in Latvia. Implementation of the ERDF project No.1.1.1.4/17/I/006, "Concentration and Strengthening of Institutional Capacity of Institute "BIOR", played an important role there, thus opening new horizons for the local and international scientific staff.

Research in food safety, veterinary medicine, fisheries, public and environmental health has been in the focus of the Institute's strategy to create a comprehensive platform within One Health framework. The goal is to achieve better public health outcomes as well as to strengthen sustainable food systems in the future. Currently the Institute carries out research of international significance and quality as well as implements risk assessment projects and provides scientific advice to various governmental agencies under the Ministry of Agriculture, Ministry of Health, Ministry of Environmental Protection and Regional Development, and others. All departments, including laboratories, fishery and aguaculture research units, have long-accumulated professional experience over several decades with international recognition.



Fig. 1. International Scientific Symposium "Science to Strengthen Sustainable and Safe Food Systems" in Rīga, National Library of Latvia, 30 January 2020, celebrating the 10th Anniversary of the Institute of Food Safety, Animal Health and Environment "BIOR"

From the left: Dr. Bernhard Url, Executive Director of the European Food Safety Authority (EFSA); Mr. Kaspars Gerhards, Minister of Agriculture of the Republic of Latvia; *Dr. med. vet.* Aivars Bērziņš, Director of the Institute of Food Safety, Animal Health and Environment and Vice-chair of the Management Board of the European Food Safety Authority (EFSA)

Fisheries and aquaculture are important fields within the food system in the Baltic region, including the Baltic Sea and inland waters of Latvia. Research activities of the Institute provide scientific support and advice for sustainable use of fish resources in the waters of Latvia, including the Baltic Sea, the Gulf of Riga, and inland waters. Resources of internationally regulated fish species are accounted and assessed on a regular basis, and also unregulated fish stock and its condition in natural sea and inland waters are examined annually. An important role of the Institute is to evaluate the influence of fishing, angling and the environmental conditions of fish stock and biological diversity. It also ensures the monitoring of fishing fleet, fish

processing and aquaculture operations and provides economic assessment. Scientific results of research in fisheries are regularly published in prominent international peer-reviewed research journals and widely used as scientific advice to national and international organisations, such as ICES (International Council for the Exploration of the Sea) and HELCOM (Baltic Marine Environment Protection Commission).

One of the main animal health research areas of the Institute was the start of Horizon 2020 project VAC-DIVA, funded by the European Commission, "A Safe DIVA Vaccine for African Swine Fever Control and Eradication". The main objective of VACDIVA is to solve the African Swine Fever (ASF) problem in

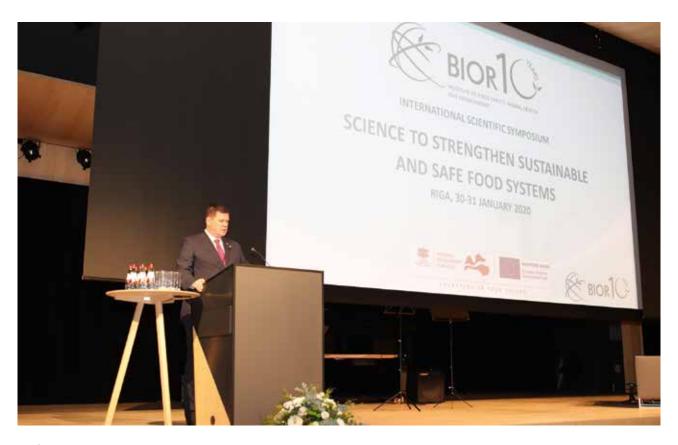


Fig. 2.

Opening of the International Scientific Symposium "Science to Strengthen Sustainable and Safe Food Systems" in Rīga, National Library of Latvia, 30 January 2020. Mr. Kaspars Gerhards, Minister of Agriculture of the Republic of Latvia

Europe and affected countries, by developing three safe and effective vaccines for domestic pigs and wild boars, their companion DIVA tests and effective tools for control and eradication strategies in Europe. In addition to design improved ASF control strategies in different epidemiological scenarios worldwide, tests of the pilot vaccines are foreseen in real environments during the project. Oral immunisation of wild boar with a non-hemadsorbing, attenuated ASF virus of genotype II isolated in Latvia in 2017 by the Institute of Food Safety, Animal Health and Environment "BIOR" (Lv17/WB/Rie1), conferred 92% protection against challenge with a virulent ASF virus isolate (Arm07). Thus, this was a first report on a promising vaccine against ASF virus in wild boar by oral administration. This work is continued during VACDIVA project (Fig. 3).

Research on the epidemiology of food and waterborne diseases as well as molecular characterisation of associated pathogens and their antimicrobial resistance provides an important scientific



Fig. 3.
EC Horizon 2020 VACDIVA project kick-off meeting in Madrid, Spain.
Dr. med. vet. Edvīns Oļševskis introducing the Institute of Food Safety,
Animal Health and Environment "BIOR" and its tasks in the project

information to the National Centre for Disease Prevention and Control, Food and Veterinary service and other stakeholders. It is important to emphasise that Institute has developed comprehensive microbial collections, including a wide range of bacterial pathogens of environment, animal, food chain and human origin. This provides valuable data sets to trace back major food or waterborne pathogens in the food chain "from farm to fork". Novel technologies, including next generation sequencing (NGS) and other pathogen subtyping methodologies were successfully implemented and used over recent years to provide timely scientific support and advice to public health authorities.

The importance of scientific expertise and support from the Institute to combat COVID-19 was acknowledged widely during 2020. Alongside an extensive involvement in SARS-CoV-2 testing in humans in Latvia during the pandemic, the Institute was involved in the recently launched project "Multidisciplinary Approach to Monitor, Mitigate and Contain COVID-19 and Prevent Other Future Epidemics in Latvia". During the project, cost- and time-efficient monitoring tools, using a wastewater-based epidemiology approach for monitoring COVID-19, were developed for the first time in Latvia and knowledge of the occurrence and diversity of coronaviruses including SARS-CoV-2 in susceptible pet population in Latvia was assessed providing evidence-based recommendations to the pet owners and veterinary practitioners. For the first time, SARS-CoV-2 positive domestic cat was found in COVID-19-affected household in Latvia at the end of 2020 and beginning of 2021. This highlighted the possibility and importance of the possible zoonotic transmission of SARS-CoV-2 virus from humans to animals, as a sign of reverse zoonotic transmission. SARS-CoV-2 highlighted also the importance of One Health, where the human, animal, and environmental health are interconnected and creates one ecosystem to understand epidemiology of the disease, particularly during the pandemic situation. Thus, transdisciplinary approach is essential to understand better viral transmission patterns and the epidemiological process of the disease.

In 2020, the researchers of the Institute continued their scientific activities related to the application

of high-resolution mass spectrometry for the analysis of chemical contaminants in food products. For example, the analytical methodology based on Fourier transformation ion cyclotron resonance mass spectrometry was used to achieve the quantification of residues of pharmaceuticals in food products and environmental objects without time-consuming sample preparation procedures. Another study significantly extended the number of analysed mycotoxins by the implementation of two-dimensional liquid chromatography. Those newly proposed methodologies proved their reliability and accuracy within several occurrence studies of contaminants in a broad range of food samples. In addition, the proposed sensitive determination procedures facilitated the research in the area of food technological processes aimed at diminishing the content of harmful chemical compounds.

L'ORÉAL Baltic "For Women in Science" programme, in cooperation with the National Academies of the Baltic States and UNESCO National Commissions, has awarded Dr. Iveta Pugajeva for her scientific work "Elaboration of New Methodology Using Ultra High-resolution Mass Spectrometry for Assessing Public Health via Wastewater-Based Epidemiology". Over the last years, wastewater-based epidemiology (WBE) is used at the Institute as a novel approach of sampling and analysing chemical substances in wastewater samples to estimate a population's exposure to chemicals. This methodology was proposed for the first time as a potential tool to assess the use of illicit drugs and misused therapeutic drugs within a community. Nowadays the application area of WBE has extended to pharmaceuticals and personal care products, population markers, industrial chemical exposure markers, stress, food and diet markers, and biological markers. Despite the latest development, a number of open scientific issues remain, such as insufficient sensitivity of analytical methods, a lack of data on the occurrence of several biomarkers, and the suitability of proposed biomarkers as a characterisation tool in WBE, which need to be solved in order to successfully apply WBE in new areas.

Scientific advice and risk assessment are essential parts of the work of our Institute providing timely support to government institutions working in the

area of veterinary public health. Moreover, the Institute has an important role to provide scientific advice to the public health authorities in the area of nutrition. In 2020, extensive work on the national study on salt and iodine consumption in Latvia has been concluded, for the first time combining nutritional data with biological samples, i.e. sodium and iodine concentrations in urine. The results of the survey have provided long-awaited data for policy makers and the public as iodine deficiency has been on the discussion table for a long time. The Institute has provided not only an evaluation of the situation, but also possible scenarios for solution and future steps.

The safety of environmental, animal and human health is in focus of the One Health concept, thus helping to design and implement programmes, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes. A wide range of environmental resources and ecosystems are influenced by various factors, including the anthropogenic impact, industrial pollution, climate change, and others. Therefore, there is a worldwide continuous need for new knowledge and research to ensure and improve healthy and sustainable ecosystems and rich biodiversity keeping in mind economical needs of countries.

Since the establishment of the Institute "BIOR", a new generation of scientists have joined our team, cross-appointments of our research staff with universities established, novel laboratory technologies and infrastructure have been introduced and international partnership networks have been significantly broadened (Fig. 4). We can be proud of our goals reached so far with our reputation towards scientific excellence, support in decision making, policy impact and independence.



Fig. 4.

Dr. chem. Iveta Pugajeva, laureate of L'ORÉAL Baltic "For Women in Science" programme, for her scientific work "Elaboration of New Methodology Using Ultra High-resolution Mass Spectrometry for Assessing Public Health via Wastewater-Based Epidemiology"

COVID-19 RESEARCH IN LATVIA: SCIENCE TO BE USED IN PRACTICE AND PRACTICE TO BE USED IN SCIENCE

Ludmila Vīksna, *Dr. habil. med.*, Professor, infectologist, Head of the RSU Department of Infectology, Chief Specialist in Infectology, Rīga East Clinical University Hospital, Corresponding Member of the Latvian Academy of Sciences

Oksana Koļesova, *Dr. med.,* Assistant Professor, Department of Infectology, Rīga Stradiņš University, leading researcher, Joint Laboratory of Clinical Immunology and Immunogenetics, RSU

SARS-CoV-2 emerged in the human environment very suddenly. This created many problems, but at the same time contributed to medical science research. Within a short period of time, it became evident that previous beliefs that had been held as standards regarding the course, pathogenesis and prognosis of infectious diseases have not be accurate. Similarly, beliefs about the relationship between viruses and macroorganisms have also been affected. Comprehensive studies have been launched worldwide and in Latvia in order to find out the course of the new acute respiratory virus, and what needs to be done to minimise its effects.

In most cases, acute respiratory diseases (ARDs), including viral aetiology (ARVI), are well known, since active studies have been carried out for decades. It is possible to treat and control them effectively through carefully designed vaccines that have been tested in the long term, as in the case of influenza. However, SARS-CoV-2 has brought many revelations. Due to the rapid spread of SARS-CoV-2 and COV-ID-19 researchers have not had the time to conduct their studies more slowly, and each finding has had to be put into practice immediately.

We – a group of researchers and medical practitioners – participated in the call for tender on COVID-19 research that took place in the summer of 2020. We set out a clear medical and practical research aim, defined by the National Research Programme (NRP) as follows:

Clinical, biochemical, immunogenetic paradigms of COVID-19 infection and their correlation with socio-demographic, etiological, pathogenetic, diagnostic, therapeutically and prognostically important factors to be included in guidelines.

Our group was aware that we should present evidence-based scientific knowledge on the course of COVID-19 and its effects, and that our study should have a fundamental approach, thus contributing to international science.

To achieve the aim of the study, we set 11 objectives. Among them were objectives that involved identifying properties and facts related to SARS-CoV-2, the course of the COVID-19 disease and certain stages of pathogenesis. We studied, and continue to study, the effects of immunogenetic factors and oxidative stress on COVID-19 that could play a key role in the development and course of the disease. We studied and analysed the consequences of COVID-19 through a targeted, modern and comprehensive radiological examination of the internal organs and a broad biochemical examination, including apoptosis and fibrosis markers, which could play a key role in patient disability.

I will outline the details of the findings that are already important for practical medicine.

When launching the study, there were indications that SARS-CoV-2 causes a disease with a pathogenesis





Oksana Kolesova

Ludmila Vīksna

that differs from other ARDs despite its symptoms bearing a similarity to other ARVI. An example of this is the surprisingly hyperactive involvement of the immune system in the process with unexpected clinical turning points. This results in needing to take a different approach to pathogenetic therapy, which is quite often only possible in an inpatient setting, for example, for patients to be able to receive oxygen therapy.

More than 970 indicators were analysed in order to identify specific or non-specific disease symptoms, factors that contribute to a more severe condition, and to identify the effects of the disease in detail. Thanks to the enormous amount of work that has been done in a short period of time, all of us, including practitioners, have gained a better understanding of the virus. We are now able to predict and influence the course of COVID-19. The facts and findings that we have obtained, along with data collected by researchers from other countries, have been included in COVID-19 recommendations, developed for medical practitioners through the NRP. It is of the utmost importance to inform all medical practitioners of these findings on how to lessen the effects of COVID-19 in order for them to immediately be able to use what is necessary for more efficient healthcare, in diagnostics, prognosis, and treatment. Thus, within a few months, it was possible to identify, analyse and evaluate the spectrum of the clinical manifestations of COVID-19, and to calculate and highlight a group of symptoms. Based on this information it is now possible to get an indication on whether the course of the disease will be potentially severe, as well as to recognise the factors that indicate a deadly prognosis. With this information, it is possible to get ahead of a deadly outcome and apply the necessary treatment methods. Well-designed and evidence-based guidelines for diagnosing and treating COVID-19 patients have been created based on these findings. The guidelines have been introduced to and are used by the project's largest partner – Rīga East Clinical University Hospital. The guidelines can be improved further as more information is discovered. As we have now been living with COVID-19 for almost a year, many things already seem self-evident, for example that ferritin and troponine T (which are not used in regular ARVI practice as they usually remain unchanged) are among the vitally important laboratory examinations to evaluate the new ARVI. These findings, for example, were only discovered in the summer of 2020. At first, this seemed strange and not immediately comprehensible in practice, yet it was supported by scientific evidence. Now, it already has pathogenic explanations that have been included in the guidelines. Practice shows that researchers' findings and recommendations are useful and can often save patients' lives.

Not less important, particularly from an epidemiological point of view, is the study's objective to establish which **pathways transmit SARS-CoV-2** and the dynamics of antibody formation in infected and sick patients. This part of the study was led by Assoc. Prof. Modra Murovska (Rīga Stradiņš University, RSU) and brought some surprises. Nasopharyngeal swabs, blood plasma, peripheral blood mononuclear cells, faeces and urine were examined for traces of SARS-CoV-2. Traces of

SARS-CoV-2 were present in the faecal samples of almost 50% of patients. Additionally, these traces could be found for an extended period of time and, in some cases, the trace amounts were greater than those found in the other materials that were examined.

Analysing the dynamics of patient-specific antibodies to SARS-CoV-2, it was found that IgM antibodies could often once again be found in high titres more than two months after the characteristic period of reduction during recovery, or even disappear after an acute infection. This could be explained by the persistence of SARS-CoV-2, or by reinfection. It is important to find this out, because it might be necessary to develop a different approach to evaluate the health of COVID-19 patients, or to setting up treatment.

The presence of respiratory bacteria and persistent/ chronic virus infections –7 bacteria and 12 viruses – was identified in COVID-19 patients with a multiplex diagnosis in real time with PCR. More than a third of patients have been found to **have one of the tested co-infections.** This could affect both the clinical course of COVID-19 and add co-infection symptoms to COVID-19 symptoms, in this way creating the illusion that the other symptoms that are characteristic to bacterial or viral diseases belong to COVID-19.

An immune response regulating gene analysis was conducted by Dr. med. Jelena Eglīte and Oksana Kolesova in order to evaluate the genetic factors that may, or may not, affect whether a patient contracts SARS-CoV-2. Four more common and three less common HLA Class II gene alleles have been identified in Latvian COVID-19 patients. These might contain the answer to whether a patient is at a higher risk of contracting, or of not contracting COVID-19. This has resulted in practical recommendations that will supplement public epidemiological recommendations. Our research also focused on the subject of oxidative stress and selenium. It is known that selenium deficiency can lead to changes in the virus' genome, increased virulence, problems with the host's immune system, inflammatory processes and to an increase in oxidative stress, which is of particular importance during COVID-19. Under the leadership of Prof. Andrejs Šķesters (RSU), a group of researchers evaluated levels of selenium and selenoprotein in patients who had recovered from COVID-19 and determined the level of oxidative stress in their plasma. Levels of selenium in

patients who had recovered from COVID-19 were close to the lowest acceptable norm. In some patients the concentration of selenium was dramatically low. The material is now being supplemented and the findings require detailed analysis and interpretation.

Whereas in relation to oxidative stress the results obtained were three times over the norm. These could be the effects of post-infection or a continuation of inflammatory processes in the body, including the "cytokine storm" which is typical to COVID-19.

On the basis of previously proven facts, researchers recommend the use of organic selenium in physiological doses for both prevention and recovery.

The aftereffects of COVID-19 are also being examined within the framework of the project. We conducted in-depth medical examinations of people who had recovered from COVID-19 by creating a biochemical profile, identifying apoptosis and fibrosis factors (as mentioned above), identifying immunological indicators, and conducting a modern special radiological investigation. The findings of the examinations show that most people still had health complaints three or more months after the acute period of the disease. These were characterised by breathing problems, lingering symptoms in the nervous system and the cardiovascular system. The examinations discovered changes in the biochemical markers of the liver, cardio markers and immunological parameters, as well as high levels of oxidative stress. It was found that approximately 6% of people experienced severe changes in the number of T lymphocytes after COV-ID-19, indicating a state of immunodeficiency.

The radiological examinations were performed by two associate professors at RSU – Ardis Platkājis and Maija Radziņa. The examinations show that some patients remained affected by changes in the lungs and had abnormalities in their liver parameters potentially associated to COVID-19. Levels of fibrosis and apoptosis markers in serum, which indirectly imply potential disability, confirmed an increased tendency in connective tissue formation in these organs following acute COVID-19 infection.

Through various serological tests a group of researchers, led by Prof. Dace Gardovska (RSU), **identified an immune response to SARS-CoV-2 infection in children with selected chronic diseases**. The study's findings show that the presence of antibodies, i.e. the

seroprevalence of SARS-CoV-2, is low at 1.7% in blood samples from children with chronic diseases. Thus, it is possible to draw a preliminary conclusion that children suffering from chronic diseases are more susceptible to SARS-CoV-2.

Prof. Mārcis Leja (University of Latvia, UL) took the lead in ensuring participation in the Solidarity Trial. This project is mainly related to studying different drugs and evaluating them in the treatment of COVID-19 patients. This part of the project is closely linked with the World Health Organisation (WHO) and involves cooperating with many countries worldwide. It was thanks to the Solidarity Trial that Remdesivir could be used in Latvia so quickly. Participating in the Solidarity Trial together with Rīga East Clinical University Hospital and Pauls Stradins Clinical University Hospital is strategically important on a national level as it demonstrates the ability to cooperate with the WHO and also allows for the staff involved in the study to raise their qualifications by participating in trainings and following the course of the study on an international level. The trial's findings will affect international guidelines for pharmacological COVID-19 treatments.

The project launched studies in a number of directions aimed at improving COVID-19 diagnosis by using modern and adequate technologies. Thus, a group of researchers at the Latvian Biomedical Research and Study Centre, led by Vita Rovīte PhD, introduced and optimised a completely new technique for sequencing one-cell transcriptomes. The study revealed a number of factors controlling inflammatory blood cell processes that need to be further analysed in detail in order to allow them to be used in disease prognosis or as targets for more effective therapy.

Another group of researchers from the Latvian Biomedical Research and Study Centre, led by Prof. Aija Linē (UL), developed **a new type of antibody test** that enables antibodies to be detected against 30 SAR S-CoV-2 protein fragments simultaneously. This test is currently being used to analyse the profile of antibodies in serum from COVID-19 patients, and to understand its relationship with the severity of the disease. Led by Prof. Leja, specialists from the UL Institute of Clinical and Preventive Medicine have developed another type of **sensor technology** together with specialists from Rīqa East Clinical University Hos-

pital and the company JLM Innovation GmbH. This technology can be used to monitor changes in various chemicals in the exhaled air of patients who are connected to artificial respiration systems. This method could allow doctors to predict the course of how the disease is developing in patients with severe COVID-19. Measurements of respiration sensors have already been performed on the first patients.

As part of the project, recommendations for COVID-19 diagnostics and treatment have been drawn up in accordance with scientific and practical information and recommendations from the WHO, the Centres for Disease Control and Prevention (CDC) and specialists from the European Union and the USA.

The recommendations have been developed by more than 30 specialists from a variety of fields. Among them are infectologists, laboratory and intensive care specialists, general practitioners, pneumologists, paediatricians, radiologists and others. Advisers with extensive and varied experience also participated in drafting the recommendations. The final version of the recommendations consists of 20 chapters on epidemiology, pathogenesis, clinical manifestations, complications, diagnostics and the treatment and prevention of COVID-19. It is intended to be used by all medical practitioners involved in the care for COVID-19 patients, and by medical students and residents. Presumably, for now, the recommendations can be seen as one of the best practical materials the NRP has produced. The contribution is both scientific and practical. The most important practical sections are aimed at clarifying facts about the disease agent, the pathogenesis, approaches to treatment, and other essential disease-related problems.

It should be emphasised that mathematical processing and analysis of the material that has been obtained from patients is ongoing, as a large part of the material was obtained during the study's second phase when there was a significant increase in the number of COVID-19 patients in Latvia.

We are sure that we are going to gain much more scientific knowledge and recommendations for medical practitioners and patients. The scientific facts that were obtained during the unique initial stage of COVID-19 will serve as an outstanding platform on which to base many future studies.

THE 30TH ANNIVERSARY OF MODERN CARDIOLOGY IN LATVIA

Andrejs Ērglis, MD, PhD, Professor of Medicine at the University of Latvia, Head of the Latvian Centre of Cardiology, Pauls Stradiņš Clinical University Hospital, President of the Latvian Society of Cardiology, Vice President of the Latvian Academy of Sciences, Full Member of the Latvian Academy of Sciences

We have spent the past year under the burden of COVID-19. Has it taken toll on people's cardiac health and on cardiology? Currently, we do know that cardiovascular diseases are the most common co-morbidities in COVID-19 patients correlating with a harsher course and worse prognosis of the

disease. On the other hand, cardiovascular diseases still are the leading cause of death in Latvia and in Europe, with a high incidence and prevalence in the total population. The number of patients with cardiovascular diseases still is significantly higher than the number of SARS-CoV-2 infected people,



Fig. 1.
The 1st Heart Team after 30 years. From the left: Guntra Kucika, Andrejs Ērglis, Iveta Mintāle, Ilja Zakke, Romans Lācis, Andis Dombrovskis, 2020. Photo: Kaspars Teilāns

therefore we must not leave behind the first ones taking care of the latter. Living in this new reality, we have acquired the cornerstones of infection prevention: hand washing, physical distancing and using personal protective equipment; but we also have experienced significant changes in the way how health care is organised, especially the planned health care services. In 2020, for the 1st time, we performed almost 500 PCIs less than in 2019 at Pauls Stradiņš Clinical University Hospital, Latvian Centre of Cardiology, which had cast a shadow on the 30th anniversary of the 1st balloon angioplasty in Latvia.

THE 1ST PCI IN LATVIA

Just one month before the independence of Latvia was regained on 4 April 1990, two at that time young doctors - Andrejs Erglis and Andis Dombrovskis - using a small balloon, widened an atherosclerotic narrowing of the right coronary artery in a female patient who complained about chest pain under physical activity. Quoting Niel Armstrong, our small balloon was like "one small step for man, one giant leap for mankind" because under the leadership of Prof. Uldis Kalnins and with the help of our compatriot Dr. Andris Saltups from Australia, we founded modern cardiology. We initiated evidence-based diagnostics and treatment of cardiovascular disease, which later developed into team science and aspiring towards precision medicine (Figs. 1, 2).

By growing clinical experience and actively performing scientific research, the angioplasty procedure has gone through major evolution during the last 30 years. Thanks to new technological solutions, such as stents and bioresorbable scaffolds, and improvements of the techniques, for example, initial modification of the atherosclerotic plaque using special balloons and performing it all under additional intravascular imaging procedures, today balloon angioplasty has grown into minimally invasive micro-surgery called PCI or percutaneous coronary intervention, aimed to restore the impaired blood supply to the heart muscle or, in other words, to perform revascularisation of the arteries narrowed or fully blocked due to atherosclerosis.

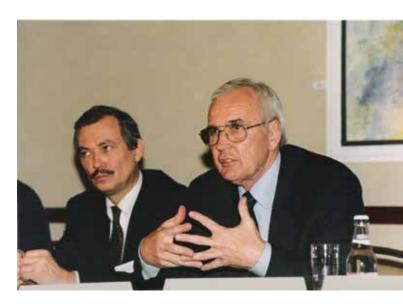


Fig. 2. Prof. Uldis Kalninš (1946–2004) and Dr. Andris Saltups, in circa 1999

REVASCULARISATION IN ACUTE MYOCARDIAL INFARCTION PATIENTS

Similarly as the German cardiologist Andreas Grüntzig did it for the 1st time ever in 1977 in Switzerland, we also performed our 1st PCI in a female patient with stable angina. However, initially the greatest scientific evidence and procedure benefits were in patients with acute myocardial infarction, when the blood supply to the heart is suddenly interrupted because the atherosclerotic plaque is unstable, ruptures and leads to arterial lumen thrombosis. Timely-performed PCI both improves the quality of life and reduces mortality. That is why, during the 1st decade of modern cardiology, we put much effort into creating a network of invasive cardiology in Latvia and in improving the treatment strategy for myocardial infarction patients. Under the leadership of Prof. Uldis Kalniņš, we conducted a retrospective study analysing the efficacy and quality of diagnostics and treatment of patients hospitalised with the diagnosis of myocardial infarction in Latvia, in a 1-year period. Only 26% of the patients received pharmacological reperfusion or thrombolysis, and 1% of the patients had mechanical revascularisation using PCI. The hospital mortality rate for patients after myocardial infarction was 22%. Taking into consideration the significant deficiencies identified, in 2003, the Latvian Society of Cardiology published the 1st guidelines for the acute coronary syndrome, and invasive cardiology centres were extended up to four hospitals in Rīga, Liepāja and Daugavpils with 24/7 units at the two largest hospitals in Rīga (currently also in Daugavpils city). In 20 years, the hospital mortality in myocardial infarction patients has reduced to 10% because the scope of revascularisations has grown nationwide from 27% in 2001 to almost 90% in recent years[1].

COMPLEX CORONARY LESIONS: PCI OR SURGERY?

While PCI undoubtedly is the leading procedure in treating patients with acute myocardial infarction for already almost 20 years, the road to scientifically proven indications for patients with a stable coronary artery disease has been very long, especially for patients with complex coronary lesions, such as left main lesions, calcified lesions, bifurcations, chronic total occlusions.

The left main coronary artery (LM) is the most important section in the overall vascular network of the heart. Sometimes it is called the "artery of life" because its lesions are associated with harsh symptoms, but its total occlusion usually is fatal for the patient. In such a case, in addition to lifestyle changes and drug therapy, revascularisation is a must, to alleviate ischemic symptoms, improve quality of life and reduce mortality. 20 years ago, the European and American guidelines recommended coronary artery bypass grafting (CABG) as the only treatment method, but PCI was contraindicated (Class III indications). The newest quidelines of 2018 for patients with lesions in the left main coronary artery recommend both CABG and PCI as Class I indications under certain angiographic risk (Syntax score 0-22). Latvia played a recognised role when the recommendations changed.

Lesions of the left main coronary artery has been one of the main subjects of our scientific research for almost 20 years. At first, we conducted the 1st study globally, where comparison was made between PCI with implantation of a bare metal stent (BMS) or a first-generation drug-eluting stent (DES) in unprotected LM lesions. Out of 103 patients, 2 patients died within the 6-month follow-up period

(mortality rate 1.9% in each group), there were no thrombosis events, 70% survived in the BMS group and 87% survived in the DES group (p = 0.036) without significant cardiac events. However, this study was not a simple comparison of two stents. Firstly, we showed that the PCI method is safe also for patients with LM lesions. Secondly, our results can be extrapolated only for the specific technique that we used in this study. Before the implantation of BMS and DES, we initially evaluated the atherosclerotic plaque using intravascular ultrasound imaging, accurately identifying its structure and dimensions, and afterwards we modified the plaque using a special cutting balloon [2]. During the following years, we included more than 1000 patients in the real-world register of LM lesions. The technique used in the randomised study increased life expectancy in comparison to PCI performed only under angiographic control without the support of intravascular imaging methods and without the modification of atherosclerotic plaque using a cutting balloon. Further on we took part in international randomised studies (SYNTAX, EXCEL, NOBLE), where PCI was compared to CABG [3]. The results of the studies changed the guidelines. PCI became an equivalent alternative for patients with LM lesions and low angiographic risk (SYNTAX score 0-22), although under high angiographic risk (SYNTAC score > 32) only CABG has recommendations.

Why has PCI not reached the efficacy of surgical therapy for patients with high angiographic risk? As opposed to CABG, the outcomes of PCI are significantly affected by the LM anatomy. PCI can become especially complex, when the narrowing is localised at the distal bifurcation of LM or where LM divides into the main branch – left anterior descending artery (LAD) and the side branch - circumflex artery (Cx). Together with the colleagues from the Nordic countries, we have protractedly studied the properties of PCI in bifurcation lesions specifically and have concluded that overall the best solution is the one-stent technique [4]; however, often such a narrowing must be treated by implanting two stents both in the main and the lateral branch. In such a case, there is a high risk of recurrent narrowing, especially in the side branch. Possibly, if we implanted bioresorbable scaffolds (BVS) instead of a metal stent in the side branch, which support the artery only temporarily and gradually resolve, freeing the coronary artery from a metal foreign body, maintaining normal physiology and the anatomic entirety of a blood vessel as the result. However, studies show that inappropriate implantation of BVS is related to high complication risk, thus now it is allowed only within clinical studies. Our experience shows that safe implantation of BVS is possible using the iPSPi strategy based on 20 years of experience and adaptation to today's conditions [5]:

i – imaging – evaluation of the atherosclerotic lesion using imaging methods, mostly intravascular ultrasound:

P – plaque Pretreatment – modification of the atherosclerotic plaque using a cutting balloon or rotablator:

S – appropriate vessel Sizing – implantation of a stent or bioresorbable scaffolds of appropriate size; P – appropriate Post-dilatation – post-dilatation of the stent to ensure optimal expansion;

i – imaging – evaluation of the stent outcome using imaging methods, mostly optical coherence tomography.

We showed the efficacy of the new iPSPi strategy also in LM bifurcation lesions. Performing intravascular ultrasound (IVUS) guided and optical coherence tomography (OCT) optimised implantation of two "stents" (DES in the main branch and BVS in the side branch), the risk of recurrent revascularisation is reduced when there is a lower cholesterol level, use of a cutting balloon to modify plaque in the side branch, larger diameter of the bioresorbable stent in the side branch, and use of intravascular ultrasound (Fig. 3).

THE HEART TEAM AND STRUCTURAL DISEASES

Although in 30 years, as invasive cardiology has been developing, we have partially stolen the job from heart surgeons, our mutual collaboration has not been affected; it has significantly improved, since we have launched the Heart Team – a team of various specialists, with a patient being at the very heart of the team. As a team, we decide upon the best treatment method, and we have initiated new minimally invasive treatment methods not only for patients

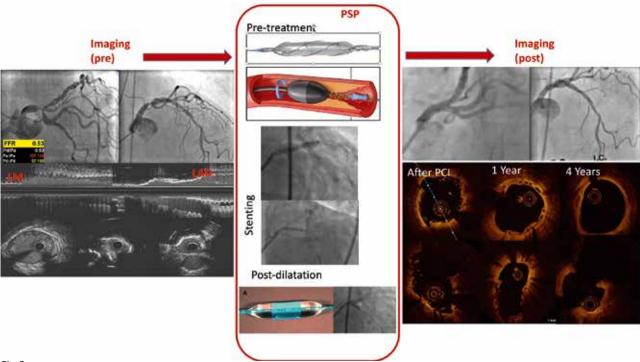
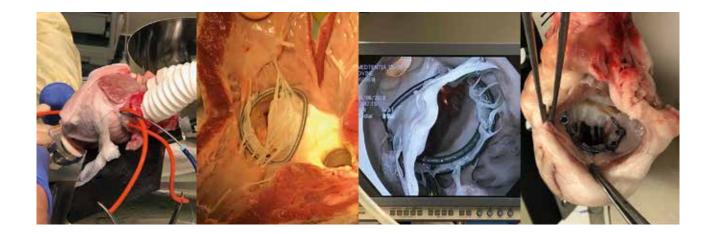


Fig. 3. iPSPi strategy for lesions in the left main coronary artery. On the left, left main coronary artery lesion, angiography and intravascular ultrasound images. In the center – pre-treatment of plaque, stent implantation and post-dilatation. On the right, the outcome of PCI in angiography and optical coherence tomography immediately after stent implantation, after 1 year, and after 4 years



with coronary artery disease but also for patients with structural heart diseases, heart failure, etc.

Ten years ago, we performed the 1st transcatheter aortic valve implantation in Latvia, which today has become a standard treatment for patients with critical aortic valve stenosis and high surgical risk. Furthermore, now our scientific interest is more related to the treatment of the mitral and tricuspid valve pathology. Recently we finished the MAVERIC study. where, for the 1st time in the human population, we used the ARTO system (MVRx Inc., San Mateo, California), which consists of a suture between two percutaneously inserted anchors in the interatrial septum and in the coronary sinus. By tightening the suture, the mitral annular anteroposterior diameter decreases, thus improving the coaptation of the mitral valve leaflets and reducing the mitral regurgitation [6, 7]. In the previous year, we started percutaneous repair of the tricuspid valve within the STTAR study, but in the animal laboratory, we are studying a new option for mitral valve repair using the Double Helix Annuloplasty System (Fig. 4).

Invasive cardiology has undergone a long and intensive phase in terms of medicine and science, which allows us to take the next step towards precision medicine. We are proud of our achievements, but also have a clear view of the existing problems and future challenges. Thank you, colleagues, for your effort!

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SEVERE INFECTIONS IN CHILDREN – PRAGMATIC ASPECTS OF RESEARCH

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Historically, humanity has experienced many epidemics and pandemics, but is still not prepared for every kind of event. The COVID-19 pandemic is an example of an event that has medical, social, and economic impacts and touches our moral and ethical values at the core. This is a time when public trust in science is dependent on clear and practical answers to complex problems related to the new situation. Where can these answers be found? Is it in the framework of medical practice, applied or fundamental research? What are the priorities today? There are more questions than answers.

Theoretically, fundamental research can help us understand phenomena and leads us to new knowledge. Applied research focuses on immediate needs-driven applications and the pragmatic aspect of research and strived to solve practical problems in an evidence-based manner. The aim of clinical practice is to care for patients and respond to public health needs using the best technologies, skills and professional experience available. It is not easy to separate basic research from applied research in practice - one of the options is to understand clear research targets and researchers' motivation. Recently, the American Academy of Paediatrics published seven great achievements in paediatric research in the past 40 years: preventing diseases with life-saving immunisations; reducing sudden infant death syndrome (SIDS) with the Back to Sleep campaign; curing common childhood cancer; saving premature babies by helping them breathe; preventing mother-to-baby HIV transmission; increasing life expectancy for children with chronic diseases; saving lives with car seats and seat belts. These achievements give definitive answers to practical health problems affecting children and their families, save lives and improve the quality of medical care.

What is paediatric research in Latvia like? Theoretically, the future of fundamental research is very promising, but in Latvia it is mostly physicians who are the researchers in this field, who are close to patients and try to solve practical problems by applied research. We understand that the funding provided by national research programmes is not stable and that paediatric research in Latvia is relatively underfunded. Short-term grants do not ensure sufficient development of this field, but this does not undermine the activities of researchers on an international level. For us, it is important to change the clinical practice. This article provides some examples from our studies of paediatric infectious diseases.

The study started with a large outbreak of gastro-enteritis caused by Salmonella spp. that occurred among children in Latvia. Over 4000 cases were reported from 1991 through the first quarter of 1998. Approximately 70% of patients were under the age of one, and their condition was moderate to severe with bloody stool and a high fever. The outbreak saw several lethal outcomes. Some of the cases were complicated by extraintestinal infections. In this study, conducted together with peers from Washington University School of Medicine, the St. Louis Children's Hospital and Wyeth-Ayerst Research, New York, we reported a new member of the CTX-M cefotaxime-hydrolyzing β -lactamase family, designated CTX-M-5. The outbreak strain

was resistant to multiple antibiotics, including ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole, and cefotaxime, which were commonly recommended and used to treat serious infections caused by Salmonella spp [1]. These strains were uniformly susceptible to ciprofloxacin; however, the extremely young age of most of the patients prevented its use in treatment. The prevalence of this cefotaxime-hydrolyzing β-lactamase among *S. ty*phimurium strains in Latvia was possibly related to the increased usage of expanded-spectrum cephalosporins during that time. With the recognition of the high prevalence of resistance, efforts were made to curtail the use of antibiotics in patients with salmonellosis and other gastrointestinal infections to control the spread of S. typhimurium infection, which was very successful. The detection of a new member of the CTX-M family in Latvia raised important questions about whether such enzymes arise de novo in multiple geographic locations or, alternatively, are transmitted across national borders. The importance of these questions emphasises the need for global surveillance of antibiotic resistance so that appropriate control strategies can be designed and implemented. Later, the changes made to the nation-wide antibiotic policy for children had a significant impact on other infections. Based on our previous experience, we minimised the frequency and duration of high-risk antibiotic therapy and the number of antibiotic agents prescribed to children and implemented antibiotic stewardship for paediatric patients.

During our participation in the WHO Multicentric (Egypt, Latvia, Brazil, Croatia) Study (The Grasp Study, 2001–2004) and later in the National Research Programme (2008–2009), we investigated diseases caused by Group A beta haemolytic streptococcus (GAS) that have been known since the 19th century [2]. Despite the improvement of socio-economic circumstances and environmental factors in Latvia, prevalence of GAS in aetiology of acute pharyngitis in children was still a pressing matter and the necessity for early diagnosis and treatment with antibiotics was very important due to the risk of late complications – rheumatic fever and poststreptococcal glomerulonephritis. We found that around half of children who had

GAS obtained from throat posterior wall cultures, or who had a positive rapid antigen detection test (RADT), were noticed carrying GAS with acute pharyngitis clinical picture of some other unspecified aetiology. This meant that these cases did not need treatment with antibiotics, which was a common clinical practice in the past. We found that GAS strains used in the study had a very high macrolide resistance (78%) – an antibacterial drug which was widely used in outpatient settings. Since then, great attention has been paid to a deliberative strategy of antibiotic use in the population of children in Latvia. The association of antimicrobial resistance with certain GAS emm types was similar to that in other European countries. During the course of the study, a new GAS emm 1.51 subtype was discovered, which is now approved by the Centers for Disease Control and Prevention (CDC, USA). The findings of the study also indicated that certain HLA class II alleles, genotypes and haplotypes are associated with risk/protection from RHD and that these associations are more evident in patients among clinically homogeneous groups. This is a useful tool for predicting clinical outcomes of rheumatic fever.

Staphylococcus aureus is a major cause of purulent infections. The spectrum of staphylococcal infections varies from mild superficial to invasive life-threatening diseases due to the ability of S. aureus to produce a wide range of virulence factors, including toxins, for example, Panton-Valentine leukocidin (PVL). Due to PVL positive S. aureus, community-acquired necrotising pneumonia is an emerging infection. Pneumonia often arises from the blood-borne spread of organisms from infected tissues and can follow viral respiratory infections, especially influenza. Necrotising pneumonia mainly affects children and young adults and up to 75% of cases are lethal. The isolates collected in our study were typed by spa gene. We found out that the prevalence of PVL positive S. aureus in hospitalised children with S. aureus infection was 75% and the spread of spa clonal type CC435 S. aureus isolates was observed in children treated in hospitals [3]. A new and successful approach to the antibacterial treatment of necrotising pneumonia was introduced following this research.

The Department of Paediatrics is conducting longterm studies on fever, severe bacterial infections and sepsis, which is one of most significant causes of hospitalisation and mortality of children. Between 1995 and 2000, the child mortality rate from sepsis at the Children's Clinical University Hospital was 24.4%. The situation has not improved significantly over a period of almost ten years - a repeated epidemiological survey demonstrated that 21.7% children died from sepsis and only 22.9% children with sepsis were hospitalised on the first day of illness. National research programmes have enabled Rīga Stradiņš University (RSU) to start studies on life-threatening infections in children [4, 5, 6, 7], which demonstrate low awareness in the evaluation process of children with fever in outpatient settings and also during hospital admission as evaluations were mostly based on physicians' personal experience and less on evidence – test results or approved hospital guidelines for sepsis patients. As a result of this study, new inflammatory markers were evaluated and algorithms, guidelines and pathways for outpatient and hospital settings and parents were developed and implemented in 2019 -2020 across all children's healthcare institutions in Latvia with the support of the Ministry of Health. It is very important for paediatric research in Latvia to be a part of an international research team and to cooperate with other countries [8]. In recent years, we have participated in the following Horizon 2020 projects: PERFORM (Personalised Risk Assessment in Febrile Illness to Optimise Real-Life Management across the European Union) and DIAMONDS (Diagnosis and Management of Febrile Illness using RNA Personalised Molecular Signature Diagnosis). The aim of the DIAMONDS project (2020–2024) is to design new diagnostic tests that can quickly and accurately tell what illness a patient has when they come to a hospital with common symptoms such as a fever. This would help give patients the right treatment at the right time ("personalised medicine"). An international and a multi-disciplinary team of researchers and scientists from across 28 institutions and 13 countries (11 out of the 13 being European countries) are working on this project. Besides that, we have studied other infections, including the human bocavirus (HboV) [9], rotavirus



From the left: Associate Professor Jana Pavāre, Dean of the Faculty of Medicine, RSU; Professor Dace Gardovska, Head of the Paediatric Department, RSU; Professor Aigars Pētersons, Rector of the RSU; Valts Ābols, Chair of Board, Children's Clinical University Hospital

[10], tick-born encephalitis [11] and respiratory syncytial virus (RSV) [12, 13] in children. We proved the usefulness of the introduction of a rotavirus vaccine for infants in Latvia and studied evidence of the human bocavirus HBoV in the aetiology of diseases in children, epidemiology and treatment options for RSV bronchiolitis, variations in paediatric hospital antibiotic use and levels of paediatric preparedness for emergency situations in Latvian hospitals [14]. Since SARS-CoV-2 was first identified in December 2019, it has become a global pandemic at an incredible rate. In March 2020, we successfully started studies on COVID-19 and since then we have been conducting an investigation on laboratory-confirmed SARS-CoV-2 infected children in Latvia. This study includes long-term follow-up and evaluation of how COVID-19 affects the quality of life to understand all phases of the disease and its outcomes. We have performed SARS-CoV-2 serological testing

in children with chronic diseases with no COVID-19 clinical evidence to understand the spread of the infection in this population. SARS-CoV-2 seroprevalence is only 1.7% among children with chronic diseases enrolled in the study, which means that this group of children is not protected against SARS-CoV-2 infection and it would be risky and unethical to wait for an asymptomatic natural infection. We have recommended the Ministry of Health to support prioritising the vaccination of family members of children with chronic diseases. In addition, evaluating the health-related quality of life in children with chronic diseases, we found that the emotional health and school/educational activities are most affected by the pandemic. Despite all restrictions, physical health and social activity are less affected. This means that instead of informing adults alone, the information has to contain understandable explanations for children as well.

The most important value of our research projects is to develop a generation of motivated young scientists. Over the last 15 years, eight researchers have defended doctoral theses and been awarded PhDs in the field of paediatric infectious diseases. The next five dissertations are currently being prepared. The RSU Department of Paediatrics has become an internationally recognised centre for the research of paediatric infectious diseases. In close cooperation with the Children's Clinical University Hospital, the RSU Institute of Microbiology and Virology, Department of Human Physiology and Biochemistry, and the RSU Institute of Oncology, E. Gulbis Laboratory Ltd, and our international partners we try to give the best possible input for improving children's health in Latvia.

Where next? In the USA, mortality and prevalence data from nationally representative disease statistics provide the public and policymakers with information that is helpful for understanding research portfolios, the budget and its relationship to public health needs. The budget for paediatric research in National Institutes of Health (NIH) in 2015 was 3632bn USD. The aim of the article is not to compare research budgets in different countries, but rather to be a reminder that the return on investment for paediatric research does not only have a direct impact on improving children's health. It is

now recognised that adult health risks and chronic diseases have their antecedent early in life (even before birth) and that paediatric research is really lifespan research. The future of paediatric medicine depends on young scientists who are interested in children's health and research, but in order for this to happen, long-term, sustainable funding for paediatric research must become a priority for the state. We understand that researchers have to meet foreseeable national goals, but sometimes it is not so easy to measure for short period. When Gladstone, the British Chancellor of the Exchequer in the 1850s, asked physicist Faraday whether electricity had any practical value, Faraday replied: "One day, Sir, you may tax it."

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MEDICINAL PLANTS IN LATVIA: FROM FOLKLORE MATERIALS TO PRACTICAL APPLICATIONS NOWADAYS

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The application of plants in traditional medicine has a long history, and the use of plants as medicine is as old as human civilization. Historically, medicinal plants have gained considerable recognition for prevention and treatment of different sicknesses. Numerous biologically active components have been isolated from traditional medicinal plants. It is estimated that 122 drugs from 94 plant species have been discovered based on ethnobotanical

leads [1]. The local people in the territory of Latvia used medicinal plants to treat different ailments. The knowledge about the chemical composition of plants might not be known to the local people, but they knew medicinal plants that were useful to treat many kinds of diseases and health conditions. Information about herbal medicine is documented in various folklore materials including the records of Latvian folk medicine (more commonly known as folk beliefs). During the 19th century, across Europe and including in the territory of Latvia, folklore research became increasingly popular [2]. Folklore materials collected during the 19th century today are an integral part of Latvia's cultural heritage. The analyses from two neighbouring Baltic states, Estonia and Lithuania, have been published recently [3–5], and now, also the extensive folk knowledge from Latvia and overview of the Latvian folk herbal traditions in the 19th century have been analysed and brought to an international audience [Sile

Records of Latvian folk medicine collected by the folklore researcher Pēteris Šmits from four volumes of *Latvian Folk Beliefs* (Rīga, 1940–1941) and additional materials stored in the Archives of Latvian Folklore were analysed (Fig. 1). In total, more than 40 000 records were reviewed to select those con-

2019; Sile 2020].

Zobu sāpes pariet kad sāpigo zobu baksta ar zeltenāja zaru, vai smēķē drigeņu sēklas. Zeltenājs, krūmu koks aug, mitrās avotainās vietās, vairāk starp citiem lapu kokiem, ezeru un upes krastos. Daudz tadu krūmu koku Vaidavas ezera krastā hubenē.

23,4905 /- Vaidavā



Fig. 1.

An exemplar file card from the Archives of Latvian Folklore with information about the medicinal use of a highly poisonous plant mezereon (*Daphne mezereum*) from the village Vaidava. Translation of the record of Latvian folk medicine: The toothache goes away when the sore tooth is pocked with a twig of mezereon or by smoking henbane seeds. Mezereon is a shrub/tree that grows in wet soil around spring waters, among other deciduous trees, on the shores of lakes and rivers. There are many such shrubs/trees on the shores of Lake Vaidava in Rubene



Fig. 2.

The most frequently mentioned plants from the records of Latvian folk medicine

taining information about plant usage in medicine. Indications, plant parts used, preparations of the medicine, and their administration were described for each plant mentioned in the records. Over 1900 records containing information about medicinal plant usage in the Latvian-populated territory were found in folklore materials. In total, 211 genera belonging to 71 families were mentioned. Several local plants were mentioned more than 40 times: yarrow (Achillea millefolium L.), chamomile (Matricaria chamomilla L.), onion (Allium cepa L.), wormwood (Artemisia absinthium L.), greater plantain/ribwort plantain (Plantago major L./ P. lanceolate L.), birch (Betula sp. L.), oak (Quercus robur L.), bird cherry (Prunus padus L.), and juniper (Juniperus communis L.) (Fig. 2). The most frequently mentioned foreign plants were tobacco (Nicotiana L.) and aloe (Aloe sp. L.). At the same time, a large number of plants (135) were mentioned only in 1–2 records.

All plants from the records of Latvian folk medicine were compared with plants included in the Russian pharmacopoeia (1891). A large proportion (78%) of Latvian medicinal plants was not mentioned in this official document of the 19th century. This discrepancy could be explained by the fact that a large number of medicinal plants included in the pharmacopoeia were not common in the flora of the territory where the records of Latvian folk medicine were collected. Unlike the pharmacopoeia, the records of Latvian folk medicine were a source of information on plant species used traditionally. The information in pharmacopoeias was scientific evidence-based and was not appropriately understandable for broader public. During the 19th century, there were two parallel medicinal plant-related knowledge systems: one based on folk pharmacy and another based on scientific pharmacy. According to information provided in records, Latvians generally limited their tradition of plant use to locally growing plants, but the Latvian pharmacopoeia compiled by pharmacy specialists included quality standards for the most frequently prescribed herbal drugs available in pharmacies, including also foreign plants.

Fifty-nine plants reported in this study are important for medical practice nowadays, and they are used as traditional herbal medicines according to the EU monographs. Many species mentioned in the Latvian folklore materials and described in monographs of herbal drugs [6] are primarily used in folk medicine with no sufficient pharmacological evidence of their use. For those species, additional pharmacological studies and phytochemical analysis should be performed in order to obtain sufficient scientific evidence and justify their long-standing use.

In total, 1976 cases were reported for disease prevention or health improvement. The use reports were attributed to 17 medicinal use categories. A large number of the records of Latvian folk medicine mentioned the treatment of symptoms related to digestive and respiratory system disorders (Fig. 3), allowing for the mapping of useful medicinal plants. Thirteen plants were described as having activity for more than eight medicinal use categories. Plants that have the highest medicinal value were: chamomile, which was mentioned in 13 use categories, and birch, which was mentioned in 11 use categories.

In addition to wild medicinal plants, foreign plants were also used for medicinal purposes in the territory of Latvia. Aloe is a frequently used house plant that is effective in treatment of respiratory and skin disorders. Several plants such as lime tree, juniper, Scots pine, and yarrow from Latvia's flora were used

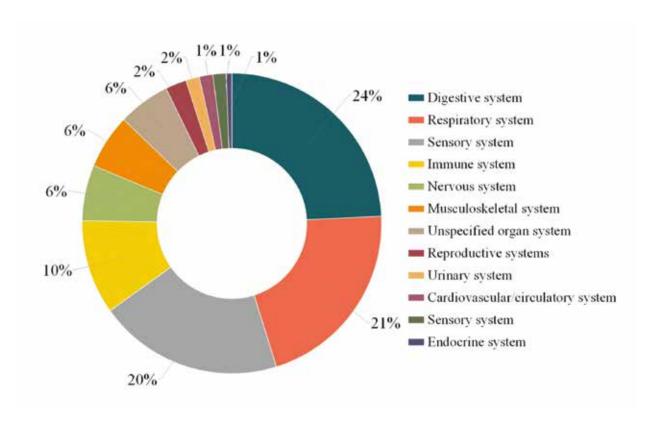


Fig. 3.
Percentage of medicinal use reports for different body systems

for the same purpose as aloe. The number of times aloe was mentioned suggested that this plant grew in almost every household in Latvia in the 19th century. Along with aloe, sea-onion (*Albuca bracteata* (Thunb.) J.C.Manning & Goldblatt) and pelargonium were used for cough and earache, respectively. These plants were used throughout the year, especially in winter, as fresh material.

According to information provided in the records of Latvian folk medicine, oral administration of herbals was the most commonly used, simplest and fastest route of administration. Many records mentioned that plant leaves, such as plantain, yarrow, aloe and apple tree leaves were applied directly to fresh wounds or insect or animal bites, as they had properties that reduced inflammation and healed wounds. Tinctures made of fresh birch buds, valerian roots, and wormwood stems were very convenient for use in respiratory and digestive system disorders because of their long shelf life. To improve the taste of herbal medicine, honey or sugar was added. In the records of Latvian folk medicine, milk, cream, beer, fat, oil, vinegar and even urine were mentioned as solvents instead of water. For babies, young children and adults, bathing in boiled plant water, as mentioned in the records, is commonly used to reduce pain, improve skin diseases or to calm the nervous system. The most frequently used plants in records of Latvian folk medicine, namely, yarrow, chamomile and onion, are now used for extract preparation to obtain tablets or capsules (www.zva.gov.lv; registri.pvd.gov.lv). In folk medicine, these plants were used in other kinds of preparations, such as decoctions, teas, juices and tinctures. Now, when this information is available internationally [7-8], our results can be used in comparative ethnobotanical studies, including cross-cultural comparisons. Plant species and their uses described in the records could be potentially useful for future herbal medicine research.

Inspired by the ethnobotanical knowledge found in the records of Latvian folk medicine, we investigated anti-inflammatory effects of *Prunus padus* L. and *Pelargonium sidoides* DC [9–10]. Bird cherry was among the top ten most cited plants in the records, and pelargonium was a frequently mentioned foreign plant. In the experimental studies, we aimed to confirm ethnomedicinal benefits of these two

plants against inflammatory diseases by employing *ex vivo* inflammatory models using the ethanolic extract of bird cherry flowers (Fig. 4) and water extracts of *Pelargonium sidoides* root (PSRE) and proanthocyanidins from PSRE.

The growing interest in plant research in Latvia is also shown by the contribution of the "SIA Field and Forest", the Institute for Environmental Solutions (IES) (Fig. 5) and the Latvian Institute of Organic Synthesis (IOS) in the research project (Nr. 1.1.1.1/18/A/043) on the cultivation and use of wild spring medicinal and aromatic plants. The main objective of this research is to gain practical knowledge how to cultivate such wild growing plants as: cowslip (Primula veris L.), woodruff (Galium odoratum (L.) Scop.), mezereon (Daphne mezereum L.), coltsfoot (Tussilago farfara L.), pasqueflower (Pulsatilla pratensis (L.) Mill.), lily of the valley (Convallaria majalis L.), ground-ivy (Glechoma hederacea L.), greater celandine (Chelidonium majus L.) and lady's mantle (Alchemilla spp). Documentation and analysis of historical and existing knowledge of these



Fig. 4.
Preparation of ethanolic extract of bird cherry (*Prunus padus*) flowers for experimental analysis



Fig. 5.
Institute for Environmental Solutions trial site, summer 2020

nine wild plant uses in Latvia will be conducted. An ethnobotanical expedition lead by IES team in Vidzeme region (Rūjiena and Naukšēni municipalities) as part of the project already took place in the summer of 2019. Medicinal uses as well as food uses were documented across the local communities of interest. In total, thirty-eight interviewees were interviewed following a pseudo-random and snowball sampling methods. As an example of medicinal uses, for coltsfoot the most represented emic categories were the uses against cough (preparation: tea) and swelling (preparation: topical application and tea). Apart from the usages, the interviewees also added remarks on the landscape change. As for example, an elderly lady (b. 1961) recalled that *Primula veris* have been growing in the meadows but not anymore and stressed the intensive mowing as part of the reason for disappearance. IOS will perform an analysis of the chemical composition (Fig. 6) as well as evaluation of biological activity of extracts of wild growing plants and

plants grown in experimental fields to assess their potential use in medicine, food, and cosmetics. One hundred and fifty-two plants mentioned in the records of Latvian folk medicine are still not included in the EU herbal monographs. This means that safety and efficacy of use of those plants is not yet sufficiently evidenced and they deserve further exploration as traditional herbal medicines. Information from Grandma's dowry chest, complemented by the most up-to-date research technologies, can prove useful and inspire both scientific research by multidisciplinary teams (Fig. 7) and the development of new products in the 21st century.

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Fig. 6.
Sample preparation for chemical analysis using liquid chromatography-mass spectrometry method



Fig.7.
Baiba Prūse (first from the left), Inga Sīle (second from the left) and Maija Dambrova (fourth from the left) participated in Rīga International Biennial of Contemporary Art (RIBOCA 2018) and shared information about the use of medicinal plants from the folklore materials and ethnobotanical expeditions in Latvia

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PROJECTIONS AND STUDIES IN THE HUMANITIES AND SOCIAL SCIENCES

DEMOGRAPHIC DEVELOPMENTS IN LATVIA

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The article seeks to provide a brief overview of demographic developments in Latvia and to sketch potential near-term future developments. The evolution of total population and its composition will be assessed in terms of major demographic processes in our present century.

Already at the end of the Soviet occupation period, population dynamics showed a clear tendency of a falling rate of population growth. At the time of restoring Latvia's national independence in the late 20th century, its population had reached the maximum thus far (2.67 million). On 21 August 1991, the day of the *de facto* restoration of independence, the population of the Republic had already fallen by more than 20 thousand. At the beginning of 2014, the number of residents fell below two million, and,



subsequently, regularly continued to decrease. At present the total population (less than 1.90 million) is even smaller than that at the beginning of 1940. Some 750 000 residents have been lost during the three recent decades of independence.

Table 1. Changes in the population of Latvia from 1991 onwards

Year	Overall change thousands	Incl	uding	Relative weight of international migration	
. 33.		due to natural causes	due to international migration	in the decrease of the number of residents %	
1991-1995	-188.6	-51.2	-137.4	72.8	
1996-2000	-116.2	-70.4	-45.8	39.4	
2001-2005	-125.5	-59.3	-66.2	52.8	
2006-2010	-153.2	-44.0	-109.2	71.3	
2011-2015	-105.7	-40.2	-65.5	62.0	
2016-2019	-61.3	-33.0	-28.3	53.8	
2020*	-11.6	-9.6	-2.0	17.2	
1991-2020	-762.1	-307.7	-454.4	59.6	

Source: CSB database and author's calculations

^{*}Author's estimates (numbers for October-December have been extrapolated)

Table 1 shows that there has been a negative balance of natural movement and international migration. In the period from 2008 to 2017, more residents were lost due to emigration than as a result of excess mortality over birth. Only in the last four years, has the loss of human resources due to outmigration been lower than that due to natural decline.

From the early 1990s onwards, Latvia pursued active diplomatic efforts to have Russian troops leave Latvia, a process which began in March 1992 and was completed on 31 August 1994. A large number of family members of Soviet army officers and security personnel also left during this period of time. The process was facilitated by reluctance of many former immigrants to remain in Latvia due to job losses in former factories and institutions, and also due to their lacking knowledge of the state language.

Exodus of the population was also facilitated by a

drastic change in the economic system and social policy, with a pronounced increase in unemployment as well as numbers of those living in poverty. The economic downturn was pronounced during the first half of the 1990s, and also during the years of economic crisis. Outmigration of the young individuals and middle-aged people was exacerbated by Latvia's accession to the EU in 2004. In the period from 2006 to 2010, the decrease due to migration was 109.2 thousand, or on average, 21.8 thousand per year, accounting for 71% of the total decrease of the population.

The number of registered immigrants has increased significantly over the past decade (an average of 5.6 thousand per year in 2001–2010 (see Table 2), and more than 10 thousand in 2011–2020). On the other hand, there is also a decrease in numbers emigrating, after having reached a definite maximum in 2008–2011.

Table 2. The extent of international migration in over the period 1991–2020

Year	ear Immigration		Emigration		Net migration flow	
	total	annual average	total	annual average	total	annual average
1991-1995	30 842	6168	168 230	33 646	-137 388	-27 478
1996-2000	17 079	3416	62 844	12 569	-45 765	-9153
2001-2005	27 616	5523	93 833	18 767	-66 217	-13 244
2006-2010	28 149	5630	137 386	27 477	-109 237	-21 847
2011-2015	51 680	10 336	117 171	23 434	-65 491	-13 098
2016-2020	49 355	9871	79 695	15 939	-30 340	-6068
incl: 2016	8345		20 574		-12 229	
2017	9916		17 724		-7808	
2018	10 909		15 814		-4905	
2019	11 223		14 583		-3360	
2020*	8962		11 000		-2038	
1991-2020	204 721	6824	659 159	21 972	-454 438	-15 148

Source: CSB database (in particular the dataset "Long-term migration (ledzīvotāju ilgtermiņa migrācija)" IBG010 etc.) and the author's own calculations

^{*}Author's forecast

It should be noted that many migrants today do not show traditional hallmarks, with a length of stay of more than a year and a change of place of residence. From 2012 onwards, the total population of the Republic of Latvia has been determined by the CSB (Central Statistical Bureau of Latvia) using a logistic regression model. According to this model, the resulting migration indicators are determined from calculations based on data held by various national administrative entities. In the beginning of 2020, 2.08 million people have declared their place of residence in Latvia, but according to CSB estimates, the number of permanent residents is about 180 thousand lower, showing up weaknesses in the records of international migration. The forthcoming census in 2021 will be conducted for the first time on the basis of registered data and administrative units, without recourse to a population survey. There is some reason to believe that the number of inhabitants included in the Population Register is exaggerated, because tens of thousands of people have not cancelled their residence declaration.

In terms of the rate at which depopulation is occurring, Latvia is one of the leading states in the Baltic Sea Basin region, in the EU, and also in the world. Of the ten countries in the Baltic Basin, the population decline in our country has been the fastest, from 1990 onwards (around 30%). In Lithuania, this indicator is comparable, whereas in Estonia the decline has also been high but is lower.

Eurostat recently (2019) compiled data on the developments in the demographic situation in EU member states. The depopulation rate was greater only in Bulgaria. In this list Latvia is followed by Rumania, Croatia and Italy. According to data published by the UN Population Division, Latvia in regard to depopulation rate regularly is located in the list of the top five states and territories so affected. Thus, in 2010–2019, a faster rate of depopulation was found in Syria, Puerto Rico, Lithuania, and Bosnia and Herzegovina.

The gender and age structure of the resident population play an important role in the analysis of demographic resources, especially the numerical ratios of men and women at the age of starting a family. The proportion of economically active people, the workload of the population of working age

with children and pensioners, the extent of labour resources, the extent of aging of the population, etc. all depend on quantitative relations between various population age groups of people, etc. The most favourable ratio between the number of men and women in Latvia was found at the end of the 19th century. As a result of the two world wars, not only did the population decrease significantly, but the extent of the disproportion between men and women also increased. At the end of the 1950s, there were one-quarter fewer men than women. The proportion of men in the country (43.9%) was one of the lowest in the world. The numerical relationship between men and women gradually levelled off during peaceful times, but even after restoration of independence, the relative predominance of women has been one of the highest in the world.

It is easy to see systematic aging of the population from analyses of changes in the age structure. The number of children under the age of 14 halved during the years of independence, while for the group working age it fell by almost one-third, and there was a marked increase of the age of retirement. The average age of the population increased from 36 years to 42.5 years (45 years for women, 39 years for men). Latvia is among the leading countries in the world in respect of aging. The rate of the population aging will also continue to be quite high over the coming two to three decades.

Aging of society is an objective and, generally, a progressing phenomenon that reflects global objective issues since transition in society occurs towards a more rational type of generational change, with higher population viability and lower birth rates. However, excessive rates of aging, as observed in Latvia (most notably in Latgale, where the average age of contemporaries has reached 45), lead to serious socio-economic problems. The main reasons for aging of the Latvian population are a declining birth rate, outmigration of young people of working age, and, in part, an increase in life-expectancy. If the number of people in a country decreases and they age, it is important to compensate for these losses, at the very least by raising the quality of human resources, through increasing education, professional training and higher work productivity.

Analysis of the employment rate of the population shows a gradual annual increase up to and including 2008 and a decrease following the economic crisis in 2009–2010. From 2011 onwards, the situation in the labour market has been slowly improving, including lower levels of unemployment (from 16.3% in 2011 to 6.3% in 2019). About half of all employees are women. Labour productivity is also on the rise. At the turn of the century, the value added by workers in our country lagged behind the EU average by 60%; today this gap has shrunk to one-third.

Progress has been made in Latvia in the field of education. The share of persons with higher education among the adult population has increased from 11.5% to one quarter. The average time spent in education has increased to 12 years. The level of education achieved by women is significantly higher than that of men. These gender gaps in education are among the largest in the EU. Lifelong learning is still relatively underdeveloped. In terms of adult education, Latvia lags significantly behind the most economically developed countries. A particularly unfavourable situation has developed with respect to the numbers engaged in research, mainly scarce employment opportunities for doctors of science. If in 1991 there were

about 16 thousand scientists resident in Latvia, now only 3 thousand are at work in the country (in terms of equivalent normal working hours, 5.9 thousand). A critical mass has been lost, one capable of generating ideas and driving a necessary change in a number of scientific disciplines and in society as a whole.

There were approximately 730 thousand families resident in Latvia at the end of the Soviet period. A further 132 thousand family members lived separately from the rest of the family, and a further 251 thousand were single, i.e. without any family members. The approximate number of families has now dropped to 500 thousand; the 2011 census recorded 860 thousand households, with an average number of 2.38 persons per household. This figure is now among the 10 lowest in the world, according to the US Population Reference Bureau (2.2)

Changes in the ethnic make-up of the population and evolution of the titular ethnic group of the population are important aspects in assessing demographic resources. These aspects are especially important for formerly occupied and ethnically diverse countries, a group that includes Latvia. The data of Table 3 shows that the number of Latvians decreased both in the period before and after the turn

Table 3. Dynamics of the number of Latvians and members of the largest minorities, 1989–2020 (at the beginning of each year, thousand people)

Ethnicity	1989	2000	2020	2020 vs 2000	
				thousands	%
Latvians	1387.8	1370.7	1192.3	-178.4	87
Russian	905.5	703.2	471.2	-232.0	67
Belorussian	119.7	97.2	60.1	-37.1	62
Ukrainian	92.1	63.6	42.9	-20.7	67
Poles	60.4	59.5	38.0	-21.5	60
Lithuanians	34.6	33.4	21.9	-11.5	66
Roma	7.0	8.2	4.9	-3.3	60
Jews	22.9	10.4	4.4	-6.0	42
Germans	3.8	3.5	2.5	-1.0	71
Estonians	3.3	2.7	1.6	-1.1	59
Others	29.5	25.0	67.9	+42.9	272

Source: CSB database. "Resident population by ethnicity at the beginning of the year (Pastāvīgie iedzīvotāji pēc tautības gada sākumā)" (IRG069) and the author's own calculations

of the century. In comparison with the results of the last Soviet census of 1989, there were 17 thousand fewer Latvians counted in the 2000 census. In this century the decline was noticeably faster. By the beginning of 2020, there were an additional 178 thousand fewer Latvians; in total, over the years of restored independence there has been a loss of 195 thousand. No year has seen a positive balance. This speaks of serious mistakes in governance and, in particular, in the implementation of socio-demographic policies. A small natural increase of the number of Latvians was noted only in 2015–2016, however, this did not lead to an increase in the total in number of Latvians, as outmigration dominates immigration by a factor of two to three.

The number of Russians and other major ethnic minorities decreased even faster than that of Latvians. The number of Jews has decreased most significantly (by more than a factor of 2 during our century alone), the number of Ukrainians has decreased relatively less than the number of Russians, Belarusians and other ethnic minorities. Consequently, the share of Latvians in the total population has risen from 52% in 1989 to 60.5% in 2000 and 62.5% today.

The tragic situation of the Latvian people must also be seen in a longer historical perspective and, in particular, when compared with ethno-demographic developments in other countries. At present, there are over a hundred thousand fewer Latvians living in their country (1192 thousand) than during the first census of tsarist Russia in 1897 (1318 thousand) or about 300 thousand less than shortly before the First World War in early 1914 (about 1500 thousand). Almost equally large differences can be seen when comparing the present situation with that obtained before the occupation of Latvia in 1940 (Latvian numbers about 1500 thousand). There are no other nations in Europe whose losses of human resources in their country have been greater.

Demographic processes are imbued with inertia, so that obviously it is not possible to arrest depopulation in the coming years: the total population, and also the total number of Latvians will continue to decline. Neither Latvian nor international specialists, such as UN or EU demographers, predict population stabilisation in their medium-term forecasts. According to the most recent baseline forecast by

Eurostat for 2019 (the most plausible version), numbers will continue to fall through 2095, when there will be 1 million 81 thousand residents in Latvia. By 2050, numbers will have decreased to 1 million 395 thousand, which is an even more pessimistic scenario than was forecast three years ago. According to these predictions, Latvia is expected to demonstrate the highest rate of population decline in the EU. About 80% of the projected reduction relates to international outmigration. Forecasts by the UN Population Division issued in 2019 are slightly more optimistic. The main scenario predicts that by the middle of the century in Latvia there could be 1.48 million residents, but at the end of the century, 1.11 million. With such rates of depopulation, the total number of Latvians will drop to less than one million by the middle of the century. The US Population Reference Bureau predictions for Latvia give similar results. On the other hand, long-term forecasts issued by 24 American specialists, published in the journal *The Lancet*, are quite pessimistic. According to their projections, 80 years from now there will be between 220 and 770 thousand residents in Latvia (most probably around 430 thousand). This will be the largest population decrease in the world. In our opinion, their rate of depopulation is exaggerated, but the long-term systematic narrow replacement of generations, at the same time as the predominance of emigration over immigration gives serious warning of the possibility of population extinction.

Considerably better results could be achieved through urgent implementation of demographic policies and a comprehensive long-term recovery programme. Awareness of demographic theories about programmed management, together with some experience in regulating (even managing) demographic processes will provide confidence that these excessively pessimistic scenarios can be avoided. The example of Estonia or the cardinal change of the development in Latvia in the second half of the 1980s indicate real possibilities to slow down the drain of the state's human resources and prevent depopulation in the long term.

In our opinion, implementation of a well-thought-out policy for dealing with generational reproduction change as well as internal and external migration must become a priority for sustainable development of the country. An increase in birth rate and vitality must be achieved to address not only outmigration, but also immigration issues. In our century, a significant increase in the fertility has been achieved (the total fertility rate in 2000 was 1.24, in 2011 – 1.34, in 2016 –1.74, while in 2019 – 1.61) and also in the average life expectancy (70 years in 2000 – 2001 and 75.6 years in 2019). There are significant reserves in this area, especially with the birth of a second child, an increase in healthy life styles and a significant reduction in premature male mortality. However, reducing outmigration is crucial, especially for the younger and middle-aged working age groups. Statistics on births, deaths and, in particular, public health, are expected to be left outdated by the Covid-19 epidemic. From a global perspective, these effects on the demographic picture ought not to be significant.

Forecasts show that the role played by Rīga and Greater Rīga (Pierīga) in the social and economic development of our country will continue to grow. Their share of the total population has exceeded 50%, and this will increase in the coming years. Therefore, the population distribution in the country and the search for optimisation of regional development need more attention, including studies by academic institutions.

In 2012, the Latvian Academy of Sciences issued an extraordinary statement on the unfavourable demographic situation in our country, as well as on insufficient provision for public information in this area. In our opinion, there has been no real improvement over the past eight years, except that information provided by public authorities has become more extensive and reliable. Five years ago, the Demography Centre of the University of Latvia ceased to function, and there are no other comparable demographic research institutions in the country, reducing the international potential of the sector. Participation in international research is weak, and training of highly qualified demographers has ceased.

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BALTIC SYMBOLISM – THE ADDED VALUE OF EUROPEAN CULTURAL HERITAGE

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From 10 April to 15 July 2018, the Musée d'Orsay in Paris held the exhibition "Wild Souls. Symbolism in the Baltic States" (Âmes sauvages. Le symbolisme dans les pays baltes). This was an ambitious joint project of all three Baltic states and one of the largest events in the international programme of Latvia's centenary.

This exhibition invited the French public and many thousands of tourists from around the world to discover symbolism in Baltic art of the 1890s to the 1930s. It was also an opportunity to discuss the Baltic, emphasising the specific characteristics of the

art, the historical legacy, and the traditions of each country (Fig. 1).

The project was a major effort by leading cultural and diplomatic institutions, its significance underscored by the fact that the exhibition patron was Emmanuel Macron, President of France, and that it was unveiled at the Musée d'Orsay on 9 April by President Macron and the three presidents of the Baltic states (Fig. 2). We, who conceived this event and saw it through from the initial idea to its realisation, were most privileged to be involved, because the exhibition was not only an international



Fig. 1.

Musée d'Orsay, Paris. Advertisement for the exhibition "Wild Souls. Symbolism in the Baltic States". 2018. Photo: Ansis Starks



Fig. 2.

Opening of the exhibition "Wild Souls. Symbolism in the Baltic States" at the Musée d'Orsay on 9 April 2018.

From the left: President of Estonia Kersti Kaljulaid, President of Lithuania Dalia Grybauskaitė, President of France Emmanuel Macron, President of Latvia Raimonds Vējonis. Photo: Ansis Starks

manifestation of culture attracting 236 079 visitors during its 82 days (almost 3000 per day) but also developed as a continuation of historical events, emphasising France's role in the incorporation of the Baltic states into the general ecosystem of European art (Fig. 3).

Cultural diplomacy had a place in the foreign policy of the Latvian state right from the very beginning: for example, at the time of the Paris Peace Conference in 1919, in parallel with meetings between politicians, there were lectures, speeches, publications and cultural events that provided a significant instrument of influence, conveying an impression of the high professional standard of culture in the newly-established Baltic states.

The Francophile orientation in Latvian art was an abiding source of influence, starting with the expe-

rience of Paris, metropolis of European art, at the beginning of the 20th century, and continuing with the orientation towards France among Latvian artists of the 1920s and 1930s, which reinforced a sense of belonging to Western European culture, allowed the artists to perceive their work in a wider context and acquainted them with contemporary world trends.

In the 1930s, France followed a policy of actively enlarging its cultural space to become an intellectual moderator among many different nations. The Baltics were represented at the national level in Paris at the 1935 Applied Art and Ethnography Exhibition held in the Trocadéro Palace. The next joint cultural presentation of the Baltic states was in 1937, with a shared pavilion at the International Exposition of Art and Technology in Modern Life.



Fig. 3. General view of the exhibition "Wild Souls. Symbolism in the Baltic States" at the Musée d'Orsay, 2018. Photo: Ansis Starks

This proved to be the 20th century's last showing of Baltic art in France: with the outbreak of the Second World War and Soviet occupation, the names of Estonia, Latvia and Lithuania disappeared for half a century from the European map. In the 1990s, after winning back independence, the Baltic States had to demonstrate their artistic credentials in Europe anew, regardless of their earlier achievements.

Looking back now at the history of this Baltic project, the success story of Latvian symbolism has been a significant factor. After visiting Kaunas to see the Mikalojus Konstantinas Čiurlionis National Museum of Art in 1999, the French curator Rodolphe Rapetti made a trip to Riga to acquaint himself with the unknown art of this period in Latvia. Rodolphe Rapetti is France's Conservateur *général du patrimoine*, author of many publications relating to the

theme of symbolism and curator of exhibitions at the Musée d'Orsay and the Grand Palais in Paris. Rapetti's first exhibition as curator was "Edvard Munch and France" (Musée d'Orsay, Paris, 1991), followed by "Gustave Caillebotte" (Grand Palais, Paris, 1994). With the creation of the exhibition "Unknown Horizons. Art in Finland, 1870–1920" (Galerie de L'Ancienne Douane, Strasbourg, 1999; Palais Des Beaux-Arts, Lille, 1999–2000), Rapetti's interests extended in the direction of Northern Europe, exploring the distinctive characteristics of Finnish art from this period, and thus also drew him nearer to the Baltic states [1].

Each of the national art museums in the Baltic states already had its own studies and past activities on this theme. Moreover, Latvian symbolist art had already been successfully presented within the



Fig 4. Opening of the exhibition "Wild Souls. Symbolism in the Baltic States" at the Musée d'Orsay on 9 April 2018. From the left: Director of the Latvian National Museum of Art Māra Lāce, Latvian Minister of Culture Dace Melbārde, project leader Ginta Gerharde-Upeniece. Photo: Ansis Starks

framework of an ambitious international project the exhibition "Spreading One's Wings", which in 2004 and 2005 was shown at the National Museum in Szczecin, the Xawery Dunikowski Museum of Sculpture of the National Museum in Warsaw in the Królikarnia palace and the Mikalojus Konstantinas Čiurlionis National Art Museum in Kaunas. In 2010 and 2011, works by well-known Latvian classics were shown at BrusselsTown Hall and the National Museum of History and Art in Luxembourg (Musée national d'histoire et d'art Luxembourg, MNHA). Another internationally significant episode was the participation of the Latvian National Museum of Art (LNMA) in the exhibition "Symbolism and Decadence: the northern perspective" held in 2015-2016 in Sweden, at Prins Eugens Waldemarsudde, one of Stockholm's most respected art museums. In 2015, the LNMA contacted Rodolphe Rapetti, inviting him to become curator of an exhibition of Baltic Symbolism. By this time, the proposal from the LNMA had already received a positive response from colleagues at the national museums in Tallinn, Vilnius, and Kaunas, who authorised us to talk to the French side. Rodolphe Rapetti received our invitation with genuine interest, and thus, as representatives of the Baltic, we had the unique opportunity to work with this outstanding individual and professional in the field. The exhibition project was implemented jointly by four national art museums in the three Baltic states: the Latvian National Museum of Art (Riga); the Kumu Art Museum (Tallinn), with additional works loaned by Tartu Art Museum; the Lithuanian National Museum of Art (Vilnius) and the Mikalojus Konstantinas Čiurlionis National Museum of Art (Kaunas). Starting from 2016, the national art museums of the Baltic states worked together with France. Preparatory work for the exhibition involved Latvia's Ministry of Culture as well as the corresponding ministries in the partner countries, the Latvia 100 Office, the French Embassy and the French Institute in Latvia, as well as the Latvian Foreign Ministry and the embassies of the Republics of Estonia, Latvia and Lithuania in France.

In the spring of 2016, at a special meeting in Brussels, Latvia's Minister of Culture Dace Melbārde discussed the idea of the exhibition with Audray Azoulay, the French Minister of Culture, and even before the specific venue and timing of the exhibition had been agreed, they endorsed the initiative of the cooperation partners from France and the Baltic for the holding of an exhibition in Paris (Fig. 4).

The Baltic Symbolism exhibition was discussed at several meetings on different levels at the Museums Directorate of the French Ministry of Culture, the Réunion des Musées Nationaux, etc. In the framework of the discussion, the works of art from the age of symbolism were visually presented and their merits assessed. One of a series of fortunate coincidences was a meeting in Rīga in 2005. Among the art scholars and museum specialists arriving in Rīga from abroad was Laurence des Cars from Paris, who gave a paper entitled "The Musée du Luxembourg - the first museum of contemporary in France". Having become acquainted with the LNMA collections, the then curator and researcher at the Musée d'Orsay noted that, with the further development of European exhibition activity, the Latvian art she had seen in Rīga would have great potential. The Baltic museums' team had to decide on the question of holding the exhibition at the Musée

d'Orsay in just a few days. Our colleagues from

Tallinn, Vilnius, and Kaunas were quick to let us know they would not pass up this opportunity and would do their utmost to make this initiative succeed. In order to ensure successful cooperation with the four Baltic museums, Héléne Flon, Stéphanie de Brabander, and Beatrice Avanzi from the Musée d'Orsay, as well as the museum's director, Laurence des Cars herself, visited the Baltic and became personally acquainted with all the project partners.

On 1 June 2017, a press conference was held in the Symbolist room of the LNMA, at which Latvia's Ministry of Culture, the French delegation, representatives of the Baltic museums and the project organising group announced the planned exhibition at the Musée d'Orsay in Paris. This upcoming cultural event attracted great interest, which would not subside during the whole year. Thanks to cooperation with the Latvian Institute, foreign journalists also arrived in Rīga and the upcoming event was reported in the French press.

Rodolphe Rapetti undertook to select the works and made visits from Rīga to museums in Tallinn, Tartu, Vilnius and Kaunas. Each work was chosen only after viewing the original and serious evaluation (Figs. 5, 6, 7). The success of the project also is due to the professional team of museum staff from the three countries, intercommunicating in what may be characterised as a fantastic example of cooperation. This was undoubtedly helped by the creative process and the professional dialogue with the Musée d'Orsay specialists during which our French colleagues' interest in the project grew into a genuine interest in Baltic culture, languages and traditions. The idea advanced by the Musée d'Orsay was to involve specialists from various fields in a scientific exchange of views on the age of symbolism. On 3 May 2018, a symposium on symbolism was held at the Musée d'Orsay entitled "National Romanticism and Baltic Symbolism", with the participation of three researchers from each country. At the closure of the project in Paris, articles in the press and in specialist publications were collected, so that they would be available for professional evaluation in the Baltic.

In addition to the fact that the Musée d'Orsay offered the most prestigious exhibition space, it was also a major financial partner in producing the



Fig 5 Vilhelms Purvītis. Spring Waters (Maestoso). ca 1910. Oil on canvas. 102.5 × 144 cm. Latvian National Museum of Art. VMM GL-1570. Photo: Normunds Braslinš



Fig 6.
Ferdynand Ruszczyc. Nec mergitur. 1904–1905. Oil on canvas.
204 × 221 cm. Lithuanian National Museum of Art. LMD T-2691.
Photo: Antanas Lukšėnas



Fig 7.

Konrad Mägi. Composition (Meditation. Landscape with a Lady). ca 1915–1916. Oil on canvas. 81.6 × 106 cm. Art Museum of Estonia EKM M 2060. Photo: Stenislas Stepashko

exhibition and the catalogue. In the course of preparing the exhibition, the team of museum specialists from the Baltic came to the conclusion that the project also had to be shown back home, and we agreed to continue it in the three capitals. After the Musée d'Orsay, the exhibition began with great success at the Kumu Art Museum in Tallinn, Estonia (11.10.2018-03.02.2019), travelling to the Lithuanian National Museum of Art, National Art Gallery in Vilnius (24.07–11.10.2020), and ending at the LNMA in Rīga (20.11.2020-04.05.2021). The Latvian phase of the symbolist project imposed certain historical obligations on us because the building of the Rīga City Art Museum once held regular exhibitions by Baltic artists. In 1909, it was the venue for the first exhibition by Parisian artists, in addition to which there were regular showings of art from Lithuania and Estonia. In the context of cultural exchange between France and Latvia, more than eighty years ago, in March 1939, an exhibition of French modern art opened here, just a few days af-

ter a hugely successful Latvian art exhibition at the Jeu de Paume museum in Paris that had been acclaimed as a triumph of Latvian art. This fact was noted repeatedly at various organisational meetings of the Baltic symbolist exhibition.

Ending the four-exhibition project where it began, in Rīga, we may conclude that in this aspect we have been privileged in a way; the staff of Latvia's art museums as a united team were able to draw attention to the Baltic states not only in the cultural sense but also at the political and diplomatic level, delighting exhibition visitors in Paris, Tallinn, Vilnius, and Rīga. Laurence des Cars repeatedly emphasised that Europe is united not only politically but also in the creation of common cultural values. This conviction, one of the cornerstones of the Musée d'Orsay's exhibition policy, made it possible to demonstrate that, alongside the work of wellknown masters, the contribution of artists from the little-known Baltic belongs to Europe's common cultural heritage.

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1. General curator, Rodolphe Rapetti, currently Director of the National Domains and Museums of Compiègne and Blérancourt. In parallel with his research activity, Rodolphe Rapetti has also been Curator at the Musée d'Orsay, Director of the Musées de Strasbourg, Director of the Muséum National Jean-Jacques Henner and Deputy Director of the Museums of France; he has taught at the School of the Louvre and Paris Nanterre University. Rapetti's achievement in the field of symbolist research includes the exhibitions "Odilon Redon" (Grand Palais, Paris, 2011), "Van Gogh to Kandinsky: the Symbolist Landscape of Europe 1880–1910" (Van Gogh Museum, Amsterdam; Scottish National Gallery, Edinburgh, 2012); "52 Souls. Symbolist Landscape: 1880–1910" (Ateneum, Finnish National Gallery, Helsinki, 2012) and "Émile Bernard" (Musée de l'Orangerie, Paris; Kunsthalle Bremen, 2014). His most important studies include the monograph Symbolism (Le Symbolisme, Paris: Flammarion, 2007), also published in English that same year, with a condensed version in 2014.

MODERN APPLIED ART STYLE OF JŪLIJS MADERNIEKS. INSPIRATION FOR CONTEMPORARY DESIGNERS AND MATHEMATICS

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Jūlijs Madernieks (1870–1955) is a unique personality in the history of Latvian art, who has purposefully dedicated his life to the creation of original sample compositions of applied art, which today can surely be called "the style of Madernieks" [1]. He has also been called the first Latvian designer. An innovator, since in his original compositions he combined Latvian ethnography, the mythically fabulous local nature, visualisation of his lyrically musical feelings in ornament and the latest findings in the art of his time. Madernieks' ornaments might be interesting and "understandable" to nowadays mathematicians and programmers. Thanks to the ambitious project of the Institute of Art History of the Art Academy of Latvia at the beginning of the 21st century – to write the history of Latvian art in six volumes from prehistory to the present day those interested have got the opportunity to see Jūlijs Madernieks' creative heritage in the local and European context of art history. So far, three volumes of Latvian Art History have been published, revealing the artistic phenomena in Latvia from the end of the 18th century up to 1940 [2]. All volumes have been recognised by the Latvian Academy of Sciences as highlights of 2014, 2016, 2019 in Latvian science. The interpretations of the researchers published in these collective monographs also helped to shape this text.

SEEKER OF NATIONAL IDENTITY IN THE ORNAMENT OF DECORATIVE ART

Jūlijs Madernieks was born in the family of a tenant of Vecgulbene manor. He attended Rīga Craftsmen's Association School of Crafts (1891–1892) as a free listener where he studied with Oskars Felsko (1848–1921) with the aim of preparing for entrance exams at Baron Stieglitz's Central Technical Drawing School. Madernieks entered the Stieglitz School in St. Petersburg in 1892. During the studies until 1898, he acquired the skills necessary for decorative art, specialising in decorative painting. In St. Petersburg he joined the Latvian artists' group *Rūķis*, where he got acquainted with other Latvian art students and stabilised his main idea in art - to create original, however, Latvian art. In the history of Latvian art, we often call participants of the former group Rūķis the founders of Latvian professional art - the first painters, graphic artists, sculptors and designers. Immediately after graduating from Stieglitz's Central Technical Drawing School in St. Petersburg, he got a scholarship and enriched his understanding of the possibilities of applied art in Paris (1899–1900), London and Munich (Fig. 1). In 1903, J. Madernieks settled in Rīga, where he developed projects of unified interior ensembles. In Rīga, which was subject to rapid urbanisation, at

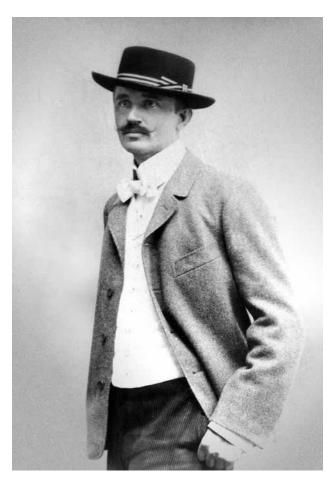


Fig. 1.
Photograph of Jūlijs Madernieks. The late 19th and early 20th century.
Art Academy of Latvia Information Centre. Folder No. 57

the beginning of the 20th century, apartment buildings were being built and had to be fashionably furnished. Jūlijs Madernieks created ornamental compositions mostly for Latvian customers, looking for solutions for visualisation of the national identity: wallpapers, ceiling paintings, furniture, and even clothing. Around 1904, he opened his drawing and painting studio for Latvian youth. In the studio, special emphasis was placed on creating original compositions. Many of Madernieks' students created the art environment of Latvia in the 1920s and 1930s; for example, Ansis Cīrulis (1883-1942) followed Madernieks' ideas and became a recognisable master of applied arts himself. He has designed the interior of the Ambassadors Accreditation Hall at the Rīga Castle [3]. Until 1937, in parallel with work in his studio, Madernieks has worked as a teacher of drawing in several secondary schools.

The artist has been called a master of ornament. Initially his work was dominated by a decorative line of sharp angles, while in the 1920s and 1930s the main means of artistic expression were colour contrasts, associative ethnic decors, pixel-like lines and square (Fig. 2). At the beginning of the 20th century, Madernieks' search of ornament can be seen in the artistic design of books, magazines and in the original compositions of ornament for applied art. Nowadays, mathematicians and programmers are able to notice reflection symmetry, parallel transfer or operational amplifier, the latest was invented only in the 1960s, some years after Madernieks passed away. Programmers might notice a visualisation of graph theory when looking at Madernieks' ornamental structures.

Madernieks' visual insights, which have arisen at least since 1903 by analysing the ethnographic materials collected by the Rīga Latvian Society (nowadays they are in the collection of the National History Museum of Latvia), are compiled in the original



Fig. 2.
"Organ's" pattern designed by Jūlijs Madernieks. Until 1930. Decorative
Arts and Design Museum, Rīga

sample composition album Ornaments. In the creation of manual graphics, black-and-white depictions of graphic ornaments have been developed in the ink technique. Jūlijs Madernieks is the first representative of Latvian applied art to have developed his own sample album of original compositions. The artist offered a new form to the Latvian alphabet as an alternative to the Gothic font. Madernieks' sample compositions are distinctly geometric, rhythmic, dominated by sharp line solutions. By his sample compositions, Jūlijs Madernieks wanted to offer an alternative aesthetics to masters of handicrafts. These sample compositions of ornaments aroused interest and were used to decorate various materials in the woven and embroidered fabrics of the arts and crafts, metal, wood and ceramics. In the compositions of the ornament, Madernieks has attached great importance not only to decorative lines, but also to colour combinations, gaining inspiration in the ethnographic textile art - basic colours and harmonious halftones [4]. In the 1920s and 1930s, Jūlijs Madernieks created ornaments and forms of model compositions, continuing with the compositions of the geometric ornament (Fig. 3).

The basis of Madernieks' style is the logic of the combination of rhythmic geometric elements, at angles of 45 and 90 degrees, analytically evaluated at the beginning of the 20th century and taken over from the knitted mittens, embroidered woollen shawls, woven sashes and fabrics for skirts of the 18th and 19th centuries. The style of Madernieks is dominated by a language new to the Latvian art the language of an associatively imaginative graphic ornament, created by expressive angular lines. There should be the publishing house Zalktis (grass snake) and the visual language created for it. The image of zalktis has a meaning in Latvian mythical thought and in the 19th/20th century it became a symbol of wisdom. Atis Keniņš (1874-1961), a Latvian lawyer and promoter of education, was the editor of Zalktis and advocated especially for Latvian art and artistically high-quality books, that can be seen in the graphic solutions of Zalktis created by Madernieks. Jūlijs Madernieks worked as a teacher of drawing at Atis Kenins School, which was located in a specially designed national romantic style building by Konstantīns Pēkšēns (1859-1928) and



Fig. 3.
Photograph of Jūlijs Madernieks in his studio. 1941. Art Academy of Latvia Information Centre. Folder No. 57

Eižens Laube (1880–1967) [5]. It was opened in 1905, and Jūlijs Madernieks developed sketches of the sample interior composition of the building. A characteristic feature of the turn of the 19th/20th century was a request for applied art artists to develop a stylistically unified interior ensemble ceiling and wall decorations, furniture. The ornamentally saturated wall and ceiling ornament sketches created by Madernieks were implemented by professional craftsmen: painters and carpenters. The first interior design was accomplished in 1903 by order of the lawyer Fricis Alberts for his Rīga apartment. Madernieks had created sketches for wall and ceiling paintings, furniture shapes and decor, and eventually they gained attention as a modern solution. Until the First World War, unified interior ensembles for Madernieks were ordered by the wealthy layer of Latvians living in Rīga. For example, the family of the Latvian lawyer Friedrihs Grosvalds (1850-1924). In the 1920s, Madernieks designed the interior (wall paintings and furniture) for Sigulda Writers' and Journalists' Palace. Nowadays, Gulbene Municipality History and Art Museum displays the interior design that Madernieks designed for his own apartment. For the interior of the State Chancellery (today - Ministry of Foreign Affairs), J. Madernieks developed a wall and ceiling painting

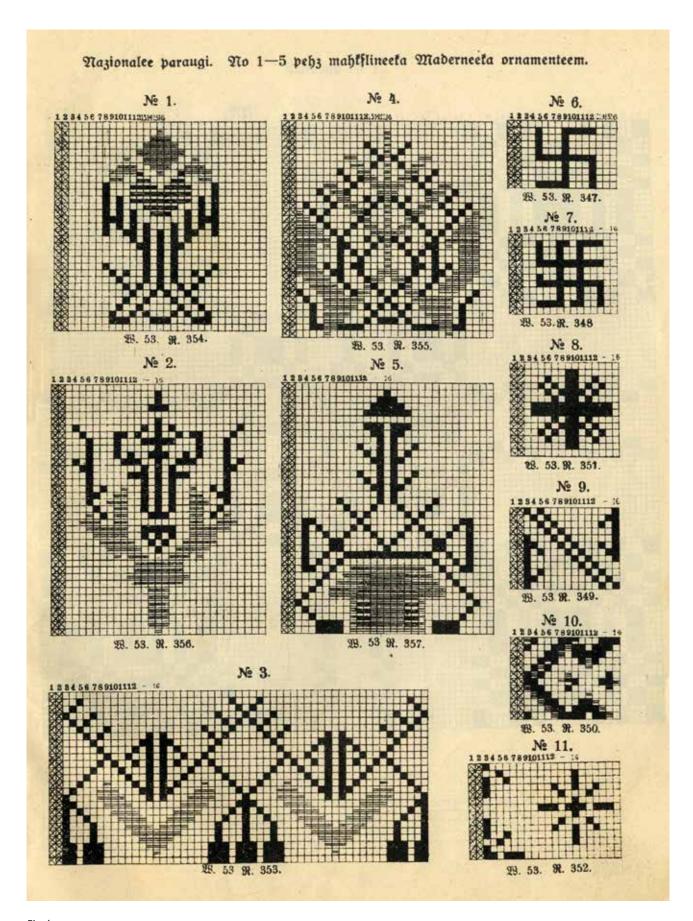


Fig. 4.
Patterns (1–5) made by Jūlijs Madernieks. Pēteris Viļumsons sample book published in 1905, *Trešdienas rīts jeb trešā musturu grāmata audējiem* (Wednesday Morning or the Third Pattern Book for Weavers).

saturated with ornaments, as well as furniture. Unfortunately, this work of art has not survived to the present day.

Of all the applied arts, Jūlijs Madernieks has created the largest number of sample sketches in textile art and textile crafts. In 1904, the women's Song Festival costume offered by J. Madernieks caused great discussions and controversy. Just like a fashion designer, Madernieks designed a modern Latvian woman's costume inspired by ethnographic heritage, which was not acceptable to Rihards Zariņš (1869–1939), the founder of Latvian professional graphics, who believed that during Song Festivals participants should wear the 19th century festive costumes. Paradoxically, the former controversy of both graduates of Baron Stieglitz's Central Technical Drawing School, although both of them considered the importance of ethnographic heritage as the basic resource of national identity, permeates the views of the contemporary Latvian art history

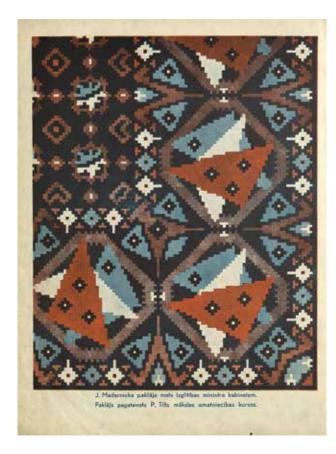


Fig. 5.
Carpet pattern for the cabinet of the Minister of Education made by Jūlijs Madernieks. Published in Sievietes Pasaule, 1936, No. 18, September 15, p. 30.

writers [6]. The ideas of both artists are topical also nowadays: at the Song Festival, participants dress in as authentic folk costumes as possible. The Latvian Culture Canon records the tradition of wearing folk costumes as a symbol of Latvian identity, but at the same time Latvian designers find inspiration for creating new and modern items by continuing the ideological path of the first Latvian designer, Jūlijs Madernieks [7].

Jūlijs Madernieks was attracted by the idea of the ethnic identity of progress in art, so it is natural that he collaborated with the professional weaver, entrepreneur and inventor Pēteris Viļumsons (1872-1939). Around 1900, P. Vilumsons set up a weaving mill in Jelgava, patented a single-spin semi-mechanical (with a prism and card system) weaving loom or weaving machine Lielupes vilni and published sample books specially suitable for these looms. In the sample book published in 1905, Trešdienas rīts jeb trešā musturu grāmatā audējiem (Wednesday Morning or the Third Pattern Book for Weavers), you can see five original ornaments invented by J. Madernieks (Fig. 4). The idea of developing original compositions that could replace the ornamental samples imported from abroad was relevant to Jūlijs Madernieks before the First World War.

The artist studied ethnographic textiles at the Museum of the Rīga Latvian Society, getting acquainted with Latvian ornaments, colour combinations and composition. The ethnographic heritage entered his work in a modernised way, combined with the current art trends of his time. He wrote in the press that the textiles composed by craftsmen and handicraftsmen according to the abstract geometric principles of artists' sketches are similar to paintings [8]. In his autobiography, J. Madernieks pointed out that he gained increased interest in creating textiles while being in Moscow as the First World War refugee, where it was stimulated by the invitation of the Tatiana Aid Committee to submit samples of drawings for implementation in material [9]. In the 1920s and 1930s, the artist abundantly created textile compositions for the interiors of modern people: carpets, wall coverings, pillows and curtains (Fig. 5). Symbolic textile works for organisations were also made – flags embroidered in art salons. In craft and handicraft schools, students acquired skills working out textile compositions by Jūlijs Madernieks in material. Madernieks' geometrically abstract, colourful and associative sketches of Latvian textile compositions were purchased for the collection of the Latvian National Museum of Art, exhibited in the exhibitions of the artists' association Sadarbs and abundantly published in Latvian women's favourite magazines such as Sieviete, Sievietes Pasaule, Atpūta and Zemnieku Saule. According to the textile sketches there were created works in weaving, embroidery and crochet techniques using woollen, linen and cotton fibre. In the 1920s and 1930s, the style of Madernieks entered almost every Latvian apartment, wherever a woman was engaged in handicrafts, becoming a part of popular culture. Textiles and Madernieks' modern Latvian style were so popular that in 1930 a book of sample sketches, Raksti, was published.

From 1904, Jūlijs Madernieks began to publish his thoughts on the current processes of Latvian art and artistic crafts. Madernieks has had the courage to be ruthless against poorly grounded, non-original artistic expressions. Art criticism, in parallel with the work of the teacher and the development samples of applied art, was an integral part of his creative activities until the 1940s. Rūdolfs Pelše (1880–1942), a contemporary of Jūlijs Madernieks and the founder of the speciality of ceramics at the Art Academy of Latvia, eighty years ago pointed out that "there is no field in our applied arts that Madernieks would not have touched upon" [10].

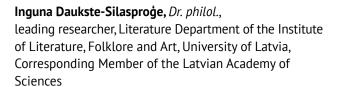
When we turn back to ornamental patterns made by Madernieks, Mārtiņš Ratnieks, the designer of the exhibition "The Style of Madernieks" [11], stated on the opening day of the exhibition that it was impossible to transfer algorithmic Maderniek's ornaments. Mārtiņš Ratnieks is a member of RIXC Centre for New Media Culture and made visual identity for the exhibition inspired by Madernieks' patterns, but this is something new, based on mathematical algorithm. It is impossible to copy Madernieks' style as he drew his ornaments by hand on paper. It is a human-made unique ornament based on an ethnic metaphor.

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IN A BOAT ACROSS THE BALTIC SEA

AN INSIGHT INTO
THE MONOGRAPH
WAITING FOR THE BOAT:
LATVIAN AUTHORS AS
REFUGEES IN SWEDEN [1]





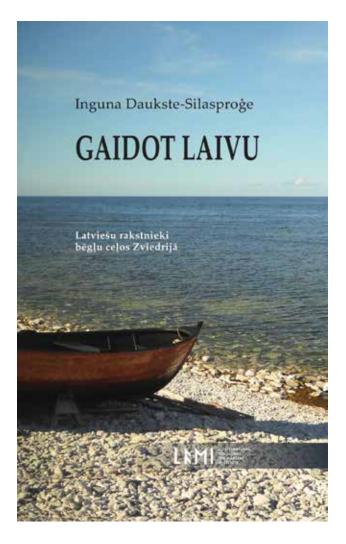
For every scholar it is of utmost importance to find his specific field of research – the range of topics, the historical period, the research aspects. Since mid-1990s, my research interests have been focused on the literature history, aspects of literary and cultural life, documentation of processes and events of the Latvian exile, the psychological aspect of exile as such, national identity and mother tongue in a multi-national environment, generation-related issues in exile situation, the geography aspects of the Latvian exile.

The 20th century was the time of change both for Europe and Latvia. Within just a handful of years, the political events of the century's history subjected Latvia to a series of dramatic changes: loss of independence on 17 June 1940, followed by deportations of the country's citizens on 14 June 1941, then the Second World War with the German occupation, and battles on the soil of Latvia. All of these factors left a truly dramatic influence on Latvia's history and tragically impacted the destiny of so many Latvians. Some part of the nation left its homeland becoming refugees and later – exiles in different countries and continents. Some stayed in

Latvia trying to survive, searching – and finding – some "secret passages" in the labyrinths of the Soviet ideology, providing them with some opportunity to be oneself without conflicting one's consciousness. In 1949, came another wave of repressions, with thousands more deported to Siberia. All of these experiences have formed the dramatic and traumatic destiny of Latvia and the Latvians.

In autumn 1944, more than 10% of the Latvian nation, including a substantial number of the intelligentsia – writers, musicians, painters, actors, journalists and university teachers – left the country to become political refugees. Most of them took to ships and travelled to Germany, a significantly smaller number took a much more dangerous route travelling in fishing boats across the Baltic Sea to Sweden. A still smaller number – mainly Latvian soldiers – found themselves in Denmark, Austria or Belgium. This was a huge wave of emigration, for many years marking a border between the Latvians in exile and those in the occupied Latvia.

This is the fourth book [2] discussing a geographic location, where the Latvian refugees ended up, this time – Sweden. In the monograph *Waiting for the*



Boat: Latvian Authors as Refugees in Sweden I continue my research of the Latvian refugees and the exile period. One may say that my research is also a set of stories about the geography of feelings or the different geographic (environment, landscape) sense. And also the destiny of the Latvians in various lands of residence. The present research is centred on a chronologically and geographically limited view of political and historical events through the perspective of individual person's experiences that of a creative individual. In a way, based on studies of sources and archives, testimonies and literary texts, a time period from the history of the Latvian exile has been reconstructed. The main purpose of the research was to remind of an age that brought hard decisions and tragic experiences to the lives of a quite a few Latvians. The chronological boundaries of the research have been marked by the status of boat passengers – at the period studied they are *refugees* – in Latvia, Gotland, Sweden. While working at this research I also had to think of Latvia – the state, the family and everyone who had experienced the historical turning points of the 20th century. It was important to view, as stated by E. V. Bunkše, while thinking of one's own life, "what is home and road for a human being and a Latvian in a violent age of great change? And how a land-scape, location and environment can impact the emotions and thoughts of an individual?" [3]

The boat on the cover of this book is a symbol, as the word 'laiva' ('boat') became one, a sign and a hope to get to the other side, to be protected. It not only symbolised the means taking one to safety, that will take across – to the other side, but also the longing for stability and peace, some humane life. The historian A. Daudze has come to a conclusion that the refugees made their choice in favour of Sweden as their refuge was based on its geographic proximity and being left outside direct fight [4]. "Going into exile, people lost everything – their possessions, jobs, social status and also the opportunity to live in their fatherland. In the context of national and ethnic identity an important role is attributed to territory, belonging to which the people feel, in which they dwell and with the name of which they relate their common identity. Latvia had grown physically out of reach, still the lost fatherland continued to exist - as an image formed by literature, recollections and communication." [5] Sweden, in the autumn of 1944, became the first exile country for the Latvians. In 1944-1945, the shore of Kurzeme (Courland) was the last sight of Latvia seen by some 5500 refugees leaving in boats. They departed for a country not touched by the war, where people had lived in peace for centuries, were accustomed to a monolinguistic environment, and the refugees of the Second World War was a challenge and a new experience also for them.

Getting on a boat and the sea itself marks a limit in the refugee's experience – the former life was left in the past, darkness or fog covered the shore of Kurzeme – that is, Latvia. For the ones leaving the shore some door was symbolically locked and a boundary was crossed – now behind it (in Latvia) was left all of the former life, while on the other – the present – side of it (in a foreign land) they were filled with uncertainty, fear and simultaneously also some hope that a return home will still be possible. Exhausted, soaking wet and desperate after the trip in an overcrowded fishing boat or cutter the refugees made their first steps on solid land in Gotland. What did it mean for the Latvian intelligentsia, including writers and poets, to lose their former life, the audience of readers and listeners, for the academics - their students, university and opportunities of research? So the present research is centered on a Latvian, a refugee, a creative personality on one's way from the shore of Kurzeme to Gotland and in Sweden. And it seemed of importance to remind in the present research that also literary texts can serve as substantial source for the study of Latvia's history, forming understanding or arousing interest in Latvia' history of the 20th century and the destinies of so many Latvians in these crossing points of historical events. And more – to remind of literary texts created decades ago; to urge to read and read again. Also, the route to Sweden taken by the Latvian refugees, their mundane and social life has been discussed, devoting more attention to Latvian writers and poets. In general they were the same refugees – as all the others having left Latvia. Writers and poets took the same route, experienced similar situations, their individual experiences became a collective documentation of Latvians' experiences in a literary form.

The study examines the "life space" of Swedish Latvians (then refugees) – designating this period as an intermediary time between various necessary choices and decisions, including the decision whether or not to stay in Sweden at the end of the 1940s, or to emigrate to another country.

The period viewed symbolically forms a cutline – on the one end of it there is the Kurzeme shore and the way across the sea in a refugee boat, on the other – the new place of residence, namely Sweden, where one assumes the new status of a refugee. The quarantine camps in Gotland and on the Swedish mainland, physical and rather mundane work to earn ones sustenance, being required to ascertain one's own skills and knowledge anew – this characterises the foreign land. The refugees are living two lives in parallel – the Swedish and the Latvian one,

publishing Latvian periodicals, books in Latvian, organising active and eventful social, cultural and literary life. All of this allows to survive emotionally both in the foreign country and being parted from Latvia by a physical obstacle – the Baltic Sea in this case.

In the mind of the refugees then the idea of a closed and limited space prevailed – first, the boat (a closed, narrow space enclosed against the outer world) while going to Gotland; second, reaching Gotland marks another closed environment as this is a world in its own right - an island in the sea; third, more such closed and delimited worlds are formed for refugees arriving behind a fence and locked gates in the *quarantine camps* on both Gotland and the Swedish mainland. The enclosed environment left strong impact on the inner world of the refugees. Geographically (spatially) the present research is delineated by three reference points - Kurzeme, Gotland, and Sweden, viewed in separate chapters. Each one of them brings its own specific impressions, tonalities and colour gamut, as well as observations into the documentation of the refugee experiences, emotionally grading the range of feelings from hopes of the departure from Latvia being only temporary to the realisation that from refugees they have turned into exiles and citizens of a different country. In the middle between these two points from the temporal and spatial perspective of refugees' feelings there is infinity, an apocalyptic doom, the power of natural elements (the sea, the wind, precipitation, etc.). This is revealed with emotional intensity in written texts both while still in the power of the experienced and immediate emotions, and also looking back after a shorter or longer time. Departure from the Kurzeme shore while leaving Latvia filled the departees with emotionally vivid and strong memories, found its expression in works of art and literature. The writers on pages of their works or memoires have authentically documented the feelings and emotions on their way to the island of hopes - Gotland, while leaving the land of hopes Latvia. The very travel in the boat forms a closed microcosmos, isolated from the rest of the world, where each individual's emotion reaches a truly high intensity. In the feelings of the Latvian refugees, their poetry and prose texts, letters or notes, a large part is occupied by contrasts and sketches of the distinctive Swedish nature. The everyday life and duties of the Latvian refugees is not much reflected in the literary texts, quite often it is possible to learn about it indirectly from the letters of the writers, their essays, reflections, articles and notes, therefore the present study came to be a mosaic of feelings and a "life-map" of sorts, showing the inner and outer world of the then-refugee. Undeniably, in general the literature of Latvian refugees and exile maps a vast spatial and geographic landscape, extending the geographic poetics, contrasts and variety of Latvian literature. Latvian authors of different generations were forced to become refugees, and it is substantial that also the youngest generation turned to writing on a foreign soil, wishing to reflect their experiences. The Latvian literature developed and differentiated.

For those to whom this age is history without direct experiences, each individual story, including also the literary texts, forms, supplements, helps to understand the events of the history of Latvia and the tragic fate of a creative personality within these processes. A multitude of Latvian writers, at the end of the Second World War becoming refugees and arriving in foreign lands, including Sweden, also changed their literary style. Emotions and loss of their homeland, life in a foreign land and the differing landscape environment contrasting with the former life and culture environment brought more pain and nostalgia, patriotic feeling and new visual imagery in their poetry and pages of some prose works, marked different relationships, everyday life and work environment. This features many autobiographic and authentic markers of the age and specific experiences. Not everything in the literary works is always an exact description, still these works feature a documental character (events, emotions, experiences, feeling, etc.) and authentic emotional, records of momentary emotions. These records of past events – the told time and people – in a way also document the age and the event spatially. The teller (the writer) has been one of them, an eyewitness of a kind, and novels turn into "life stories" told in a foreign land. On the one hand, this is a personal and individual experience, on the other it has the features of the collective memory. And for

the reader of the 21st century these literary narratives become one of the keys, allowing to comprehend the age, the complexity of history and the human fate. Although frequently the border between the memoire literature and literary work is blurred, these texts become sources for the study of the age. Literature – every book, also the ones published in a foreign country – has its audience and its specific reader. The language and literature, also a book in the native tongue provided the refugees with some shelter, strength and consolation for the soul in desperation, and literature (the writing process) provided shelter also for the writer him/herself, thus involving the author's emotions and longings of the heart in the literary work.

Studying the age it is essential to view in relation the memory with history and historical processes, especially, if those are related to a war time and reflexion of immediate after-war period. One of the ways for relation of such traumatic experience is also literature. It is essential to narrate the past experiences, in order to be capable of living in the present, clarifying/establishing the truth of the historical events of the past that have close ties with the destiny of both a single individual and that of the whole nation. Latvian refugees are characterised by collective emotional experience. From 'me' and 'my experience' to 'we' and 'our experience' - this is how the tragic age urges us to view a longer stretch of the nation's history. Such an opportunity is also provided by the literary texts, including the lifestories, memories, journals, letters and other documents of the age. The feelings of a Latvian refugee are also marked by thoughts, dreams, hopes and pain, they lived with each day (the thought of home, hope of return, memories of the past and hopes for the future). All this forms the world of a Latvian refugee in Sweden – on the one hand, each one's individual, personal feelings – and not always appropriate for publication, and on the other those that are so similar. A testimony of the time, the age, the historical events and individual experiences and feelings. This allows to grasp the events better and may become an additional source for a history study. So we can understand the tragic and dramatic age, since there is a strong aspect of direct experiences and eyewitness observation.

After the Second World War, Europe was changed, many countries were subjected to the Soviet power for decades. The Latvians living in the Soviet Latvia and those of the free world were parted for decades. The road to the renewed independence of the 4 May 1990 was long, indeed.

The historical experiences of numerous European nations in the 20th century are traumatic, especially when viewed in the war discourse and in context of various repressions. The experiences of Latvian refugees in the Second World War and their post-war experiences form a complex of traumatic feelings, on the one hand, extremely individual and personal, and on the other, showing clear traces of collective similarities and uniting emotional experiences. The individual experience of the past allows to "construct" the collective past experience in the present. It is of great importance to learn and remember the tragic pages of the Latvian nation's history. They also include the strength of spirit and national self-consciousness. The time spent by the refugees in Sweden analysed in the present research is a part from the destiny of the Latvians in the after-war Europe of the 20th century and also a part of the Latvian literature and history.

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EGYPTOLOGY ... ALSO IN LATVIA

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Egyptology could not have had a beginning in Latvia were it not for a talented professor, namely, Francis Balodis, who was able both to inspire student audiences, and also establish the Cabinet of Egyptology and Oriental Philology gathering a collection of high-quality valuable ancient artefacts. Subsequently, these became the object of his study and research, building on a thesis presented in 1912 at the University of Munich, "Prolegomena zur Geschichte der bärtigen zwerghaften Gottheiten in Ägypten (Prolegomena on the History of Bearded Dwarfs in Egypt)".

In 2000/2001, combining astute use of high-technology capabilities and an aptitude for cooperation in inter-disciplinary research, and taking advantage of the development of unconventional research techniques, the Museum of Foreign Art (Rīga), together with the Department of Egyptian Antiquities of the Louvre Museum (Paris), Polish Egyptologists, and specialists of the Naval Medical Centre (Rīga), were able, for the first time in the Baltic region, to study a mummy based on state-of-the art computer tomography and radiography, and, also for the first time ever, to image via computed tomography, a

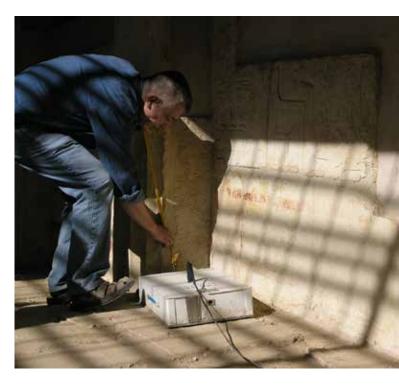


Calibration of ground-penetrating radar device. Adobe wall, New Kingdom tombs Saggara

mummy in its sarcophagus, and these data in digital form could be then studied in many countries. Implementation of this project and the excellent results obtained thereby ranked Latvia among countries engaged in the scholarly investigation of Egyptology.

Notwithstanding this, the first in-situ studies by scholars from Latvia in Egypt began much later, only in 2006, when for the first time ever, a photogrammetry survey was carried out of certain large ancient monuments and, furthermore laser scanning of exposed surfaces was performed. At that time, such technical methods had only been applied to artefacts stored indoors, but their determination and trust in the new approach permitted PhD, Dr. arch. Bruno Deslandes and Dr. sc. ing., h.c. Jānis Klētnieks, for the very first time ever, in situ to characterise in detail pylons of the Great Temple located at Thebes (*Dr. sc. ing.* Māris Kaļinka). Already in the following year, a group of researchers from Latvia, led by B. Deslandes, carried out detailed laser imaging of the Pyramid of Djoser. Technology develops unremittingly and the methods employed by this group as novel became customary during the succeeding decade, to obtain in-situ detailed characterisation of valuable cultural historical monuments. This also applies to making 3-D measurements of objects under study (ing. Klaus Kiep), and includes processing of the 3-D data (Baiba Ziemele and Oto Lukss). Analogous investigations using ground-penetrating radar led to the discovery of a number of previously unknown passages beneath the Pyramid of Djoser, in addition to enclosed rooms, and also previously undiscovered structural features (Dr. geol. Prof. Valdis Segliņš and ing. Georgijs Sičovs).

A novel aspect of these investigations was the characterisation and documentation (using GIS tools) of artefacts and underground wall decorations located beneath the central part of the Pyramid of Djoser (*Dr. geol.* Agnese Kukela). These investigations resulted in methodological guidelines that induced the Supreme Council of Antiquities (Egypt) to upgrade significantly the requirements of the quality of research, in addition to training many Egyptian specialists in implementation of these new research techniques.



Mery-Neith tomb floor tests for unknown substructures nearby the King Djosser Pyramid complex

The results of processing empirical data collected during these expeditions were an essential feature of this work – tens of publications, among which are those by A. Kukela on the subject of the weathering of construction materials employed in the Pyramid of Djoser, including the nature of binders that were used, and the development of geospatial models. Measurements of the deformation of pyramids sited on the Giza Plateau and indications of previously unknown hidden spaces in these are also of lasting significance.

Although, in the following years, our researchers were able to participate in archaeological excavation missions in Egypt organised by other countries, as of 2011 these investigations have been paused; subsequently, they have only participated in a number of French missions, Red Bubasteion (in 2013 and 2014). These have been the final missions to extensive excavations carried out in recent years; hence, the most significant discoveries in recent years relate to studies of how pigments were prepared for paintings found in the tombs of the rulers of ancient Egypt. Thus, when collapsed underground passages were found covered with a thick layer of



The First Dynnasty tombs field at North Saqqara

ochre covering the walls, such visual evidence was used to corroborate what had been described in written texts.

In addition, scholars have focused attention on investigation of artefacts that had previously come into the possession of the Museum of Foreign Art (presently, the Art Museum Rīga Bourse). It was thanks to the work of museum staff over several decades that the collection created by F. Balodis was scrupulously maintained in a good state. Moreover, a comprehensive descriptive text was compiled over many years until it was published in Latvian and English, in 2014, as *Ancient Egypt. A Collection of the Latvian National Museum of Art*. The underlying scholarly research and quality of the catalogue allow it to stand alongside similar catalogues from world-renowned museums. Scientific papers including discussion about the identity of the stat-

ue of Merire on public display in Rīga, which has been the subject of scholarly debate for many decades, are an important part of this publication.

A number of popular publications about Ancient Egypt have appeared recently in Latvian, about its cultural diversity and its role in the Ancient World (J. Klētnieks); in addition, Romualds Pipars produced, in 2010, a full-length documentary film about the Latvian scientific missions to Egypt, "Džosera piramīdas noslēpumi" (Secrets of the Pyramid of Djoser). These activities signalled the start of publication in Latvian of a number of scholarly monographs. Thus, the publication, Senās Ēģiptes rakstu dārgumi. No Piramīdu tekstiem līdz Mirušo grāmatai (Written Treasures of Ancient Egypt. From Texts Found in Pyramids to the Book of the Dead), in 2011, chiefly presents the key elements of the written cultural heritage of Ancient Egypt – notably including

raw translations into Latvian of texts found in the Mortuary Complex of the Pyramid of Unas, supplemented by basic texts from the Papyrus of Ani, as well as some inscriptions found on sarcophagi. The pyramid texts are translated in full, and provide ample material for further scholarly study of these conversations between gods, in addition to spells, thereby eschewing the need to rely on intermediate language texts, which could create insurmountable barriers for future study. A chronological framework has been established of the development periods of the Ancient Egyptian State, along with a detailed list of the ruling dynasties and rulers of Ancient Egypt, giving their names and representative written forms thereof. This information is now available for the first time in Latvian, which is an important result, because they are not available in the languages of our immediate neighbourhood. The main scientific finding of this work is largely to be found in the content of texts from the Pyramid of Unas, as providing evidence for the fragmentary nature of these texts, and contradiction of the previously held assertion that these form a single cohesive work. They are most likely to have been parts of a ritual invocation of deities by high priests, the surviving text covering only a part of the ritual, since the fragments of speech are unevenly sited on different walls of the tomb, abandoning any organisation in rows and columns.

The role played by deities in ancient civilizations is most often exaggerated, ranging from devastating to romantic, most often combining and simplifying the different ways how the ancient gods impacted society. The opportunity is lost thereby to appreciate how the image of deities gives insight into society of the period. In this sense, the publication in Latvian, Hors. Valdnieku dievs (Horus. God of Kings), in 2017, following a novel methodological approach, presents a comprehensive evaluation and analysis of artefacts and known texts of one of the principal deities of Ancient Egypt. Taking into account the geographical mapping of ancient evidence in its historical context the approach allows the image of a deity to be evaluated in terms of its variability and adaptation to the needs of the local community at any given period, and, furthermore, assessing texts as to the diversity of images of the deity provides an

insight into the changes in Egyptian society in terms of its need for spiritual values, belief in improving daily life, security, and anticipation of the afterlife. A similar approach was followed consistently in studying other ancient cultures, finding expression in a work (in Latvian), in 2018, dedicated to one of the main goddesses of Mesopotamia, Inanna/Ishtar, highlighting transformations of representations of this deity, *Ištare un desmitiem tās dažādo seju* (Ishtar and Dozens of Her Various Faces).

Many stories and myths have been known for centuries about mathematics and medicine in Ancient Egypt and what this civilisation achieved, including various facets of knowledge hidden from society. These accounts are widespread in media circles; however, all known sources dating from Ancient Egypt have been translated over the past century, and, in addition to fragments available in Latvian, complete translations are available in languages currently used in the Baltic region. A rather different situation obtains in regard to ancient texts on medicine. These have so far been translated into several languages over the past century, with no single overview to-date of these documents. For this reason, all of the various available translations, made over the course of many years, have been re-assessed taking into account the modern state of knowledge about Ancient Egypt. In all, information has been collected systematically from more than 50 different sources concerning medical treatment techniques, as well as, approximately 1500 prescriptions. In general, these comprise not only a modern-day body of texts (Senās Ēģiptes medicīnas papirusi, The Medical Papyri of Ancient Egypt, 2018), but also high-quality cognitive material on the use of medical plants and other natural products in healing and health care. The scientific novelty of this work stems from the availability of these ancient documents, accessible, in general, by means of modern translations of ancient texts, which allows for reliably tracking how medicine and pharmacology developed over nearly two thousand years, as empirical sciences in Ancient Egypt.

However, there are numerous texts dealing with magic and the casting of spells that constitute an important part of the Medical Papyri, which contrast strongly with traditional views on these issues.

Thus, a monograph was published in 2018, in Latvian, based on primary sources, reflecting the presently available knowledge on these subjects, Maģija un burvestības Senajā Ēģiptē (Magic and Spells in Ancient Egypt). This text differs substantially from similar publications in other languages, wherein the presentations of magic and casting spells in ancient Egypt are often superficial. This work is the first one clearly to separate the traditional view of these issues as were current in Ancient Egypt, from those following the Assyrian conquest, which latter were typical of the Greco-Roman period. It should be noted that the oldest Egyptian texts on magic and spells display features in common with the rich oral folklore tradition in Latvia, as studied by Janīna Kursīte-Pakule. In this sense, some basic materials exist for future research on Ancient Egypt.

Working with ancient sources is always very time consuming, particularly if there are many such sources and they have been published over several centuries relying on different translation methods and a changing vocabulary. This makes it possible to look at many issues from the outside, including ignoring traditions of the different schools of scholars, linguistic boundaries and those of Egyptology specialist sub-sectors. The latter was particularly significant in the detailed appreciation of how restoration was going on in the major temples and tombs of rulers within the necropolis at Thebes and the tombs of the Valley of the Kings. This allowed recovery of many lost details of mouldings and images. They showed not only the high craftsmanship of visual art, but also the high degree of organisation of the events depicted, in particular, detailed scenarios for ceremonies and festive events, dance choreography, and scenarios for other staged performances. It is unusual that many such mouldings and images include scrupulous and amplified signatures, and detailed descriptions of the events depicted; however, these have only been presented in studies of epigraphy. It is not exactly the case that up to now no one has paid attention to these features: several ornate large-sized mouldings with accompanying descriptions have been well known from the end of the 19th century onwards. Their publication and interpretation once provided an important source of inspiration for artists of the Art Nouveau period, as well as for the Art Deco period. In addition to visual depictions, they have also been transformed into dramatic performances and other public shows set in an imagined environment of the Ancient Egypt. The information now available permits a trustworthy quide of theatrical ceremonies for religious purposes and other performances, in terms of their scale, scenography, assignation of roles, props, layout and staging of productions (Ritual Drama and Theatrical Productions in Ancient Egypt, 2020). Certainly, fully developed theatre did not exist in Ancient Egypt, as it was to be two thousand years later that, in ancient Greece, a completely different synthesis would emerge of worldly and religious ideas, which nonetheless also has played an important role in Ancient Egypt.

Translated by Eduards Bruno Deksnis

DEVELOPMENT OF ARCHAEOLOGY IN THE BALTIC DURING THE AGE OF LEARNED SOCIETIES (FROM THE FIRST HALF OF THE 19TH CENTURY UNTIL THE FIRST WORLD WAR)

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The territory inhabited by Latvians and Estonians was incorporated by Russia during the course of the 18th century. Estonians lived in the Governorate of Estonia (Estliandskaia guberniia in Russian, Gouvernement Estland in German), and in the northern part of the Governorate of Livland (Lifliandskaia guberniia in Russian, Gouvernement Livland in German, Vidzeme in Latvian), Latvians inhabited the southern part of the Governorate of Livland and the Governorate of Courland (Kurliandskaia guberniia in Russian, Kurländisches Gouvernement in German, Kurzeme in Latvian). Part of the territory inhabited by Latvians – modern-day Latgale – was included in Belorussia (Белорусская губерния), but after its liquidation in 1802 – within the Governorate of Vitebsk (Витебская губерния). In 1801, by order of Tsar Alexander I, the Governorates of Estonia, Livland, and Courland were joined forming the province of the Baltic Governor-General (Остзейские губернии, прибалтийские губернии in Russian, Ostseegouvernements, Ostseeprovinzen in German), with Rīga as its administrative centre. The Baltics enjoyed more or less wide-ranging autonomy in regard to administrative, judicial, and legislative matters, which began to be curtailed during the second half of the 19th century. In 1876, the post of the Baltic Governor General was abolished.

The Baltics were engaged in processes ongoing in Western Europe, which also left an imprint on the

sciences, including the development of archaeology. Throughout the 19th century, German was the language of privileged and educated people in the Baltic. During this time, science in the German lands experienced rapid advance, and this impacted the Baltic as well. It is not for nothing that the first period of archaeological research in Latvia and Estonia is often called the period of German–Baltic investigations.

In like manner as in Western Europe, learned societies were formed in the Baltics during the 19th century. These sought to unite all scientists in the Baltic provinces. In a way, they became the first academies of sciences. One of the tasks of these societies was to investigate the past of their homeland. Ideas of the Enlightenment also attracted the attention of the majority of the public, who at that time was mainly comprised of peasants – Latvians and Estonians.

The first learned society, the Courland Society for Literature and Art (Kurländische Gesellschaft für Literatur und Kunst) was founded in Jelgava in 1815. In 1834, the Society for the History and Archaeology of the Baltic Provinces of Russia (Gesellschaft für Geschichte und Altertumskunde der Ostseeprovinzen Russlands) was founded in Rīga (later renamed the Rīga Society for Research of History and Antiquities) (Gesellschaft für Geschichte und Altertumskund zu Riga), and on 18 January 1838, the Learned Estonian



The Courland Provincial Museum in Jelgava. Beginning of the 20th century. Author unknown

Society (*Die Gelehrte Estnische Gesellschaft*) was founded in Tartu.

Mindful of their value and of the need for their preservation, a museum, the Courland Provincial Museum and Athenaeum (*Kurländischen Provinzial-Museums und Athenaum* in German) was founded in 1818 by the Courland Society for Literature and Art. Johann Friedrich von Recke (1764–1846) was its first director.

The Rīga Society for Research of History and Antiquities for its part was affiliated with the Rīga Dom Museum (*Das Dommuseum in Riga*); artefacts collected by the Learned Estonian Society came into the possession of Tartu (*Dorpat*) University. Private collections were also formed during the 19th century, and these were made available for scholarly study, later to be donated to museums.

The learned societies regularly published meeting reports, *Sitzungsberichte*, which were compiled in yearbooks. In these one could find information about what items had been discovered, with detailed or brief descriptions of how they were found, together with reports on excavations, longer articles published in separate editions. These societies organised public lectures to which the most prominent specialists were invited as speakers; members of other learned societies often were elected solely as honorary members, or were invited to conduct archaeological excavations. It should be noted that it was only in the 1830s that archaeology became

a science, separate from straightforward collection of antiquities.

A turning point for the development of Baltic archaeology occurred in 1837, when flooding led to uncovering several ancient burial sites in the vicinity of Aizkraukle. Tsar Nicholas I of Russia issued an order "to investigate archaeologically the whole of Livland, Courland and Saaremaa". This task was undertaken by Friedrich Karl Hermann Kruse (1790-1866), a professor at Tartu. The results of his effort included publication of high-quality images of items discovered at Aizkraukle and elsewhere in the Baltic; these were published in the well-known publication by F. Kruse, Necrolivonica oder Alterthümer Liv-, Esth- und Curlands [1]. The conclusions reached and reconstructions of the clothes, however, were incorrect. F. Kruse assumed that the uncovered remains were those of Scandinavians - "the Varangians – the Rus".

The next significant publication was *Gräber der Liven* [2], by Johann Karl Bähr (1801–1869) which appeared in 1850. In 1850, Bähr carried out excavations in Aizkraukle, Sigulda, and Seces Bajāri. In 1837, J. K. Bähr began to collect such archaeological artefacts and his collection became one of the largest 19th century collections of archaeological relics. In 1852, he sold his collection to the British Museum in London, where it is housed today. A large collection of antiquities comprising some 1200 items was also gathered by Edmund Carl Julius Krüger (1836–1909), member of the Courland Society for Literature and Art, a pedagogue and a state councillor. The Courland Provincial Museum bought his collection in 1901.

The work, *Gräber der Liven* by J. K. Bähr was particularly significant in that there was no attempt to look for traces of the "Varangians – Rus", instead attributing the burial sites and artefacts found therein to local inhabitants. Excavation methodology had not yet been developed in the 19th century, in particular during the first half of the century. The principal desired result when excavating a grave was to find relic. J. K. Beer's work already included drawings of graves, showed a burial mound surrounded by a stone fence, as well as the cross-section of a burial pit.

Two professors at the University of Dorpat, Constantin Caspar Andreas von Grewingk (1819–1887) and

Richard Gustav Gotthard Hausmann (1842–1918), made important contributions to the development of archaeology in the Baltic.

C. Grewingk is considered to be the initiator of scholarly investigations of Baltic prehistory, his work as an archaeologist covered the entire Baltic region - Estonia, Courland, Livland, as well as Lithuania and Russia. C. Grewingk was the first to study the Stone Age in the Baltic. The settlement of Kunda in Estonia was discovered in the 1890s [3]. C. Grewingk correctly considered the site at Kunda to be the oldest then known settlement in the Baltic. It was believed then that the Baltic was not inhabited during the oldest Stone Age period – the Palaeolithic, and that settlers appeared only during the newest Stone Age period – the Neolithic, which persisted until the 6th century; later, the boundary was drawn between the Stone Age and the Iron Age in the Baltic at around 100 CE, while no traces of the Bronze Age have as yet been found in the Baltic. Richard Hausmann turned to archaeology in the 1890s. Hausmann was the first in the Baltic to carry out systematic excavations and to organise the Learned Estonian Society's collection of antiquities. In 1895, R. Hausmann was elected Honorary Member of the Rīga Society for Research of History and Antiquities. He wrote the important Introduction to the Catalogue of the Exhibition of Antiquities of the 10th All-Russian Archaeological Congress [4].

The 10th All-Russian Archaeological Congress, organised by the Rīga Latvian Society, is considered to have been the main event in Baltic archaeology during the period of the Russian Empire. In his Introduction to the Exhibition Catalogue, R. Hausmann focussed on the Bronze Age, albeit with an indication that it was chiefly represented by artefacts found near the Daugava River, and which had been imported from other regions where bronze processing technology was at a high level – from Scandinavia, or Western Europe. The Iron Age was divided into the oldest period, which lasted until 800 and the newest period until the arrival of Germans at the end of the 12th century.

The Courland Society for Literature and Art took an interest in archaeology from the 1860s onward, at which time a number of personalities, such as the artist Julius Döring (1818–1898), the pastor, eth-



Antiquities at the Courland Provincial Museum. See Kruse, F. K. H. *Necrolivonica oder Alterthümer Liv-, Esth- und Curlands*. Dorpat, 1842

nographer, and linguist August Johann Gottfried Bielenstein (1826–1907), and the senior teacher Carl Boy (1853–?), took part in archaeological excavations of ancient burial sites [5], and also identified (catalogued) the castle mound [6]. Professor Adalbert Bezzenberger (1851–1922) published, in 1885, a wide-ranging list of castle mounds, and, influenced by this example, A. Bielenstein developed a standard form for recording archaeological data. In addition to the already mentioned R. Hausmann, other members of the Rīga Society for the Research of History and Antiquities, Anton Buchholz (1848–1901), and Jakob Carl Georg Graf von Sievers (1814–1879), were visibly engaged in archaeology.



Archaeological excavations in 1895 at Jaunsvirlaukas Ciemalde cemetery. Photo: Oscar Emil Schmidt. Negative 37089. Collection at the National History Museum of Latvia.

Whereas Carl Sievers turned to archaeology only at the age of 56, he managed to achieve a lot during the rest of his life. He excavated several Stone Age sites in Vidzeme, uncovered the Stone Age settlement at Rinnukalns. In 1876, C. Sievers excavated the Āraiši Lake Fortress, which at that time was mistakenly identified as a Stone Age settlement. A report on his activities was sent to the Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte, who published it. C. Sievers also submitted a similar report to the Learned Estonian Society. and wrote a letter to Ferdinand Keller (1800–1881) in Zürich, a pioneering investigator of lake dwellings. The pathologist, prehistorian, and biologist Rudolf Ludwig Carl Virchow (1821–1902) arrived in Vidzeme in 1877 at the invitation of C. Sievers. R. Virchow, unlike C. Sievers, identified the Āraiši site to be much more recent, dating from the Iron Age, and perhaps even a witness of the arrival of German knights and priests. The approach followed by Carl Sievers was scientific – archaeological findings were studied using natural science methods. Artefacts unearthed by C. Sievers during excavations

made up a large part of the Collection of Archaeological Artefacts at the University of Tartu.

A lasting picture had already been formed by the end of the 19th century as to what peoples lived within the territory of modern-day Latvia during the Late Iron Age, and which areas they occupied. Characteristics of their culture were determined - burial types, distinctive ornaments, weapons and tools. Ethnic boundaries were defined. A. Bielenstein acknowledged that there existed mixed Baltic and Liv areas from the east of Lielvārde to Aizkraukle, in addition to Idumeja, i.e. regions where Livs and Latvians lived side by side [7]. Latgalians, Selonians and Semigallians were considered to be Latvian peoples. Different opinions existed about the ethnic belonging of Curonians. They were considered to be Finns; alternatively it was held that Curonian referred to both Livs and Latvians.

Interest in Baltic archaeology by the Imperial Society of Naturalists of Moscow (from 1881 onwards, the Imperial Russian Archaeological Society) grew substantially in run-up to the 10th All-Russian Congress of Archaeology held in Rīga in 1896. In 1895,

Vladimir Sizov (1840–1904), member of this society, travelled widely in the area, and, together with local specialists, carried out excavations at several sites in Kurzeme [8]. During preparations for the 10th Congress, excavations at several locations were carried out by Sergei Bogoyavlensky (1871–1947).

The archaeologist Jevdokim Romanov (1855–1922), member of the Imperial Moscow Society, carried out archaeological excavations at several Iron Age sites in Latgale. J. Romanov and V. Sizov oversaw investigation of 388 burial sites at Odukalns near Ludza during the time leading up to the 10th Congress [9]. The first Latvian scholarly organisation, the Science Committee of Rīga Latvian Society, founded in 1869, also played a role in the development of archaeology. The "Latvian Museum", established in 1869 by the Science Committee of Rīga Latvian Society, started a collection of archaeological, ethnographic and numismatic materials, laying thereby the foundation for the modern-day National History Museum of Latvia.

In the last years before the First World War, Max Ebert (1879–1929), who came to Rīga in 1913 at the invitation of Rīga Society for the Research of History and Antiquities, became a recognised authority in Baltic archaeology. He carried out several excavations in Latvia and in 1913–1914 reorganised the prehistory department of Rīga Dom Museum [10]. The resulting publication, *Die Baltischen Provinzen Kurland, Livland, Estland* [11], which appeared in 1913 on the eve of the outbreak of the First World War, established Baltic archaeology on a solid scientific basis.

Certainly, most investigations of Baltic antiquity were done by residents of German origin who, at least initially, found it difficult to overcome the prejudice about Estonians and Livs, ones particularly deeply held concerning Latvians. At the beginning of the 19th century, individuals of this ethnicity were associated only with peasants, and it was difficult to accept that their material culture and social organisation in antiquity rivalled the culture of the Germanic peoples of that time. Therefore, it could be assumed that the Stone Age in the Baltic lasted up until the 6th century, and evidence was sought for Germanic, and in particular, Gothic influence. This, in turn, led to incisive criticism of the

contribution made by researchers of this period, as expressed in later work by Latvian archaeologists, both during the interwar period of the Republic of Latvia and during the period of Soviet occupation. Objectively speaking, archaeological investigations during the 19th century and at the beginning of the 20th century corresponded to the development level of science of the time, overcame provincial particularism, and was an integral part of science at Europe.

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Translated by Eduards Bruno Deksnis

NOVELTIES
IN INFORMATION
TECHNOLOGIES,
POWER INDUSTRY,
MATERIAL SCIENCE,
AND
ASTROPHYSICS

RESEARCH AND INNOVATION IN LANGUAGE TECHNOLOGY AT THE ARTIFICIAL INTELLIGENCE LABORATORY

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The Artificial Intelligence Laboratory (AI Lab) at the Institute of Mathematics and Computer Science, University of Latvia (IMCS UL), founded in 1992, conducts research in natural language processing (NLP) and machine learning (ML). Both research directions are closely related and have gained significant boost through the implementation of numerous innovation projects together with industry partners and through the international cooperation.

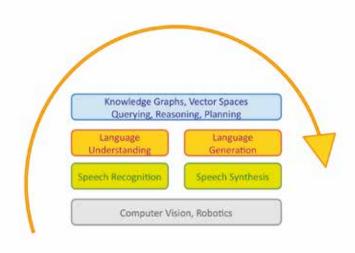
Al Lab particularly focuses on cross-lingual natural language understanding (NLU) and generation (NLG) by combining knowledge-based and machine learning approaches. Our work on NLU includes speech recognition, information extraction and knowledge graph construction from unstructured texts and audio recordings, as well as image and video data. The work on NLG includes text generation from data and abstract meaning representations, as well text-to-speech synthesis. We conduct research in NLU and NLG in several directions and aspects:

- Speech-to-text recognition and text-to-speech synthesis for Latvian.
- Syntactic and semantic parsing for cross-lingual information extraction, question answering, human-computer interaction.
- Multilingual text generation from abstract meaning representations and from data.

- Controlled natural language for knowledge representation.
- Creation of annotated language resources for NLP and ML: machine-readable dictionaries, text and speech corpora (training and evaluation datasets).
- Machine learning for NLU and NLG, also in connection to robotics, computer vision and grounded language learning.

The core research group consists of twenty staff members: leading researchers, researchers and research assistants. Since the foundation of AI Lab, there have been computer scientists and linguists working side by side; in fact, both fields are represented in rather equal proportions. Most of the leading researchers are also involved in teaching at the University of Latvia, which facilitates knowledge transfer and student involvement.

Al Lab has recently implemented multiple research and innovation projects on large-scale information extraction and speech recognition. Most notably, we have established a long-term partnership with the largest Latvian news agency LETA, developing scalable software platforms for fully automated and human-in-the-loop media monitoring. This relies on state-of-the-art speech recognition, semantic parsing and knowledge representation technologies.



Schematic representation of natural language understanding (NLU) and natural language generation (NLG)

Together with LETA, we have implemented more than ten national and EU-level projects. Through this partnership, our researchers are collaborating also with the global broadcasters, namely Deutsche Welle (DW) and BBC, helping to solve language processing tasks for the big-data media monitoring and multilingual news production.

In 2016, the successful collaboration allowed LETA to join the EU Horizon 2020 big-data project on Scalable Understanding of Multilingual MediA (SUMMA; 688139), together with leading European universities, BBC, DW and others; a team of AI Lab researchers was also fully involved through this partnership. In 2021, we have joined a new H2020 project on Stream Learning for Multilingual Knowledge Transfer (SELMA; 957017), coordinated by DW. Our team is responsible for the integration of the whole SELMA platform.

Al Lab has also established a close partnership with several research groups and public service providers working in the humanities and social sciences areas in Latvia. We have previously developed a text processing system for the National Library of Latvia, dealing with part-of-speech tagging and namedentity recognition in a billion word corpus of OCR-scanned texts. This joint work is now continued on a new level in a state research programme on Digital Resources for Humanities (VPP-IZM-DH-2020/1-0001). In partnership with the Latvian Language Institute, Al Lab is continuing a constant develop-

ment of extensive machine-readable dictionaries of Latvian and of an integrated on-line dictionary platform Tezaurs.lv (VPP-IZM-2018/2-0002), which is one of the most widely and frequently used Latvian language resources. A relatively new but rapidly growing research direction in digital humanities is also the creation of resources and tools for corpus-based analysis of language learners and for the consequent development of improved learning aids (lzp-2018/1-0527). This has strengthened our collaboration with regional universities and with the Latvian Language Agency.

For many years, AI Lab is also collaborating with the Faculty of Communication at Rīga Stradiņš University, developing tools and datasets for monitoring aggressiveness and hate speech in user-generated content of news portal communities and for annotating and analysing transcripts of parliamentary debates. In 2013, Al Lab together with LETA and the language technology company Tilde created the first general-purpose machine learning dataset for Latvian speech recognition. Since then, speech recognition of commercial quality has been rapidly developed by the leading language technology companies in Latvia. Recently, we have established a partnership with Rīga East University Hospital, the largest hospital in Latvia. Within an industry-driven research programme of the European Regional Development Fund, we are creating and adapting language resources and models for Latvian speech recognition in radiology (1.1.1.1/18/A/153). These components are being further integrated in a prototype of an automated dictation platform for medical reporting. Although AI Lab primarily focuses on the language resource and technology development for the less-resourced Latvian language, our teams have successfully participated in international NLU and NLG evaluation campaigns on well-resourced languages as well. In 2016 and 2017, we scored the best results in the SemEval shared tasks on Abstract Meaning Representation parsing and generation from and to English.

Although the language resources that we develop are Latvian-specific, the formal annotations that we add are compatible with state-of-the-art representations. AI Lab is among the early data contributors to the international Universal Dependencies (UD)



Staff of the Artificial Intelligence Laboratory, Institute of Mathematics and Computer Science, University of Latvia, in 2020: from right to left: the 2nd Normunds Grūzītis, the 5th Ilze Auziņa, the 6th Guntis Bārzdiņš

framework for syntactic parsing, coordinated by the Uppsala University. The Latvian UD dataset (a so called treebank) is already qualified as a comparatively big one and is being used in multilingual settings by many research teams world-wide. Similarly, we are active participants in the global FrameNet initiative for cross-lingual frame-semantic parsing. Our experience in creating FrameNet annotations on top of UD treebanks has attracted interest from researchers working on other languages, and it has also inspired us in the development of novel tools for frame-semantic media monitoring.

IMCS UL is the national coordinator of CLARIN ERIC, the European research infrastructure of language resources and technology for the humanities and social sciences (1.1.1.5/18/I/016). IMCS UL is also the national competence centre of the European Lan-

guage Grid platform (ELG), as well as a national technology anchor point of the European Language Resource Coordination initiative (ELRC) and an observer of the European Lexicographic Infrastructure (ELEXIS). Being a part of these infrastructures allows us to make the language resources and tools developed by Al Lab available and, first of all, discoverable to other research teams and technology companies in Europe and world-wide, which is essential for a relatively small language like Latvian not only to survive but flourish in the digital era.

A NEW DC POWER SUPPLY SYSTEM FOR ROBOTIC MANUFACTURING INDUSTRY HAS BEEN DEVELOPED AND DEMONSTRATED

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A novel DC power supply system has been developed and demonstrated for saving electrical energy in robotic production plants with significant contribution of researchers from the Institute of Industrial Electronics and Electrical Engineering (IEEI) of Rīga Technical University (RTU). Although it included some earlier developments of IEEI, the proposed DC-grid supply system was mostly developed within three years' time in the course of the FP7 project "Automation and Robotics for European Sustainable Manufacturing" (AREUS), which involved ten partners from six countries of Europe – Latvia, Italy, Germany, Sweden, Finland, and Denmark. The system was developed and tested in close cooperation with car manufacturer Daimler AG for use in Mercedes-Benz car manufacturing plants in Germany. The DC supply system improves energy efficiency by exploiting architecture benefits of DC power supply grids. This has been a large step towards the concept of smart factories of the future [1], where innovative tools, methods and technologies will be used to ensure energy-efficient and sustainable robotic production. Automotive industry exhibits one of the highest industrial robot density per square meter. Using DC power supply grid part of the energy consumed by production robots can be restored and reused later, making robots more efficient, as well as the production "greener", since renewable sources like PV panels can be integrated into DC power supply grid more easily. The official completion of the project AREUS took place in September 2016 at Daimler AG facilities in Germany, where the new DC power supply system was demonstrated in a real industrial robotic production cell at the Mercedes-Benz car production plant. The Latvian delegation was represented by the rector of RTU, academician Leonīds Ribickis, together with the researcher team of IEEI

Currently, the results of the AREUS project are approbated in an ambitious undertaking by Daimler AG entitled "Factory 56" [2]. Green production technologies and CO₂ neutral electricity supply grid is implemented in real life there and currently is being continuously perfected – the new smart factory building "Factory56" in Sindelfingen uses DC power supply grid enabling braking energy recovery of production robots, as well as solar energy integration in order to minimise the CO₂ emissions [3].

The main goal of the AREUS project was to demonstrate and test the proposed DC power supply grid

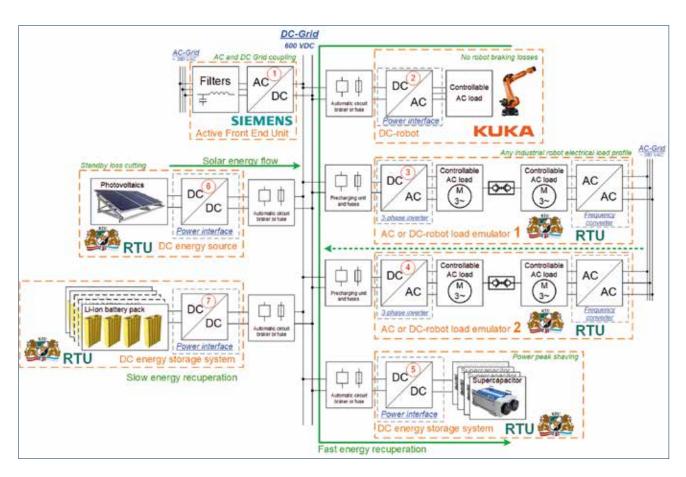


Fig. 1. 600 V DC-grid architecture of RTU demonstration laboratory

and its elements in different modes and configurations, both individually and operating in a unified DC grid. Figures 1 and 2 show the configuration of laboratory equipment developed and installed in IEEI during the AREUS project for the purpose of testing the DC grid, as well as for evaluation of industrial production cell parameters and processes. Inheriting a similar architecture, a demonstration production cell was later set up at the car manufacturing company Daimler AG - at the plant in Sindelfingen, Germany, where system testing and parameter measurements were performed in a real production environment, comparing electricity consumption of a traditional AC-grid supplied system with the novel DC-grid production cell while carrying out the same production tasks. Thus the obtained results were highly credible and reliable.

As distribution system operators of electrical grids do not currently offer DC supply voltage, the DC-grid laboratory located at IEEI had of course to be tied to the AC grid by an AC to DC converter. A unit

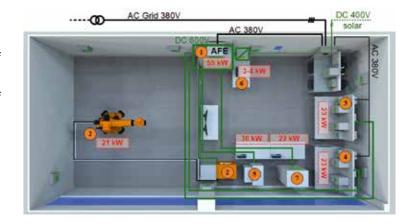


Fig. 2.
Connection scheme of DC-grid laboratory in IEEI of RTU



Fig. 3.

Power measurement device for DC industrial robot and measurement performance evaluation example against oscilloscope based power measurement.

produced by SIEMENS – an active rectifier/inverter (AFE) with power of 55 kW (see Figures 1 and 2) was installed. The task of the unit was to provide 600V DC voltage in the power supply grid, and in case of surplus DC power – to return it back to the AC grid. The unit (2) shown in Figure 2 is a 600V industrial DC-Robot prototype, built by KUKA "Quantec Prime" with a 210 kg lifting capacity and electric power up to 21 kW. While most of the time a robot is a consumer of electrical energy, during the braking modes, it becomes a generator.

Two universal robot emulator stands with power of 23 kW (3) and (4) were constructed to simulate the dynamics and power consumption pattern of any of the manufacturer's robots used in car production factories. In tandem with the actual robot (2) they formed a tiny robot production cell. The stands comprised two AC motors driven by two 4-quadrant

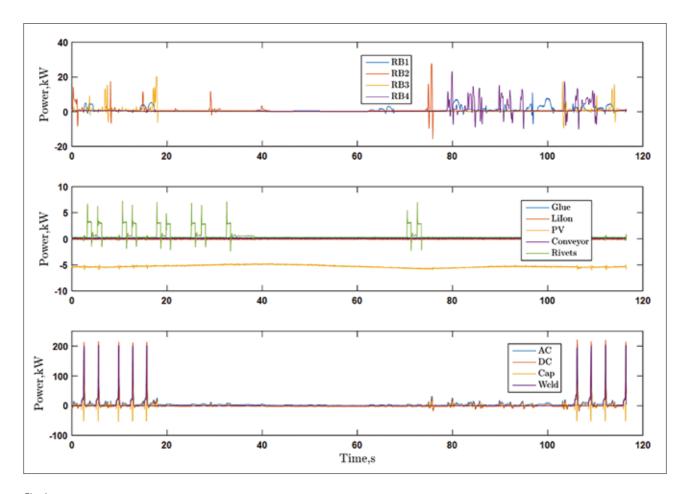


Fig. 4. Acquired synchronous power flow measurement data at 13 microgrid locations: 4 industrial robots (top), tool technologies, PV infeed and Li-ion storage (middle), AC, DC, Capacitor buffer and welding (bottom).

frequency converters. Thanks to the control algorithms developed by researchers of IEEI, the emulator stands were capable of reproducing the dynamics of electrical energy consumption or generation of various industrial robots with very high accuracy. For rapid storage and release of energy in the DC-grid, a supercapacitor storage system (5) with power of 30 kW was developed and built. Its main task was to cut off power peaks, thus equalising power consumption over time.

Since the DC power supply grid architecture simplifies the integration of renewable energy sources, a 4 kW DC/DC converter with maximum power point control algorithm (6) was developed and installed for a series of 3.3 kW PV panels set up on the roof of the laboratory building. The energy from PV panels was supplied to the DC grid, where it could be consumed by robots or stored in a Lithium-ion battery storage system (7) with a capacity of 18 kWh.

During the experimental tests, simultaneous power measurements of multiple highly dynamic devices with bidirectional energy flow proved to be a challenging task. Devices like welding guns or capacitor banks create very sharp power spikes, which the standard energy consumption measurement equipment designed for AC systems is too slow to capture. To solve that problem, the researchers of IEEI created a novel electrical energy measurement system enabling the required high-speed multi-channel measurements. The multi-channel measurement system utilised common sampling time and optical fibre data transfer system. Power measurement units were designed basing on voltage to frequency method for the voltage measurements and using compensated hall effect sensor for current measurements [4]. The Figure 3 shows the power measurement module designed for industrial robot cabinet connection and a graph from measurement validation tests.

This multi-channel measurement system was also used in the demonstration production cell set up at Daimler AG, bringing it to INDUSTRY 4.0 level.

Power flow data of 110 second time duration acquired from real industrial manufacturing process in the DC-grid production cell at Daimler is shown here as an example. Figure 4 shows 13 datasets with common time axis grouped for similar magnitudes of power flow.

The main advantage, however, of integrating industrial robots in a common DC supply system is the possibility to recuperate the braking energy, which leads to considerable energy savings. The level of savings depends on the robot count within a production cell, as well as on the robot motion patterns and tasks. Measurements acquired in the demonstration production cell of Daimler, showed that while carrying out real-life production tasks the novel DC-grid production cell could save up to 13.2% [5] compared to the traditional AC-grid supplied system. These impressive results surely played a significant role in encouraging Daimler AG to initiate the expensive and ambitious project entitled "Factory 56".

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THE BALTIC ASSEMBLY PRIZE IN SCIENCE 2020: THEORETICAL PREDICTIONS OF NEW MATERIALS FOR ENERGY STORAGE AND HARVESTING

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TOWARDS A PRACTICAL RECHARGEABLE 5 VOLT LI ION BATTERY

One of the three Nobel Prize winners in chemistry in 2019, J. Goodenough (USA), in 1980, discovered the cathode material for 4 Volt batteries LiCoO₂ Nowadays, consumer electronics widely use lithium-ion batteries containing LiCoO₂, for example, in laptop computers, cellular telephones, electric vehicles as well as airplanes and even cosmic technologies. One frequently discussed direction to improve the performance of 4 Volt batteries is the development of a family of 5 Volt cathode materials. We were the first in the world to theoretically predict that also a 5 Volt battery is possible [1]. Namely, by means of a Full Potential Linearized Augmented Plane Wave (FP-LAPW) calculations for Li₂CoMn₃O₈ battery cathode material we got the average battery voltage for this material around 5 Volt [1].

THEORY EXPLAINING SYSTEMATIC TRENDS IN PROPERTY CHANGES FOR ABO₃ PEROVSKITE SURFACES

We performed *ab initio* calculations for eight technologically most important ABO_3 perovskite neutral (001) as well as very complex, polar and charged (011) surfaces [2–7]. As a result of our calculations, we developed a theory, which describes systematic

trends in property changes for ABO3 perovskite (001) as well as (011) surfaces [2–7]. For example, based on our calculations, we discovered, that surface energies for both AO and $\mathrm{BO_2}$ -terminated ABO₃ perovskite (001) surfaces are almost equal. Just opposite for polar (011) and especially (111) surfaces, their energies for different terminations are completely different [2–7].

ENHANCEMENT OF THE PHOTOELECTRIC CONVERSION EFFICIENCY BY GRAPHENE OF A DYE SENSITISED SOLAR CELL

Solar energy, as an alternative energy source, has attracted more and more attention in the past few decades [8]. The dye-sensitised solar cell (DSSC) has been a hot topic due to its low cost and relatively high photoelectric conversion efficiency since the first device was reported in 1991. The main goal of our work was to clearly answer the question from a theoretical perspective: how does graphene enhance the photoelectric conversion efficiency in the semiconducting layer of a dye sensitised solar cell? Several arrangements of the graphene layer between the dye molecule and the TiO₂ (101) surface are carefully studied and discussed. Our theoretical investigation shows that graphene can speed up the electron injection from the dye molecules to the semiconductor layer [8].



Roberts Eglītis, *Dr. phys.*, Full Member of the Latvian Academy of Sciences, at the Institute of the Solid State Physics, University of Latvia, 12 January 2021

THE EFFECTS OF IMPURITIES IN 4,12,2-GRAPHYNE

The effects of boron (B) and nitrogen (N) substitutions in 4,12,2-graphyne on its geometric structure and mechanical as well as electronic properties have been systematically investigated with the aid of DFT [9]. The trend in the elastic properties of the substituted systems is determined by the doping positions and the type of the dopants. In particular, we discovered an obvious in-plane piezoelectricity induced by foreign atom substitutions owing to the deformation of the pristine square symmetry [9].

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DIGITAL ZENITH CAMERA

Ansis Zariņš, *Dr. phys.*, chief designer, leading reseacher, main software developer Augusts Rubans, *M. sc.*, chief constructor, researcher

Jānis Balodis, *Dr. phys.*, leading reseacher, software

Inese Vārna, *Dr. sc. ing.*, leading researcher, construction development assistant

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The studies of subsurface mass distribution is a major task for many branches of science and technologies - geology, seismology, volcanology, geophysics, geodesy and various other applications. Most often, for studies of subsurface mass distribution, gravity force measurements are applied using gravity measuring devices: absolute and/or relative gravimeters. Extreme concentrations of mass in the subsurface are characterised as gravity anomalies. Scattered sites of ground-based gravity measurements are distributed over most continents. Spaceborne and airborne gravity measurements also cover large areas, especially those inaccessible to the most accurate ground-based measurements. Gravimetric measurements determine the magnitude of gravity force at the measurement site. The gravity field and anomalous sites are determined by interpolation in the area of the measurements.

Additional information can be obtained by using the vertical deflection measurements by the digital zenith cameras (DZC). The DZC measures the direction of the vector of gravity. Distinctive mass distribution forms deep below the ground (funnel, cavity, various mass concentrations) and can be detected by developing densified network of DZC measurement points in the area of specific interest.

Efficient portable digital zenith camera (accuracy ~0.1 arcsec) was developed at the Institute of Geodesy and Geoinformatics (GGI) of the University of Latvia by a team that previously specialised in developing software and hardware for astrogeodetic cameras and satellite laser ranging devices. The innovation of Latvian DZC development is



Fig. 1. Digital zenith cameras for observations at night



Fig. 2.
Two digital zenith cameras are exposed

based on recent achievements in various sciences – fast and accurate digital imaging technology, extremely accurate super-large reference star coordinate catalogues, very sensitive electronic tilt meter technologies, available high-precision Earth rotation parameters, and GNSS-based high-precision positioning and timing capabilities.

In GGI, development of the first model of the zenith camera and subsequent field tests began in 2009. However, the required measurement accuracy was achieved only in 2016. For several years, the last models were used for regular measurements, accompanied by regular work on improvements in software and hardware. Currently, several

high-accuracy DZC instruments have been manufactured (Figs. 1–2).

The use of DZC offers the possibility of finding more anomalous sites without the need for accurate elevation values in distinction of gravimeters. Recently, DZC was purchased by Louisiana State University through a worldwide tender. Currently, this instrument is used in the USA for gravity field measurements in conjunction with absolute gravimeter.

A digital zenith camera compares the spatial direction of the local gravitational field normal (plumb line, measured with a very sensitive tiltmeter) and the direction to the geometric Earth ellipsoid zenith,

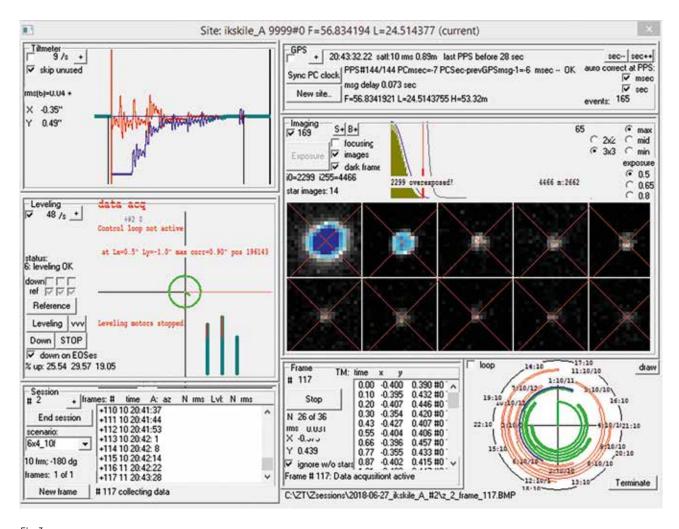


Fig. 3.

Session control panel. Clockwise from top left – tiltmeter controls, GPS and timing controls, CCD and star image controls, session scenario, frame data acquisition, session data acquisition, levelling and rotation controls

calculated from the instrument position in the inertial reference system defined by stars (Figs. 3–4).

The obtained difference between these directions (vertical deflection) characterises the gravitational effect of nearby geological mass concentrations or deficits. Geometrically, the vertical deflection represents the angle between the surfaces of the geoid (based on gravity) and the reference ellipsoid at the measurement point on Earth.

DZC development is based on recent achievements in various sciences:

- Recently available charge-coupled devices (CCD devices) enabled to have the multiple images of star background with capability to use extremely accurate and extensive reference star catalogues like GAIA (2018, 1 billion stars, 0.1 arcsec accuracy). As a result, now it is possible to have accurate coor-

dinates of practically all starlike objects up to magnitude of 20–21.

- Very sensitive tiltmeters were implemented using electronically controlled physical pendulums. That ensured very high sensitivity gain and also made these devices digital control and processing ready. Precision levelling using computer-controlled actuators is used.
- Accurate, near-real-time geocentric coordinates became widely available from GPS satellites.
- Time moments for exposure events (shutter open / close) also have been obtained from a GPS receiver through its event timing functionality. Timing accuracy itself (microsecond level or better) is more than good enough.
- Internationally supplied Earth rotation parameters enabling to find location of geocentric zenith

relative to those stars in the moment of frame exposure. What then remains is to find where on this image ellipsoidal zenith is located.

Taking all the above functionalities together, we have a telescope equipped with a CCD camera, a tiltmeter, a GPS receiver, a set of levelling actuators, a rotation drive, and some auxiliary equipment, all of which produce the data we need (a lot of it). A control computer is installed to record the measurements and coordinate the activities of the hardware elements involved. Considering the sensitive nature of the measurements (even a small mechanical disturbance can cause unacceptable displacements in the instrument assembly) and the required mobility of the assembly, the control computer is fixed on board and communication with the remote-control equipment is wireless. Power is supplied by a on-

board battery. An on-board control computer running Windows and remotely controlled via a Remote Desktop connection through Wi-Fi is provided. A single control programme controls all the hardware units involved. The process of measurements is fully automatic, except for the definition of the measurement settings and the scenario.

Since not all the required data are available at the time of the measurements, post-processing of the collected data files is necessary. Most of the computations are also automated, and the operator's tasks are usually limited to evaluating the results and, if necessary, removing some irregular data.

The next main problem is the calculation of the position of the ellipsoidal zenith position on the CCD. It includes the full extent of classical astrometric observational data reduction.

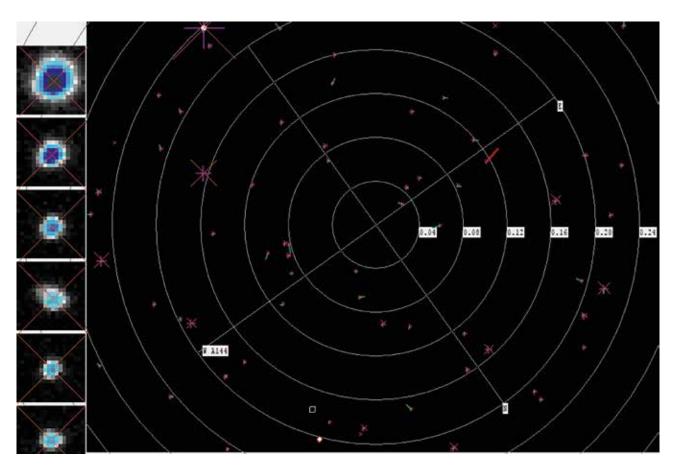


Fig. 4.

Astrometric processing of a frame. Right: frame image with superimposed calculated ellipsoidal zenith location (equal distance rings around it with degree notation) and orientation. Star images marked by slanted crosses, reference star position by straight crosses; green lines represent approximation residuals (red if rejected; magnified 20×). Left: magnified images of six brightest stars

Identifying star images with reference star catalogue (this task was generally handed over to the computer in the late photographic era), once the computer has received star image coordinates and the corresponding data of the reference stars, there are still some complicated steps of calculating the apparent places of the reference stars. This requires a very accurate (milli-arc-second level) Earth rotation theory. There are very few appropriate software packages that can accomplish this task, NOVAS (Navy Observatory Vector Astrometry System) package is used by DZC control software. In addition, actual values of the irregularities of the Earth's rota-

tion (pole coordinates, Universal time correction) are necessary. Computing the parameters of the frame model to find the projection of gravity ellipsoidal zenith on CCD is the last step. Finally, the accuracy of the vertical deflection is 0.1 arc seconds (Fig. 5).

The practical application of the above considerations led us to the DZC instrument shown in Figure 1 in operation at night and Figure 2 where two DZC are exposed. The path to this point was neither straightforward nor simple; many iterations and revised variants were tested until a satisfactory design emerged.

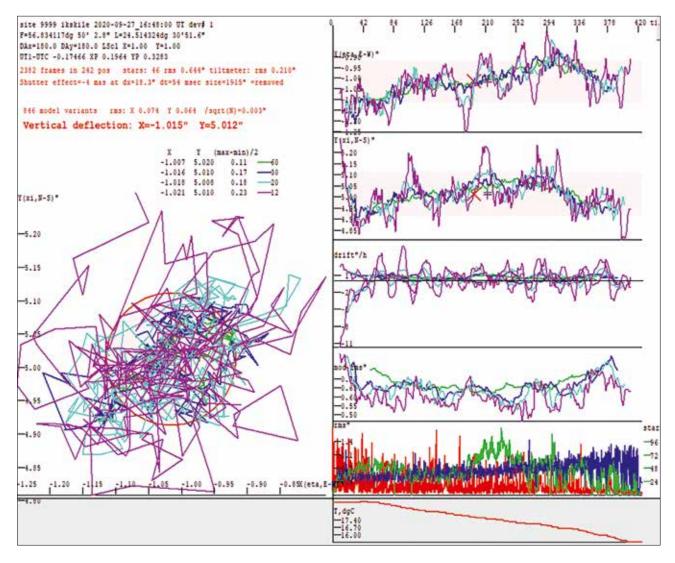


Fig. 5.

Session results analysis panel. Left – X&Y trajectories of calculated vertical deflections for various models; each colour represents a model made of indicated number of consecutive positions, each bend represents DoV values for one of these models. Right (top to bottom) – time dependencies of DoV X and Y components, thermal drift estimates, RMS estimates for various models; RMS of star residuals and tiltmeter positions for each frame and number of stars per frame; ambient temperature and cyclogram of sessions



Fig. 6. From the left: Augusts Rubans, Inese Vārna, Gunārs Silabriedis, Ansis Zariņš, and Jānis Balodis

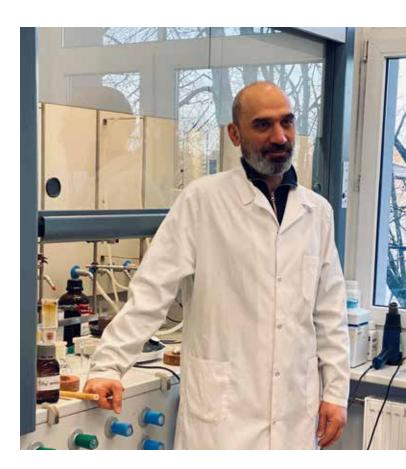
NOVELTIES
IN MEDICINE
AND CHEMISTRY
AND GLIMPSES
INTO HISTORY

CONTROVERSIAL SELENIUM: UNIQUENESS IN THE SHADOW OF TOXICITY

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Two hundred years ago, a new element was discovered by the Swedish chemist Jöns Jacob Berzelius. He named the new element **Selenium**. It was very farsighted, because 45 years ago a brilliant biochemist Prof. Thressa Stadtman found the 21st proteinogenic amino acid - selenocysteine in the active site of glutathione peroxidase (GPx). And since then, interest about selenium increased in geometrical progression. Over the past 20 years, scientific studies have clearly demonstrated that selenium is an irreplaceable microelement with essential properties for human health. Indeed, relationships between the level of selenium in the daily diet and the risks of developing various types of cancers have been established. Selenium is an active component of GPx, which is a basic enzyme involved in cell redox homeostasis. Selenium has antioxidant properties and is effective in physiological and pathological processes linked to increased intracellular free radical and reactive oxygen species (ROS) generation. Selenium is needed for proper functioning of the immune system, since a key nutrient inhibits HIV progression to AIDS, decreases a risk of cardiovascular diseases, and elevated intake of this microelement is associated with reduced cancer risk. But the main negative issue about selenium is a narrow dose range between therapeutic and toxic doses. Selenium-containing compounds used in industry are quite toxic, e.g., LD₅₀ of a widely used nutrient - sodium selenite - varies from 8.1 to 12.1 mg/kg, which is comparable with potassium cyanide toxicity.

During the last decades, introduction of selenium into biologically active molecules have attracted



increasing attention. Some compounds exhibit excellent activity as antioxidants, redox modulators, antitumor, antihypertensive agents, etc. Regarding the biochemical role of both naturally occurring and synthetic selenium compounds, based on their action mechanism, they could be divided in three major groups:

- 1) Se-compounds that can be metabolised to hydrogen selenide and, therefore, be able to serve as Se source to be incorporated in Se-proteins;
- 2) Se-compounds possessing bioactivity that is not directly related to selenium itself;
- 3) Synthetic mimics of known Se-enzymes.

Unfortunately, of thousands of synthesised and studied selenium-containing compounds no one has been approved as a drug so far.

Since Na₂SeO₃ is the most common additive in nutrients, we started our research preparing several series of ammonium selenites, hydroselenites of ethanolamines, amino acids and gamma-butyrobetaine (GBB) derivatives. According to cytotoxicity and in vivo antitumor activity it was found that triethanolammonium and diisopropyl GBB are able to suppress sarcoma growth in vivo up to 100%. Acute toxicity decreased more than 10 times compared with sodium selenite. However, toxic effects during in vivo experiments were detected as well. Attempts to find promising antitumor agent using inorganic selenium failed. Notably, the main problem in this field remains the high toxicity and unpredictable selectivity of selenites against cancer cells versus normal cells.

The introduction of selenium atom in already known drugs in place of sulphur, oxygen and nitrogen was very popular, medicinal chemists desired to endow positive properties of selenium to drugs with the aim to lower toxicity, increase selectivity, etc. One of our projects was connected with modification of selective estrogen receptor modulators (SERM), which are widely used to prevent osteoporosis, reduce breast cancer risk. These drugs lower LDL cholesterol level and prevent prostate cancer as well. Of course, as for all synthetic drugs they have a long list of side effects. Raloxifene molecule contains benzothiophene ring, and our idea was to introduce selenium instead of sulphur in purpose to compare both compound activities. Both compounds were not toxic, but selenium analogue inhibited breast cancer growth by 30% (15.0 mg/kg), besides, Raloxifene was ineffective in triple negative breast cancer model (4T1 carcinoma). It could be accepted as a positive result, but more profound studies let us to conclude that we should focus on other projects.

Based on many scientific reports we decided to go in a little opposite way as other researchers.

Coumarin core is very common in natural product structures, which are widely used in Indian (Ayurveda) and Chinese medicine. Ayurveda medicine lies on a different principle than Western techniques; it is based on the treatment of a patient with a mixture of natural herbs containing biologically active substances with the aim to create a balance between body and soul. In other words, it helps the soul remedy a body and vice versa. This therapy is always slower, but usually do not harm organism with side effects. Western scientists also paid attention on Ayurveda: coumarin derivatives as medicines with substantial activity in vitro and in vivo have been discovered (Psoralen, Angelicin, Xanthotoxin, Bergapten, Nodakenetin, etc). Imperatorin shows the ability to inhibit tumour growth. Osthole inhibits the migration and invasion of breast cancer cells and effectively blocks matrix metalloproteinases promoter and enzyme activity. In a long list of coumarins, furocoumarins always make a separate group, because these natural products are very effective poisons in up to femtomolar concentration, because of their phototoxicity. To our knowledge, the introduction of a heavy element in the molecule lead to bathochromic shift of emission, reducing quantum yield and depleting fluorescence. We decided to use this effect by the introduction of selenium instead of oxygen atom. In a series of more than 150 various derivatives we have found the leading compound (PA-27) with no phototoxic properties. PA-27 exhibit outstanding antimetastatic activity. Moreover, pre-treatment of laboratory animals with this compound led to impressive suppression of metastasis and malignant tumour formation in in vivo experiments. Cancer development (breast cancer model) results with no signs of tumour in three mice out of six, but two had less than 7% of occupied with tumours areas (total: 90%, p=0.001). In a pre-treatment model, four mice had no signs of tumour (100% inhibition); however, treatment did not influence on tumour growth in two mice (total: 58%, p=0.122). Beginning of the treatment right after metastatic melanoma cells inoculation resulted in 75% inhibition. Notably, three mice out of six had no melanoma nodules in lung after the end of the experiment on day 22. Even more interesting results were received from pre-treatment experiment (treatment in advance from day 19th till 3rd before cancer cell inoculation): four mice from a group of seven animals had no tumour nodules in lung and one animal had only one small nodule. LLC1 lung carcinoma growth suppression caused by PA-27 in dose 20 mg/kg was completely (100%, p=0.050) prevented. Moreover, only one mouse out of five had only 1 tumour nodule (97%, p=0.056) performing the pre-treatment (treatment in advance from day 14th till 0 before cancer cell inoculation). Those values were particularly encouraging, bearing in mind that PA-27 did not induce any major side effects either: all animals looked healthy and active and weight change was visually non-existent. This unexpected discovery makes PA-27 very promising immunomodulating drug candidate for the suppression of cancer metastasis development and prevention of tumour formation. PK and safety studies of PA-27 were performed. Bioavailability (AUC) was determined after intravenous (IV), subcutaneous (SC) and peroral (PO) administration of PA-27 at a dose of 20 mg/kg in adult Balb/c female mice. According to our results PA-27 bioavailability is high, 85% after s.c. administration and 38% after p.o. administration. Dose linearity of PA-27 was determined after peroral (PO) administration at doses of 20-1000 mg/kg. The disposition a PA-27 is linear at doses from 20 mg/kg to 400 mg/kg. Single maximal peroral tolerable dose (MTD) of **PA-27** is 1000 mg/kg. Same dose is also No Observable Adverse Effect Level (NOAEL).

Twenty-eight-day safety studies were determined on Balb/c female mice. **PA-27** administered at a dose of 400 mg/kg (PO). Animals weight, behaviour and clinical signs were monitored during 28-day treatment, plasma collected for PK after the last dose; organ (spleen, kidney, liver, heart) weight recorded, marker measurements in plasma and urine. Liver function tests show significantly elevated levels of ALAT and ASAT although the observed increase does not indicate on marked liver damage. Notably, PK profile and exposure of **PA-27** was similar after 28 days of administration and single administration.

Notably, at the moment there is no effective treatment for cancer metastasis suppression. Monoclonal antibodies are widely available, but they are characterised by serious side effects. Therefore, novel drug candidate molecules are required for treatment of cancer metastasis development and prevention of tumour formation. Based on previously

received data, **PA-27** can be regarded as a promising novel drug candidate, characterised by a wide range of therapeutic effects and fewer side effects compared to currently available drugs.

Thus, masking of selenium pharmacological properties in the development of drug candidate, gave an impressive result and may be accepted as new direction in the search of anticancer drugs in **Unmet Medical Need** category.

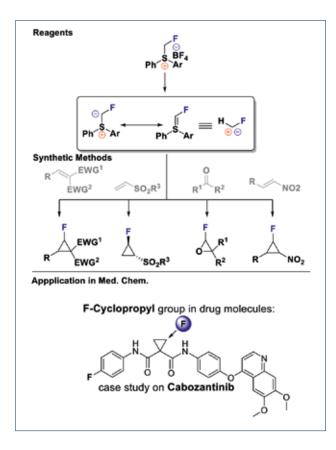
NEW REAGENTS FOR FLUOROMETHYLENE TRANSFER CHEMISTRY

Jānis Veliks, *Dr. sci. nat.*, leading researcher Renāte Melngaile, *Mag. chem.* Artūrs Sperga Armands Kazia Latvian Institute of Organic Synthesis

Chemistry is all around us. All visible matter is made of atoms and molecules. The biological processes taking place in a living organism are complex cascades of chemical reactions catalysed by enzymes. Since ancient times, humans have tried to transform matter - smelting ore into metals, converting fat and oils into soap, making fermentation to rise bread and produce beverages. The modern chemical science has not only revealed the molecular bases of all these processes known for millennia but also has created methods and reagents to make new, previously inexistent compounds, to develop drugs against previously incurable diseases as well as specialty materials that make our modern life possible. The same as surgeon needs all kinds of tools, like scalpels, forceps, and scissors, a chemist needs reagents to manipulate molecules. New compounds are created in chemical reactions requiring special reagents dedicated to do a certain task by converting a starting material into a desired product in a predictable manner. Our research group deals with the development of methods and reagents for the synthesis of a special class of chemicals - organofluorine compounds.

Fluorine is an extremely rare element in living organisms. A completely different picture reveals when looking at the chemical structures of known pharmaceutical drugs. Almost 25% of currently available drugs in the market contain at least one fluorine atom in their chemical structure which belongs to a class of organofluorine compounds. Why fluorine is

so special in pharmaceuticals? This arises from the unique properties of this element. Due to the small size of a fluorine atom it can often be considered as bioisosteric replacement of very abundant hydrogen atoms in the structures of organic compounds. Also, it forms strong carbon-fluorine bonds, which is a prerequisite to have stable chemical entities. Additionally, it is the most electronegative element in the periodic table, which can significantly alter the electronic landscape of the molecule under investigation, bringing additional interactions with the enzyme of interest. Thus, incorporation of this element can be used to trick naturally occurring enzymes to improve the biological activities or increase the metabolic stability of the potential drug. Replacement of one or several hydrogen atoms in a drug molecule with fluorine substituent is a common practice in medicinal chemistry to alter the biological activity of a compound in the lead optimisation studies. This process in drug discovery is very important, where an initially identified hit compound is chemically modified to improve overall biological properties of the active scaffold and, eventually, the potency of the future therapeutical for the treatment of a disease under investigation. All these unique properties make organofluorine compounds an important class of chemicals with various applications. Therefore, for chemists the development of new techniques and reagents that would allow synthesis of new organofluorine compounds is a task of high priority.



A route of fluoromethylene transfer reagents from a concept and methodology development to a medicinal chemistry relevant compounds

Our research team is involved in the development of new reagents for a transformation that would facilitate the synthesis of previously difficult to access organofluorine compounds. More specifically, our group deals with the development of reagents that can be used for fluoromethylene transfer applications. This is a chemical transformation where one-fluorine-one-carbon-one-hydrogen unit (CHF:) is transferred from the reagent to a target substrate. This is a synthetically very useful approach to access certain classes of monofluorinated compounds, for example, small fluorinated cycles. The current approach to perform such type of chemistry was mostly dealing with fluorohalomethanes or freons as reagents, which are gases or low-boiling liquids possessing ozone depleting properties. In this situation our goal was to find solid, easy-to-use and effective reagents capable to perform the aforementioned transformation. Sulphur ylide chemistry is a well-known approach among chemists, to transfer methylene groups to alkenes or carbonyl compounds. However, in 2018, when our studies begun, there were no reports in literature on the existence of sulphur fluoromethylide species as a reactive intermediates, which we envisioned to be easily accessible from diaryl fluorometyhlsulfonium salts. These salts adored to the expected properties for being good reagents for the purpose - as bench stable compounds with tunable reactivity and crystallinity depending on the substituent. Initially, deuteration experiments showed the first mechanistic evidences suggesting of sulphur fluoromethylide intermediates. This finding was eventually developed into a useful synthetic methodology to access rare organofluorine compounds - monofluorinated epoxides. Further, we were able to show that fluoromethylene transfer from diaryl fluoromethylsulfonium salts can be used as a synthetic strategy for the preparation of various monofluorocyclopropane derivatives offering a good alternative to the existing technologies. Pursuing the research in this area we were able to showcase that our developed synthetic methods can be applied for the synthesis of relevant medicinal chemistry targets. We opted to synthesise the fluoro-analogue of anticancer drug cabozantinb- a c-Met and VEGFR-2 kinese inhibitor, which is used for the treatment of medullary thyroid cancer and renal cell carcinoma. This molecule attracted our attention because its chemical structure contained a cyclopropyl ring, but its fluorocyclopropane analogue was unknown in literature. We anticipated that our methodology would give a straightforward access to such fluoro-analogues. Consequently the diastereoselective synthetic route was developed to access the F-analogues of cabozantinib. In collaboration with our pharmacology colleagues at LIOS, J. Kuka and M. Videja, we have demonstrated that incorporation of fluorocyclopropane moiety in cabozantinib could be an interesting tool for fine-tuning of the properties of biologically active compounds. In vitro cytotoxicity studies have shown that one of the stereoisomers of F-cabozantinib displayed better selectivity when compared to the non-fluorinated parent drug. Of course, there is still a long way for this to be developed in real therapeutics, but at this point, we have opened a new perspective for further studies. There is still a lot to do, and our highly dedicated team



Dr. sci. nat. Jānis Veliks in the lab

consisting of very talented students R. Melngaile, A. Kazia, A. Sperga was the key to the success of this project. This was recognised by various awards that these young investigators received for their work on this project.

In conclusion, our investigations have led us from demonstration of proof-of-concept to the development of new reagents and synthetic methodologies, to the application of the method on medicinal chemistry target placing it as an important contribution in the area of fluorine chemistry.



Renāte Melngaile receiving Straumanis and Ieviņš Prize for young researchers in chemistry



Armands Kazia receiving Best Poster Award in the 11th Paul Walden Symposium, Rīga, 2019. From the left: *Dr. chem.* Vilnis Liepiņš, Armands Kazia, Professor *Dr. rer. nat.* Herbert Mayr

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RECENT DEVELOPMENTS OF AZIDOPURINE AND TRIAZOLYLPURINE CHEMISTRY AT RĪGA TECHNICAL UNIVERSITY

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Māris Turks, Irina Novosjolova, Ērika Bizdēna

Synthetic chemistry of nucleoside, nucleotide and nucleobase analogues is a constantly developing research field since the discovery of antiviral and anticancer agents in this compound group in the 1960s. Later the medicinal chemistry achievements were complemented by luminescent nucleobase analogues which have found their application in biological chemistry and very recently in materials science. The development of novel synthetic methods for substitution of purine and pyrimidine systems provides access to hitherto unknown derivatives that will allow medical chemists and materials scientists design new types of molecules and their applications.

The team of researchers lead by Māris Turks, Ērika Bizdena and Irina Novosjolova from the Faculty of Materials Science and Applied Chemistry, Rīga Technical University (RTU), was awarded the Diploma of the President of the Latvian Academy of Sciences for Achievements in Science 2020 for their work on "New synthetic methods in purine chemistry and their application in materials science". Since the 2010s, many Bachelor, Master and PhD students have contributed their passion of science and synthetic skills to the development of the methodologies described below. Their names can be found in the references and we are grateful to them for their valuable contributions. We thank also our external collaboration partners whose names are both in the references and on the manuscripts still in preparation: Kaspars Traskovskis and Valdis Kokars (Institute of Applied Chemistry, RTU), Aivars Vembris (Latvian Institute of Solid State Physics), Anatoly Mishney, Sergey Belyakov, Reinis Vilšķērsts (Latvian Institute of Organic Synthesis), Sigitas Tumkevičius and Saulius Juršėnas (Vilnius University), Huan-Tsung Chang (National Taiwan University), Kathrin H. Hopmann (The Arctic University of Norway), Andrey A. Fokin (Igor Sikorsky Kiev Polytechnic Institute).

The Institute of Technology of Organic Chemistry at the Faculty of Materials Science and Applied Chemistry, RTU, was involved in nucleoside and nucleotide research since the late 1980s, and the first focus back then under the leadership of Professor Ērika

Bizdēna was on the synthesis of oligoribonucleotides by the H-phosphonate approach using base labile 2'-O-protecting groups [1]. The development of 2'-(2-chlorobenzoyl) protection and its application in synthesis of ribo- and arabinonucleotides was the PhD thesis topic of Eriks Rozners, who presently is Professor and Chair of Department of Chemistry, State University of New York at Binghamton. In the late 1990s, Ēriks Rozners initiated research on amide-linked ribonucleic acids [2, 3], which required sugar amino acids as building blocks - a Master's thesis topic of Māris Turks [4]. Then, in the first decade of the new millennium, the Institute of Technology of Organic Chemistry started fruitful collaboration with JSC "Grindeks", a Latvian pharmaceutical company. And who would have thought so - the first contracts were on the development of synthetic technologies for production of generic nucleos(t)ide drugs cytarabine and fludarabine. Working around the purine scaffold of fludarabine initiated the idea about the novel substitution patterns and reactivity modes of purine ring. Synthesis and applications of triazolylpurine nucleosides became the PhD thesis topic of Irina Novosjolova [5] with professors Ērika Bizdēna and Māris Turks in the roles of the scientific supervisors. With the above described historic overview, we are ready to discuss the novelties of synthetic chemistry of azidopurines, triazolylpurines and their materials science applications.

Azolyl purines constitute a distinct class of substituted purine derivatives containing azole rings at either of the possible positions of the purine ring: C(2), C(6), N(7), C(8), and N(9). They are investigated as adenosine receptor agonists and antagonists and also as antivirals [6]. We have developed a synthesis of 2,6-bis-triazolyl-purine derivatives and studied their chemical and photophysical properties (Fig. 1). The key starting material was 2,6-dichloropurine, the anion of which can be alkylated with alkyl halides, including the glycosyl bromides [7]. Yet a more

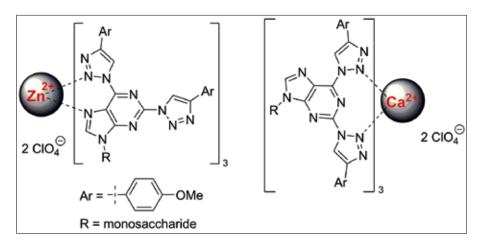


Fig. 1. Synthesis of starting materia

Fig. 2.
Metal complexation mode with 2,6-bis-triazolylpurines purine derivatives

convenient and N(9)-selective method appeared to be Mitsunobu alkylation [8]. Next, the N(9)-substituted 2,6-dichloropurine was treated with NaN₃ and 2,6-diazidopurines **2a-e** were obtained up to quantitative yields. Alternatively, commercial 2,6-dichloropurine can be transformed into 2,6-diazido-9*H*-purine **3**, which is submitted to the Vorbrüggen glycosylation [7].

When electronic properties of substituents R^2 were adjusted (e.g., R^2 = 4-MeO- C_6H_4), photophysical properties of compounds of type **4** were exploited to create a new concept of a ratiometric chemical fluorescence sensor harnessing photoinduced electron transfer due to the metal ion complexation (Fig. 2) [9]. It is interesting to note that depending on the intrinsic properties of the metal ion, its com-

Fig. 3.
Showcasing of nucleophilic aromatic substitution reactions of 2,6-bis-triazolylpurines

Fig. 4.
Azide-tetrazole equilibria and their influence on purine reactivity

Fluorescent properties of push-pull purines **5** and **12**s

plexation site can be switched between both triazolyl substituents or between N(7) and the triazole at C(6).

On the other hand, 2,6-bis-triazolylpurines $\bf 4$ appeared to be quite reactive towards various nucleophiles in S_N Ar reactions. Thus, over several years reactions with various N- [7, 8, 10, 11], S- [11, 12, 13], O- [14], P- [15] and C-nucleophiles [14] were developed (Fig. 3). Reactions with selenol and hydrazine nucleophiles are currently underway. The diversity of nucleophiles demonstrates the generality of this methodology towards numerous 6-substituted 2-triazolyl-purine derivatives. The C(6)-selectivity of this S_N Ar process has been proven both by X-ray analysis and controlled synthesis of the opposite regioisomers. The methodology is transferable also to other purine congeners such as 7-deaza-purines [16].

Nucleophilic aromatic substitution reactions at the purine ring were investigated also with 2,6-diazido-9*H*-purine (**3**) and its 9-substituted congeners **2**. It was discovered that depending on N(9)-substituent two reactivity rules can be observed due to azide-tetrazole tautomeric equilibrium [17], which acts as a regioselectivity switch. Thus, 2,6-diazido-9H-purine (3, R = H) provides traditional C(6)selectivity, but quite surprisingly, 9-alkylated/ qlycosylated-2,6-diazidopurines 2 (R = alkyl, monosaccharide) exhibited unprecedented C(2)-selectivity in S_NAr reactions and provided products of type **10** (Fig. 4) [8, 12, 18]. Indeed, azide-tetrazole tautomeric equilibrium at C(6)-position (2,6-DAP-6T) masks C(6) for nucleophile attack and activates the ring system for C(2)-nucleophilic attack due to the electron withdrawing properties of the fused tetrazolo ring. Also, quantum chemical calculations

conform to the diminished activation energy for the pathway leading to products of type **10**, when R = alkyl, monosaccharide. Similar substitution rules were observed also for 7-deazapurines [16].

Such a regioselectivity switch gave a possibility to prepare 2-amino-6-triazolyl-purine derivatives **12** and to compare them with 6-amino-2-triazolyl-purines **5**. Compounds of type **12** possess mostly blue fluorescence with higher quantum yields than compounds of type **5** (Fig. 5) [7,8,10,11]. It is interesting to note that fluorescence spectra of some of the compounds (e.g. **12a**) possessed a strong positive solvatochromic effect, which was studied in solvents such as THF, CHCl₃, DMSO, MeCN and MeOH. In this case also a good linear correlation between the fluorescence quantum yields and the Dimroth–Reichardt polarity parameter E_{τ} (30) was found.

When bulky substituents are attached at N(9) or at the triazole moiety, the obtained products form good quality thin films and exhibit excellent fluorescence quantum yields in solid state. This sets a stage for their further investigation in organic optoelectronic devices, such as organic light-emitting devices (OLEDs) [19].

During the development of synthetic procedures, we have observed other notable features of azidopurines. It was found that their azide-tetrazole equilibrium is responsible for functional group swap around the purine cycle, a phenomenon, which we named a functional group dance (Fig. 6) [20]. It is particularly pronounced in the case of 2-chloro-6-sulfonylpurines 13. Sulfonyl group at C(6) of the purine ring is suitable for S_NAr reaction with azide as a nucleophile. Next, the intermediate 14 exists in tautomeric equilibrium, in which the

Fig. 6. Sulfonyl group dance in purine systems

tetrazole form **14T** is more reactive, yet at C(2) position. The sulfinate anion, which was nucleofuge in the step **13→14**, becomes a nucleophile and forms product **16**. Intermediate Meisenheimer complex **15** characteristic for the nucleophilic aromatic substitution reactions and featuring azide-tetrazole tautomerism was observed by NMR and FTIR spectra. These findings provided a simple one-pot procedure for selective functionalisation of purine core with substituents that are suitable for further chemical transformations. A similar functional group dance of arylthio groups (arylsulfanyl group dance) was developed by us also for quinazoline congeners [21].

In summary, azido group was used as both a reaction centre and a regioselectivity switch and novel purine ring substitution reactions were developed.

This allowed reversing the traditional purine substitution style and forming C-N and C-S bonds. The use of 1,2,3-triazoles as leaving groups in purine S_N Ar reactions has also been discovered and new C-N, C-S, C-C, C-O and C-P bond formation reactions were developed. The developed methodology is general and can be applied also for synthetic modifications of quinazolines, 7-deazapurines and other heterocycles used in medicinal chemistry. The new purine derivatives have strong luminescent properties and they have been used to develop new metal ion sensors and organic light emitting diodes.

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ONCOLYTIC VIRUS FOR CANCER TREATMENT: THE REAL DIAMOND OF LATVIA

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The world's fight with cancer seems the never-ending story. The worst illness that every year takes away our beloved ones, leaves no family without loss, no soul without grief. Latvia is the lucky place where the idea about the virus to treat cancer was born, thanks to viruses' natural properties – proactively finding and killing the cancer cells, thus promising the mankind a cure of this deadly disease.

The first-ever registered oncolytic virus in the world – Rigvir (ECHO-7 virus strain) comes from the hands of honourable scientist Aina Muceniece who is the founder of practical virotherapy. The sequel, now described in just a few words, was the result of titanic

work, perseverance and desire to the science, and true willingness to help people. The virus itself became a safe one with high efficacy and well tolerated by patients, and even without significant side effects. It started in the 1960s, in Augusts Kirhenšteins Institute of Microbiology and Virology, where in a special laboratory the very first preclinical trials with animals were made, followed by safety and efficacy trials. Soon after that, clinical trials started in Rīga, Moscow, and Saratov. It became known that the oncolytic virus induces tumour cell lysis, local immunological reaction, and enhance systemic anti-tumour immunity.

At the same time, the science in the world, outside the Iron Curtain, took another direction. Nobody was speaking about oncolytic virotherapy in cancer treatment except Aina Muceniece, who was from the Soviet Union, in the hard embrace of KGB, which meant silence for the rest of the world.

The late 1980s came with a collapse of the previous regime, which brought freedom to Latvia, but fully stopped the pan-Soviet registration process of Rigvir, which was started before. Only a few years after 1991, when the restoration of the independence in Latvia was established, Rigvir was available for patients only experimentally. While the state was reborn, there were almost ten years of silence around this promising medication. Rigvir became a kind of a victim of an epoch, almost falling through the separator of the era. However, at the beginning of the new century, the scientists, who previously were working together with Aina Muceniece, came together once more for



Aina Muceniece with colleagues at the Institute of Microbiology and Virology (first row, fourth from left)

establishing the non-governmental organisation, with the one and only purpose – to restart Rigvir. The work went great and after a few years of decent work with all the materials, studies, and trial results collected and analysed, the revival of this medicine took place, followed by national registration in 2004. By 2005, Rigvir was already included in the TOP 10 of National Achievements, recognised by the Latvian Academy of Sciences, which was chaired by academician Jānis Stradiņš at that time.

On 14 February 2010, sad news were brought to the world about Aina Muceniece's demise. Her life had been filled with happiness, achievements, miraculous discoveries, inventing and entering into the circulation of Rigvir, and helping to save lives and life quality to thousands of cancer patients all around the globe, the motto of her life was "science, science unite, promise to protect mankind". This goes on thanks to her children and grandchildren, and colleagues who continue her work.

From 2011, when Rigvir medicine was included in the medicines reimbursement system of the state, it was applied for 65–70% of melanoma patients in Latvia. Collection and analysis of patient data in this

country showed amazing efficacy, revealing that using Rigvir for patients may prolong progression-free time and reduce mortality 4-6 times (publication in the journal Melanoma Research, 2015), which made many take a more serious look at oncolytic virotherapy as a perspective cancer treatment, and also at Rigvir. Further, the Horizont2020 grant was received, and the decent work with European Medicines Agency (EMA) resulted in EMA's scientific advice (at 2017), which stated: the available data are sufficient to enter any clinical trial phase II necessary for the central registration procedure in the future. In the meantime, Rigvir developers received several Seal of Excellence certificates from the European Commission and the prize WIPO for the high-level intellectual property patent protection.

The medicine under the name of Rigvir was registered as a drug for melanoma treatment in several countries – besides Latvia also in Georgia, Armenia, Uzbekistan.

Nowadays, real help for cancer patients is provided, using health tourism, in collaboration with the International Virotherapy Center. The scientists and healthcare organisers are participating in different



Contract signing ceremony during China International Import Expo, November 2019

medical and healthcare conferences all around the world reporting on the development of virotherapy. In 2018, deciding to restructure into a biotech company, Rigvir developers Rigvir Group purposefully decreased the volumes of commercialisation. This made it possible to attract the much-needed investment for further product development and research and, consequently, for subsequent registration of Rigvir in more developed markets or the sale of licenses. The successful development of previous years allowed attracting more investments within a short time, including from a venture fund and an international biotech company.

Year 2019 came with a new success – good laboratory practice (GLP) Toxicity Study was held, granted by the EU fund European Regional Development Fund, with the total cost of 560 000 EUR, which was completed in 2020 with the best possible result: no observed adverse effects (NOAEL). The study has just been published in the scientific journal *Toxicology Reports*.

In 2019, also, the first out-licensing deal in the Chinese market took place – the signing of the agreement was organised by the Chinese side as part of China International Import Expo in the presence of several thousand spectators.

Year 2020 ended with the completion of the final phase of the brand new laboratory and obtaining its

good manufacturing practice (GMP) certificate, with 2.3 million EUR invested in this project.

Today Rigvir Group has taken a convincing course to attract investments, which would allow continuation of research and successful implementation of a strategic direction in the markets of highly developed countries.

It should be noted that numerous publications have been issued since the beginning of Rigvir journey – both retrospective data, several unique case reports, and detailed descriptions of the appearance of Rigvir. Also, it is worth mentioning that the foundation created by Aina Muceniece's relatives implemented the incredible project when eight cancer patients (even in the 3rd and 4th stages of illness) attempted Mont Blanc. The ascent was filmed and the movie "Another Taste of Life" showing their courage to overcome themselves was shown later.

Since then, scientists of the world have become introduced to and investigated oncolytic virotherapy; now it is widely known that oncolytic viruses as a medication can be applied both as monotherapy and as combinations to increase the effectiveness of other therapies.

Life is a journey. Aina Muceniece's life definitely was. Life became a journey for each who got on Rigvir, the almighty ECHO-7 virus. Let the journey continue!



The new Rigvir laboratory building in Riga, Atlasa Street

EMĪLIJA GUDRINIECE - 100

Pēteris Trapencieris, *Dr. chem.*, leading researcher, Latvian Institute of Organic Synthesis, Full Member of the Latvian Academy of Sciences

Māra Jure, Dr. chem., Professor, Rīga Technical University, Corresponding Member of the Latvian Academy of Sciences



Emīlija Gudriniece performing an experiment. 3 March 1964. Photo: J. Fadejevs

3 August 2020 marked the 100th anniversary of the birth of *Dr. habil. chem.* Emīlija Gudriniece, an outstanding scientist, chemist, patron of and Professor at the Rīga Technical University (RTU), and Full Member of the Latvian Academy of Sciences (LAS). Over 64 years, her scientific and teaching work was associated with the Latvian State University (LSU), the Rīga Polytechnic Institute (RPI), later RTU, and for more than 40 years, also with the Academy of Sciences of the Latvian SSR (LSSR AS) and the LAS. SJSC "Latvijas Pasts" commemorated the centenary of Emīlija Gudriniece, issuing a striking postage stamp dedicated to her. On it the artist Arta Ozola-

Jaunarāja has depicted Prof. E. Gudriniece and the formula for furacillin. One of the first successful syntheses of heterocycles developed in 1948 by E. Gudriniece was that of furacillin, for which she was later awarded the LSSR State Prize.

Emīlija Gudriniece was born on 3 August 1920 in Kromani village, Rēzekne District, and attended the six-grade "Ziedonis" elementary school in Kaunata Civil Parish. While studying (1935–1941), at the Rēzekne State Teachers' Institute, she acquired skills and lifelong love of pedagogy. After one year (1942), during the war, E. Gudriniece taught at a rural school in Daugavpils District, and then began her studies at the Faculty of Chemistry, University of Latvia. In 1948, she graduated from the LSU Faculty of Chemistry, with a chemical engineering degree, and in 1952 she defended her dissertation as a Candidate of Chemical Science. After that she taught at the LSU until 1958, being from 1956 to 1958 Dean of the LSU Faculty of Chemistry. E. Gudriniece was elected Vice-Rector for Science of RPI and at the re-opened RPI (1959–1962) where she laid the foundations for scholarly research at the RPI. In 1960, she defended her doctoral dissertation (Dr. habil. chem.). In 1963, Professor Gudriniece established the RPI Department of Organic Synthesis and Biotechnology, which she headed for the next 27 years. Presently this is the Department of Chemical Technology of Biologically Active Compounds at the RTU Institute of Technology of Organic Chemistry. Emīlija Gudriniece died in Riga on 6 October 2004 at the age of 84; she is buried in the Meža (Forest) Cemetery, next to her mother and Professor Alfrēds Ieviņš.

Emīlija Gudriniece's scientific interests touched upon various theoretical aspects of chemistry and organic synthesis; these have related to heterocyclic compounds (thiazole, pyrazole, xanthine and



Emilija Gudriniece. 1998. Photo: I. Liepiņa

acridine) synthesised from 1,3-diketones. During her academic career, she has overseen more than 80 student research projects, co-authored 734 publications and was granted 40 patents. All of the 28 doctoral dissertations, which she supervised, have been defended, five of her students later became professors at the RTU. In 1963, Emīlija Gudriniece was elected as Corresponding Member of the Academy of Sciences of the Latvian SSR, and in 1978 – Full Member of the Academy of Sciences of the Latvian SSR. From 1996 onwards, she held the title of State Emeritus Scientist, and from 2000 onwards, a Professor (Emeritus) of the RTU.

Beneficiaries of a broad range of professional and social activities of Professor E. Gudriniece lauded her, while others engaged in malicious gossip. She was actively involved in the organisation and hosting of the 7th IUPAC (International Union of Pure and Applied Chemistry) International Symposium

of Chemistry of Natural Products, the largest meeting of eminent scientists in the history of Latvia, which was held in Rīga from 21 to 27 June 1970. The Symposium was attended by 1900 scientists from 40 countries and by five Nobel laureates. The vivid presentation by Har Gobind Khoran, the 1968 Nobel Prize winner for biochemistry, of Indian origin, who reported on the world's first gene synthesis, has a lasting place in the world history of science. Furthermore, the event was also attended by two outstanding expatriate Latvian professors of chemistry, who first came of Riga after the Second World War - the biochemist Bruno Jirgensons and physical chemist Mārtiņš Eduards Straumanis. The two professors Mārtiņš Straumanis (USA) and Alfrēds leviņš (Riga) met again in Riga, and for them there was much to discuss about two asymmetric radiography methods developed in Latvia before the war.

In 1990, the professor participated in organising re-founding the Latvian Chemical Society, as well as re-establishing the Latvian Association of Academically Educated Women (*LAISA*). From 1992 to 1999, she was the president of *LAISA*. She was an active member of the Latvian Union of Scientists and was one of the organisers of the First World Congress of Latvian Scientists, held in 1991. She was also actively engaged in the work of both the Rīga Latvian Society and the Latvian Association of Professors.

The scientific and social activities of Professor Emīlija Gudriniece were highly esteemed both during the USSR period and after the restoration of Latvian independence. In 1957, the Latvian SSR State Prize was awarded to the team which included E. Gudriniece, for the synthesis and introduction into medical use of the antimicrobial preparation furacillin. In 1970, E. Gudriniece was awarded the title of honoured worker of science and technology of the Latvian SSR; in 1972 – the Gustavs Vanags Prize of the Academy of Sciences of the Latvian SSR. In 2000, she was awarded the Paul Walden Medal of the Rīga Technical University, and in 2003 – the LAS and JSC "Grindeks" award "Golden Owl" for lifetime contribution to the training of young chemists.

The name of Emīlija Gudriniece, LAS academician and the most outstanding Latvian woman scientist

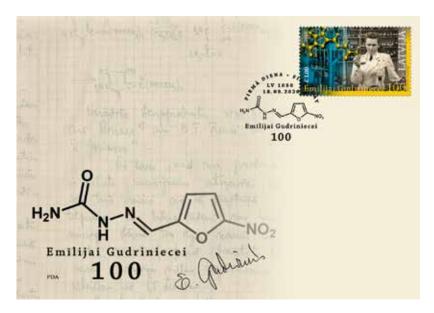
of the second half of the 20th century, is associated with the following achievements, first in Latvia:

- the first woman in Latvia to defend, in 1952, a dissertation of candidate of chemical sciences;
- the first scientist to win, in 1949, the Latvian SSR motorcycle championship in the 350 cm³ class for women;
- co-author of the first and so far the only textbook on organic synthesis to be published in Latvian (1976);
- the first in Latvia to focus on research on the oxidation stability of vegetable oils and the use of rapeseed oil for production of biodiesel;
- during her postgraduate studies in 1948, she was the first in the USSR to resynthesise the antibacterial drug furacillin.

A special prize recognising the best chemistry teacher of the year, established on the basis of funds left by Professor Emīlija Gudriniece, has been awarded by the LAS and RTU Faculty of Materials Science and Applied Chemistry, from 2005 onwards. In addition, the LAS annually confers a stipend named in honour of academician Emīlija Gudriniece to the

best young scientist of the year, and a scholarship in the name of LAS academicians Emīlija Gudriniece and Alfrēds Ieviņš.

Insatiable curiosity, vision of escaping penury and obscurantism, longing for a better life, the desire to be the first and to be among the smartest, and the noble goals and ideals set at the Rēzekne State Teachers' Institute, as well as the love of Latvia these were the driving forces that motivated Emīlija Gudriniece all of her life. Until the very end, the Professor was full of energy, restless, tireless, always eager to learn something new, an organiser and a leader, conscientious and demanding of herself and others, helpful, selfless, and full of compassion for others experiencing hard times; however, intolerant of greed, carelessness, and dishonesty, of those careless and indifferent to their work. She had an unusual knack of sensing the future direction science might take, and, having extensive knowledge in various fields, she was versatile, uncomplicated and accessible, with a desire to listen and the ability to hear.



A postage stamp and special 1st day envelope for Emīlilja Gudriniece – 100. Latvian Post publicity photo. 18 September 2020

Translated by Eduards Bruno Deksnis

BIOLOGY, AGRICULTURE AND HEALTHY FOOD

LATVIAN COLEOPTEROLOGISTS STUDY BEETLES IN THE TROPICAL RAINFORESTS OF THE PHILIPPINES

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Science that studies beetles is called coleopterology. This name comes from the Latin name of the beetle order Coleoptera. Daugavpils University has the only coleopterological research centre in Latvia and the Baltic, which is well-known in the world. Beetles are one of the most numerous and diverse species of insects in terms of insect orders in the world. More than 400 000 species are known to be found virtually everywhere around the globe, except in ocean waters and areas of ice and permafrost. Beetles live in forests, meadows, agrocenoses, rivers and lakes, caves, bird nests and human apartments. Beetles play an important role in nature. They promote decomposition of various parts of plants, including wood, they are natural sanitizers, they maintain the balance of ecosystems, pollinate plants, indicate significant changes in the environment. Beetle blood - haemolymph contains various chemicals that are of great importance in medicine, but their body surface structure, structure of individual body parts and mechanical movements are used in mechanics and materials science. Many beetle species are highly endangered and can serve as umbrella species to protect entire ecosystems, such as the hermit beetle (Osmoderma) species found in Europe. To protect this species, a human protects its habitat - old hollow trees, which in parallel are important for hundreds of other species living there, which are also endangered, because in nature the number of old, hollow trees is reducing. Many popular beetles and especially their larvae are also used

in food. The diversity of beetles and their uses are being studied around the world.

One of the research directions that beetle researchers at Daugavpils University are developing is the research of tropical beetle biodiversity. Tropical rainforests are currently one of the most endangered ecosystems in the world. Forests are cut down in huge numbers, giving way back to palm gardens and livestock pastures. At the same time, tropical forests have the highest biodiversity in the world and are very poorly studied in a number of regions. Beetle researchers at Daugavpils University mainly specialise in the study of beetle diversity in the Philippine archipelago.

The Philippines is one of the 18 mega-biodiverse countries of the world, which contains two-thirds of the earth's biodiversity and between 70% and 80% of the world's plant and animal species. The Philippines is also one of the world's biodiversity hotspots. The Philippine archipelago is an isolated group of 7000 small islands and it may harbour the greatest concentration of unique species per unit area in the world. Approximately 33 percent of its plants, 75 percent of its amphibians, 70 percent of its reptiles, and 44 percent of its birds are endemics and can be found only on the Philippine archipelago.

The diversity of beetles is much higher in the Philippine archipelago, which is still very poorly studied. Therefore, every year many hundreds of new beetle species are discovered in the Philippine



Tropical rainforests in the environment of Mount Talomo, Mindanao island



Arvīds Barševskis together with the girls of the tribe Bagoba Tabagawa and coleopterologist Dr. Analyn Anzano Cabrasisland

archipelago. The latest updated list of beetles in the Philippines was done by Ballentes in 2001 of which she listed a total of 7375 species from 1567 genera and 87 families. 5840 species, or 79.20%, are endemic to the Philippines. There are a very few data in literature about the distribution of Philippine beetles. For many species, no new records have been published since they were described. Annual expeditions to the Philippines, joint studies with coleopterologists at the University of Mindanao, and joint scientific communication activities with local tribes can do much to protect the local rainforest biodiversity. Every year, beetle researchers at Daugavpils University discover and describe dozens of new species and genera for science.

In 2020, a total of 80 new taxa for science were discovered and described by scientists at the Coleopterological Research Centre at Daugavpils University. Among them, 9 unknown genera were discovered of which five are fossil (extinct),

described from the Baltic amber, but four of them were present-day genera, which are from the tropical regions of East Asia (three genera) and the Caucasus (one genus). Last year, 68 scientifically new beetle species were described, of which the most newly discovered species are from the Philippines - 23 species. Research on beetle biodiversity in the Philippines is necessary, because local biodiversity is under a great threat due to tropical deforestation. Assuming that almost 80% of the beetle species in this country are unique local endemics, catastrophic deforestation has an irreversible effect on the biodiversity here. Many undiscovered species are disappearing. The Philippines is, therefore, clearly one of the world's hotspots for biodiversity.

According to some scientists, the Philippines had 70% forest cover of the country's total land area in 1900, to 50% in 1950 and to less than 19% by 1990. Less than 1 million ha consists of virgin forest. Forest resources are being rapidly depleted (by an average of about 120 000 ha per annum) and there is a real prospect of Philippine forests being virtually eliminated within the next 20 years. In 2011, the official forestry statistics showed that the country had only around 7.2 million ha of forests. The Philippines lost around 10 million ha of its forests over the last seven decades, placing the country among those with the highest deforestation rates in the world. These processes show us that the most serious action is necessary to ensure real protection of the Philippine's biodiversity. Much more extensive support programmes are needed for local tribes to offset the income from timber sales, and they need to be introduced to the world's richest countries. which mainly use these tropical timber resources. Therefore, biodiversity research in the world's biodiversity hotspots must clearly be one of the global priorities for scientific development. Daugavpils University scientists in close cooperation with Philippine colleagues not only discover new species, but also offer solutions for their protection. Particular attention is paid to the Philippine endemic species, which form a unique, previously unexplored genus mimicry complex, Doliops-Pachyrhynchys-Metapocyrtus, whose inter-species relationship is crucial to offer as a potential umbrella species







Batocera victoriana Thomson, 1856, collected in the environment of Mt. Talomo, Mindanao island

Callimetopus bumbierisi HT

Callimetopus cabrasae Barševskis, 2018 from Mindanao island



Doliops daugavpilsi Barševskis, 2014 from Mindanao island. This species is named after Daugavpils City



Parazosmotes shavrini Barševskis, 2020, from Mindanao island

complex for the protection of all Philippine rainforest biodiversity.

To promote the development of coleopterological research in the Philippines, Daugavpils University coleopterologists initiated the establishment of the Coleopterological Research Centre at the University of Mindanao (Davao, Philippines) and the establishment of the Philippine Coleopterological Network (PhilColNet). In collaboration with Philippine coleopterologists Dr. A. A. Cabras and Dr. M. N. Medina, joint expeditions, joint seminars for students, and joint trainings for local coleopterologists are held every year. This will facilitate the development of coleopterological research in the Philippines. Mankind are responsible for the preservation of bio-

Mankind are responsible for the preservation of biodiversity for life on Earth. Alongside research on global climate change, related research on global biodiversity must be a priority for scientific development at an international level. Until we have the fullest possible information on what lives on the plant, we cannot think seriously about protecting its ecosystems, especially those that are most diverse and most at risk, thus, securing a full and sustainable future for humanity. In these processes, faunistic and floristic research play an invaluable role.



Pseudodoliops ditumaboensis Barševskis, 2018, from Luzon island

JAPANESE QUINCE (CHAENOMELES JAPONICA) – FROM FIELD VIA LAB TO TABLE: THE ROLE OF "GREEN" TECHNOLOGIES

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Plants of *Chaenomeles* sp. are known as ornamentals worldwide. However, Japanese quince (Chaenomeles japonica) as a fruit crop is well known only in the Baltic countries, Ukraine, Belarus, Scandinavia, and Poland. The Japanese quince fruits are a valuable raw material for the food industry because of their nutritive value. In Latvia breeding of Chaenomeles japonica as a fruit crop was initiated in the 1950s. The first large plantations of Japanese quince were established in the 1970s, in the 1980s reaching approximately up to 300 ha. All these commercial plantations were established using seedlings, which are very heterogeneous. At the Institute of Horticulture (LatHort), breeding of Japanese quince was started in the 1990s with the aim to obtain local cultivars adapted to the Latvian climate. Only one species – *Ch. japonica* – was used in breeding, since the others are not winter hardy in the northern part of Europe. During 1998–2002, LatHort together with Swedish and Lithuanian scientists evaluated a broad range of *Chaenomeles* germplasm within the scope of the EU Project "Japanese quince (Chaenomeles japonica) - a New European Fruit Crop for Produce of Juice, Flavour and Fibre" (EUCHA). Later after evaluation at the LatHort three cultivars were selected and registered in Latvia: 'Rasa' from the Latvian breeding material and 'Darius' and 'Rondo' from the EUCHA breeding programme. These cultivars are thornless, productive (4–8 kg per bush); fruits are homogenous, 40–60 g, ripen in the beginning or middle of September [1]. Since Japanese quince is relatively resistant to disease and pests, it can be grown in an environmentally friendly way, using integrated and organic growing systems.

In Latvia, Japanese quince is considered to be a **significant commercial crop** (558 ha in 2020, incl. 235 ha organic). During the last five years, the area of plantations in Latvia has increased four times showing that **cultivation of Japanese quince** becomes more popular every year. A similar trend is also observed in countries of Baltic see region, e.g., Poland. Market demand for fruit shows an upward trend with the pointing to ecological "BIO" products, therefore popularity of organic orchards can be observed. However, the quality of the Japanese quince fruits currently available on the market is diverse, since most of the growing areas are still planted using seedling material.

In order to raise knowledge on the cultivation, storage and processing of Japanese quince, ERDF project "Environment-Friendly Cultivation of Emerging Commercial Fruit Crop Japanese Quince –



First-registered Japanese quince cultivar 'Rasa'

Chaenomeles japonica and Waste-Free Methods of Its Processing" was carried out in 2017–2020. The aim of this project was to develop environmentfriendly technologies for growing, plant protection, storage and waste-free processing of Japanese quince, biosynthesis study of hydrophilic and lipophilic compounds during fruit development, an economic evaluation of production for faster development and increased export potential of the fruit and their products. Based on research results, technological solutions for the introduction of integrated and organic Japanese quince growing system have been developed. These include the correct selection of growing sites and cultivars, soil preparation, planting, fertilising, plant protection against pathogens and other harmful micro- and macro-organisms.

The demand for Japanese quince comes from the processing industry due to high acidity and fruit hardness. Japanese quince fruits are processed into juice, syrup, jams, and candied fruit. The processing of Japanese quince in Latvia can be divided into two periods with the first in the 1970s when the available products were juice and puree. The juice has found a niche use in the production of a sparkling non-alcoholic drink. Over time, this drink has gained great popularity, the demand for it is constantly growing, it is currently being exported, and various flavours have been created for it. The puree faired

worse on the market and the production decreased due to limited processing options. The second period started at the beginning of the 21st century when, simultaneously to the breeding, the first technology for production of candied Japanese quince fruit in Latvia was developed and patented by LatHort in collaboration with the Latvia University of Life Sciences and Technologies. More than ten years passed before industrial production, but candied Japanese quince fruit is currently produced by more than 15 companies, as well as exported.

LatHort has considered the application of "zerowaste" processing technologies in Japanese quince processing. During the production of candied fruit, two by-products are produced: cores and seeds. Considerable quantities of biologically active compounds (incl. procyanidin B1, chlorogenic acid, epicatechin) have been found in Japanese quince cores, and the organic acid content facilitates their use in the production of salty sauces. Seeds constitute 4–10% of the original weight of fresh fruit. It has been shown that the Japanese quince seeds are a source of oil rich in bioactive compounds with high potential industrial application [2]. The content and profile of organic acids in Japanese quince fruits are found to be comparable to that of lemon fruits, which are most widely used as raw material to produce acidifiers in the form of juice concentrate and powder. However, the composition and concentration of bioactive compounds in Japanese quince fruit, i.e. catechin, epicatechin, procyanidins, vitamin C, and essential amino acids are more valuable than found for lemon fruits. Since most commercial plantations due to economic reasons use seedling material, which produces uneven fruit, the part of the yield is suitable only to produce juice or puree. Therefore, the development of juice concentrate or powder can also be noted as a relevant use of Japanese quince in the "zero-waste" strategy. The development of juice concentrate production technology is being done under the project "The introduction of innovative, competitive growing technologies for Japanese guince and the extension of the range of fruit-processed products". Economical growth can be expected for producers and processors of Japanese quince with the application of this technology in the industry.

Environment-friendly techniques in bioactive compound extraction and analytical chemistry are also becoming more and more important in parallel to the food production. Despite the relatively low oil content (10-14%) of Japanese quince seeds, affected by the harvest year and cultivar [3-5], it is possible to obtain oil by applying "green" techniques such as cold pressing and supercritical extraction using CO₂ [2, 3]. A similar content of oil can be found in grape seeds obtained mainly as a by-product during juice and wine production. Since the production of grape seed oil is commercialised, the same could be done in the case of Japanese quince seed oil, especially that it is a valuable source of α-tocopherol (vitamin E), carotenoids, phytosterols, squalene, and phenolic compounds [2]. Determination of the chemical composition of food and plant material is often associated with using several harmful solvents. Currently, the supercritical fluid chromatography (SFC) provides a meaningful advantage on the liquid chromatography (LC), due to uses low viscosity a supercritical carbon dioxide (CO₂) as the main mobile phase, which allows higher operational flow rates and rapid analysis as compared with LC. Additionally, the application of the CO₂ makes the SFC an environment-friendly method for the determination of lipophilic compounds, e.g., tocopherols [6].

Many studies in LatHort are made in close collaboration with several institutes and faculties of the Poznań University of Life Sciences, publishing results in joint articles in high quality international scientific journals. As part of the ERDF project a PhD student from the Lithuanian Agriculture and Forestry Sciences Centre worked on part of her thesis at LatHort by studying the possible use of the fruit and leaves of different Japanese quince varieties in food and beauty products.

Japanese quince is not only an interesting research subject in the field of science; interest in it for Latvian and foreign businesses has also increased. Cultivars bred in Latvia are being tested in Lithuania, Estonia, Poland, and Norway. An exclusive licensing contract has been signed with a tree nursery about the propagation of Japanese quince varieties 'Rasa', 'Darius' and 'Rondo' in Poland.

In general, all of these activities show that the Japanese quince has good future potential!



For the results in Japanese quince research the scientist group received the prestigious Ministry of Agriculture award "Sējējs" in 2020 (D. Segliņa and E. Kaufmane)

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FOOD, ITS PACKAGING – FOR A HEALTHIER AND ENVIRONMENTALLY FRIENDLY LIFESTYLE

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Sandra Muižniece-Brasava in the Packaging Laboratoy at the Faculty of Food Technology, Latvia University of Life Sciences and Technologies

Food production is an integral part of Latvian industry. Food industry is one of the most important economic sectors in Latvia. Both in Latvia and around the world, the issue of healthy food made from natural raw materials is becoming more and more topical. Research on the development of new products is important, with a strong emphasis on the use of plant-based products, as well as the introduction of residue-free technologies, thus reducing food waste not only in the final consumer's household, but also preventing potential waste in product development processes, product quality and competitiveness.

In Latvia University of Life Sciences and Technologies, Faculty of Food Technology Centre for Studies and Science, research is carried out at all stages of the chain, from the research of raw materials, development of recipes and technologies, selection of packaging, determination of an optimal sales time and quality testing during the storage of the developed products. The main research areas are:

- new products from plant and animal raw materials, their nutritional studies;
- solutions for the use of food production by-products for the production of high value-added products (niche products);
- food safety and risks analysis;
- research of biologically active substances in food raw materials and products;
- food waste reduction options and packaging optimisation studies.

In the world, and also in Latvia, more and more emphasis is placed on the production of healthier and more environmentally friendly food, including the use of plant-based raw materials specific to each region. In Latvia one of such important materials are legumes (peas and beans). Legumes contain a high level of protein and an adequate proportion of carbohydrates and oil, which make them very valuable as a food source. The combination of proteins and amino acids in leguminous plants makes them interesting also for vegetarians and vegans to ensure a balanced diet. Despite the valuable qualities of local and traditional legumes, there are some drawbacks of legume-based food: a) the preparation is usually time-consuming, so people often prefer to consume cereal products which are available in a much larger range and are faster to prepare, and b) legumes contain antinutritional proteins, such as lectins, protease inhibitors and the non-antinutritional compound, angiotensin I-converting enzyme (ACE) inhibitor, raffinose-series oligosaccharides, tannins and phytic acid. Various deleterious effects may occur following the ingestion of legume seeds or flours, such as hemagglutination, bloating, vomiting and pancreatic enlargement, due to the activity of the antinutritional compounds inside the host. However, antinutritional compounds of legumes have many beneficial properties in the treatment and/or prevention of disease when properly processed. Therefore, the introduction in the market of new food products, such as sweet and salty snacks, muesli mixes, dry pea puree, or legume pate reinforce the driving force of the project. It should be acknowledged that soaking and heat treatment of legumes stop their negative effects. In Latvia University of Life Sciences and Technologies, the Faculty of Food Technology Centre for Studies and Science has developed pulse spreads with extended realisation time using high pressure technology and SOUS VIDE technology, as a result of which the doctoral thesis was developed and defended. Another important study is the development of extruded legumes, where extruded sweet and salty legume products have been developed using peas and beans as raw material. These products have a wide range of usage: they can be used

as breakfast cereals, toast in soups, as well as as an

additive to salads. The exuded products have been given the taste of fried onions, cheese, chocolate and almonds. This research also resulted in the defense of the dissertation. Continuing the started research of extruded products, both sweet and salty snack bars of extruded legumes have been developed, where research has resulted into a master's thesis. Moreover, the development of innovative products to use legumes, research has been conducted in the advance of pasta.

It is known that methionine is lacking in amino acids in legumes and lysine in cereals, so pasta made to combine the principle of complementarity with wheat and peas is lacking; wheat with beans and wheat with lentils results in pasta with a complete amino acid complex.

With the growing number of vegetarians both in the world and in Latvia, a significant role in Latvia University of Life Sciences and Technologies, Faculty of Food Technology research has the development of vegetarian sausages, sausage masses and burgers using various technological solutions and parameter analysis.

Expanding the usage of legumes also will significantly expand the sortiment of products. Consequently, the development of protein drinks, the use of legumes for enrichment of sugar confectionery and flour products with legume protein, which can significantly expand the range of products produced, were also carried out. Research has also been launched on the use of roasted legumes to enrich the amino acid profile of various foods, which will open up a wide range of legume uses.

When developing innovative foods, the issue of their delivery from the place of production to the consumer is very important, therefore the choice of packaging plays an important role. Food packaging has an essential role in ensuring safe delivery of food products from "farm to fork". Food packaging is used to protect food from the influence of external factors, which can deteriorate the product and reduce its shelf life, to contain food, to provide a convenient use of the product and to inform the consumer. More often than before packaging is becoming the main factor affecting consumer purchase choice, perception and food acceptance, therefore, packaging innovations aid in selling products in this

competitive environment. Consequently, identifying consumer expectations of food packaging design and concept is important in order to avoid negative attitudes and lower sales.

Each year, the quantity of packaging materials raises, and accordingly the waste and the need for recycling of the used materials increases. Food packaging accounts for almost two-thirds of total packaging waste by volume and approximately 50% by weight of total packaging sales. Today, only 14% of the global plastic packaging materials are recycled (>60% in the EU), and based on the composition of materials it is expected that around 30% of plastic packaging materials may fail to be recycled or reused.

Nowadays, it is especially important to educate consumers on the advantages of environmentally friendly (bio-based, biodegradable, recyclable) packaging, based on the current issues on marine plastic pollution. Up to 13 million tonnes of plastic is dumped in oceans every year, leading to engenderment of a large number of marine animals. In recent years, the issue of the amount of packaging waste that is closely related to consumer products is becoming more urgent, therefore it is very important to ascertain consumer opinion on the amount of packaging. The Latvia University of Life Sciences and Technologies, Faculty of Food Technology is conducting surveys annually to oversee the situation in Latvia. According to survey data, Latvian citizens are concerned about the issue of packaging use and tend to greener lifestyle, but it should be noted that much remains to be done in order to achieve the EU objective, by year 2035 to reduce waste going to landfill to 10% of the output.

EU documents set stricter minimum requirements for packaging:

- reduce the amount of (excessive) packaging and packaging waste;
- stimulate the creation of reusable and recyclable packaging;
- consider reducing the complexity of packaging materials, including the number of materials and polymers used.

Looking at the packaging industry, it is important to note that the term 'more environmentally friendly packaging' is not perceived in a narrow sense, but rather more closely related to the circular economy and the principle of sustainability (raw materials; design; production; distribution; consumption, collection; recycling).

Packaging material that looks natural will not always be the most environmentally friendly. It is always necessary to take into account the resources and technologies used throughout the packaging process, from the extraction of raw materials to the potential processing costs and resources required. The volume of packaging must definitely be reduced, but it must be done wisely in order to maintain the quality and competitiveness of food products, and packaging must be optimised. It is important to choose packaging for food and beverages that can

be reused or that has recycling options. Moreover, it is important to avoid using too much and unnecessary packaging, because it is often seen in shops that the volume of packaging is large, but it contains a very small object. Packages are often used where the product is packaged in apackage, which is placed inside another one, which is not necessary at all, since it does not perform any strategically important function. Another important issue that has to be addressed is the amount of print on the packaging. Yes, it is important to place the necessary information on the packaging, but there are often large colored areas of stickers. The amount of paint and varnish used can significantly complicate packaging recycling processes. Of course, another alternative is to use biodegradable packaging materials, but they have two major drawbacks - they have weaker barrier properties (gas and moisture permeability) and are currently more expensive than conventional packaging materials. The issue of the cost of biodegradable materials is to some extent addressed by changes in natural resource tax rates. When choosing biodegradable materials, it is also important to pay attention to which biodegradable materials to choose - biopolymers are divided into four large groups, with different conditions for their ability to degrade. Some of them would decompose in the environment at a certain pH, with the participation of microorganisms, but most of them decompose only industrially. This means that they must be collected, sorted and distributed under

industrial conditions at a temperature of 60 °C. It is also important to follow the biopolymer labels on the packaging, since in order to claim that the packaging is environmentally friendly it must have a specific label. Such hazardous packaging are those on which information is found to be oxo-biodegradable packaging. In order to reduce the amount of packaging, the Faculty of Food Technology laboratories are conducting packaging optimisation experiments for various foods, reducing the amount of packaging, the number of layers and looking for alternatives to biodegradable packaging. Nowadays, healthy food and environmentally friendly packaging solutions are becoming more and more important issues not only in Latvia, but all over the world, and we in Latvia have the potential and efforts to successfully solve these issues.

LATVIAN ACADEMY OF SCIENCES THROUGH DECADES AND CENTURIES

Ilze Trapenciere, Head of the International Department, Latvian Academy of Sciences

DEVELOPMENT OF THE ACADEMY

In 2020, the Latvian Academy of Sciences (LAS) marked the 205th anniversary since the foundation of *Academia* – Courland (Kurzeme) Society for Literature and Art. This society served as the first Academy of Sciences in the Baltic provinces of the Russian Empire until 1939.

The Latvian SSR Academy of Sciences was founded in 1946. The Academy was composed of individual members and a large number of research institutes, libraries, and other institutions, which served as the leading research system in Latvia for 45 years. The Academy introduced and developed branches of modern science previously absent in Latvia.

The contemporary independent Latvian Academy of Sciences was founded in 1992. The Academy is governed by the Statutes of the LAS (1992) and the Charter of the LAS (ratified in 1997 by the Parliament, Republic of Latvia). In accordance to the Charter, the Latvian Academy of Sciences has clear duties and responsibilities: promote an active role in the development of the science policy and advice to the parliament and government; participate in scientific expertise of different governmental programmes, protect and promote principles and traditions of scientific research ethics (Art. 4).

The mission of the LAS is to identify, select, and unite distinguished scientists at a national level, to carry out scientific expertise, to care about the development and promotion of national science, and endorse implementation of the national science policy aimed at facilitating competitiveness and growth of the national economy. With its almost 400 members – corresponding, foreign and honorary members – and support from entrepreneurs, the LAS is a significant centre of intellectual and scientific life, a place of technology transfer, of rapprochement between science and entrepreneurship on the shores of the Baltic Sea.

The Latvian Academy of Sciences organises its work in line with the common European Science and innovation policy in collaboration with government officials, policy executives, scientific and educational institutions, entrepreneurs, local municipalities and non-governmental organisations, as well as foreign partners. The Academy endorses acknowledgement of scientific achievements, participates in the development of national economy and provision of a sustainable society. All the important issues are discussed at the Senate of the Academy, but the decision making is the prerogative of the General Meeting of the Academy.

COMPOSITION AND MANAGEMENT OF THE LATVIAN ACADEMY OF SCIENCES

The composition of the Latvian Academy of Sciences is the following: full members (academicians), honorary members, foreign members, corresponding members. The number, procedure of nominating and discussing candidates is determined by the Statute of the LAS (1992, with amendments).

The LAS works in accordance to the Charter of LAS (1996, with amend.), Statutes of the LAS (1992, amend. 2012), and the Code of Ethics (1997, amend. 2017).

The highest decision-making body of the Latvian Academy of Sciences is the General Meeting (General Assembly), in which elected full, honorary, foreign, and corresponding members take part. In between general meetings, the work of the Latvian Academy of Sciences is headed by the President and the Senate.

From 2012 to 2020, the President of the LAS was *Dr. habil. art.* Ojārs Spārītis. In the General Meeting of 2020, a new President of the Latvian Academy of Sciences was elected. The President of the LAS is *Dr. habil. chem.* Ivars Kalviņš, who started to lead the Academy in December 2020. During the General Meeting, three Vice-Presidents, the General Secretary, the International Secretary, the Board, and the Senate were elected.

PresidentIvars KalviņšVice PresidentAndrejs ĒrglisVice PresidentOjārs SpārītisVice PresidentAndris ŠternbergsSecretary GeneralBaiba RivžaForeign Affairs SecretaryModris Greitāns

The Senate is a decision-making body together with the President of the LAS and the Secretary General to coordinate the work of the academy between the General Meetings.

Senate, Latvian Academy of Sciences

Chair Tatjana Koķe
Vice-chair Aivars Bērziņš
Scientific Secretary Alma Edžiņa

Members: Ivars Kalviņš, Ojārs Spārītis, Andrejs Ērglis, Andris Šternbergs, Baiba Rivža, Modris Greitāns, Bruno Andersons, Andrejs Siliņš, Pēteris Trapencieris, Guntis Zemītis, Maija Dambrova, Donats Erts, Tālis Gaitnieks, Jānis Grundspeņķis, Ilga Jansone, Kristaps Jaudzems, Maija Kūle, Dace Markus, Indriķis Muižnieks, Andris Ozols, Īzaks Rašals, Jānis Spīgulis, Māris Turks.

Board, Latvian Academy of Sciences

The Board regularly discusses and audits the full-fillment of the objectives and tasks of the Academy, including its economic activit. The Board is headed by the General Secretary.

Divisions of the Latvian Academy of Sciences

There are four core structural units forming the Academy, taking responsibility on stepping up research results, increasing academic qualification, exchanging research experience and mobility of scientists, and organisation of workshops and conferences.

The Academy organises its work in four main divisions – agriculture and forestry, physics and technical sciences, chemical, biological, and medical sciences, and humanities and social sciences.

Division of Agriculture and Forestry Sciences

Chair: Baiba Rivža

E-mail: lmzn@lza.lv, Tel. +371 29254469

The Division unites leading scientists in agriculture and forestry sciences. The Division cooperates with the Ministry of Agriculture, universities and research institutions, aimed at increasing the international competitiveness and closer cooperation with industry, joint organisation of conferences, expositions and other events aimed at popularising scientific achievements, cooperation in the organisation of young scientist

contests in agricultural sciences. The Division participates in the European Union research projects.

Division of Physics and Technical Sciences

Chair: Andrejs Siliņš

E-mail: fizteh@lza.lv, Tel. +371 67211405

The Division unites leading Latvian and foreign experts in physics, astronomy, mathematics, computer science, mechanics, energetics, and other fields of engineering. The activities of the Division include discussions of the latest research results, offering advanced technologies to industry, assistance in the development of Latvia's science policy and organisation of conferences and other public outreach events. The Division closely collaborates with Latvia's leading research institutions in the above-mentioned areas.

Division of Chemical, Biological, and Medical Sciences

Chair: Pēteris Trapencieris

E-mail: chem@lza.lv; Tel.: +371 29158550

The Division unites scientists from the fields of biology, chemistry, and medical sciences. The Division resumes the new developments in natural sciences in Latvia and discusses the problems in those areas. The Division organises regular interdisciplinary seminars, public lectures and discussions on topical issues in science.

The Division has a close cooperation with the main universities and with the scientific institutions in all fields of chemical, biological, and medical sciences in Latvia.

Division of the Humanities and Social Sciences

Chair: Guntis Zemītis

E-mail: humana@lza.lv, Tel. +371 26416884

The Division of the Humanities and Social Sciences brings together scientists of the highest rank and acclaimed arts and cultural personalities representing a vast number of science sectors: anthropology, archaeology, architecture, art, art history, art theory, bibliography, culture history, demography, economics, ethnology, folkloristics, history, history of science, journalistics, law, linguistics, literature and literature theory, philosophy, pedagogy, political science, psychology, sociology, theology.

Department of International Relations

Head: Ilze Trapenciere

E-mail: int@lza.lv; +371 67227391

The Latvian Academy of Sciences is represented in international academy organisations – All European Academies (ALLEA), Interacademy partnership (IAP), International Science Council (ISC), participates in the

activities of the European Academies' Science Advisory Council (EASAC). The LAS participates in the activities of the Scientific Advice for Policy by European Academies (SAPEA), i.e. workshops and conferences on cooperation between academies.

The LAS has around 30 bilateral agreements with national academies in Europe, Asia, and America, and has almost 20 agreements on bilateral mobility and cooperation projects.

The LAS organises and participates in bi-annual conferences of Baltic intellectual cooperation (BICC). The Academy participates in the UNESCO and L'Oreal Scholarship Award (since 2005), organises and leads the expertise to evaluate the applications; evaluates nominations and organises the Walther Zapp Award (since 2004) for the best inventions in Latvia together with the Patent Council, Republic of Latvia, and Minox GmbH.

ORGANISATIONS IN ASSOCIATION WITH THE LATVIAN ACADEMY OF SCIENCES

Institute of Economics, Latvian Academy of Sciences (IE LAS)

Director: Nina Linde

E-mail: nina.linde@lza.lv, Tel.: +371 29188707

The main activities of the IE (founded in 1946) are focused on academic and applied socio-economic and other types of research; development and implementation of projects in the field of technology, economy and entrepreneurship development. The mission of the Institute is to study the prospects for the development of regional and national economies, provide research-based expert assessments and analysis on current economic and social development processes in Latvia, the Baltic states and Europe, as well as recommendations for economic and social development in the long term. Webpages: www.eilza.lv, www.eilza.lv, www.economicforum.lv

European Institute for Policy Studies (EIPS)

Director: Zane Zeibote

E-mail: eppi@lza.lv , Tel. +371 29417214

EIPS (established in 2018) develops and implements research projects and programmes, ensures the quality and involvement of scientists in cross-disciplinary research and co-operation in European policies. The functioning of the EIPS is aimed at providing researchers and other stakeholders with the opportuni-

ty to acquire knowledge of the interdisciplinary challenges of European integration, the implementation of topical research and projects for the development of the society, particularly in the context of economic, legal, political and sociological aspects, with a view to promote the visibility of the Latvian Academy of Sciences in the international scientific environment.

State Scientific Qualification Committee

The LAS coordinates the work of the State Scientific Qualification Committee. The State Scientific Qualification Committee reviews doctoral thesis, submitted by the candidates and approved by promotion councils of the universities, by appointing relevant experts.

Council of the State Scientists Emeritus

Chair: Īzaks Rašals (Isaak Rashal)

E-mail: Izaks.Rasals@lu.lv, Tel. +371 29516935

The LAS coordinates the Council of the State Scientists Emeritus. The Council of the State Scientists Emeritus is a collegial institution deciding on the annual quotas for the state scientists emeritus, making a selection of candidates to whom the status of the state scientist emeritus is to be granted.

Terminology Commission, Latvian Academy of Sciences

Chair: Māris Baltiņš E-mail: tk@lza.lv

The Terminology Commission deals with the development, approval, and harmonisation of terms. Although the work on the development of national terminology was started in Latvia already in 1919 when the Terminology Commission for the Ministry of Education (which operated until 1921) was established, the current Commission was born simultaneously with the Latvian Academy of Sciences, when it gathered for its first meeting on 2 September 1946. Since then, the Terminology Commission has held more than a thousand meetings, organised working groups, and prepared many terminological resources (such as dictionaries and bulletins), and its subcommissions have arranged several thousands of their own meetings. Website hhttps://termini.gov.lv/

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LATVIAN ACADEMY OF SCIENCES - 75

Each country has certain symbols of national pride and national independence, such as the parliament and government, university, opera, national theatre, and national library, and an academy of sciences. Latvia is proud to have all of these attributes of an independent state. The Latvian Academy of Sciences (LAS) celebrates its 75th anniversary this year.

In 1945, the USSR government authorised creation of the Academy of Sciences of the Latvian SSR as a formally independent academy of sciences, whose activities would be coordinated by the USSR Academy of Sciences. In 1946, the Latvian SSR Academy of Sciences was founded by a decision of the Council of People's Commissars of the Latvian SSR. The Academy was constituted to comprise both individual members and scientific research institutes. The research topics were dictated by post-war needs to renew the national economy, i.e. energy, animal husbandry, forestry, health protection, use of natural resources. Within the USSR, the science in Latvia saw rapid growth; new scientific research directions appeared – magnetohydrodynamics, solid-state physics, nuclear physics, chemistry of medicine and heterocyclic compounds, wood chemistry, mechanics of composite materials, etc. Latvian scientists were obliged to involve in the fulfilment of orders by military industrial entities, given that financing for these studies was the most generous. In some science sectors (e.g., pharmacy, biotechnology) the Academy of Sciences was able to implement a full-cycle of innovations from scientific concepts to actual production of goods. The prestige of the exact and life sciences, and that of the Academy of Sciences, was very high in Latvia. In the area of humanities and social sciences those research directions flourished that were unrelated to the prevailing ideology - archaeology, ethnology, linguistics, literary science. Other directions encountered difficulties, with many topics proscribed.

With the collapse of the USSR, the situation for science in Latvian changed. The ruling elite tended to copy the system prevalent among the academies of sciences in the European Union, and a new concept of the LAS was adopted – the academy as a body of individuals, elite researchers. As the role of the LAS changed, a disruptive blow was made to science and innovation in Latvia, since the infrastructure for innovation was liquidated.

In November 2020, the LAS General Assembly voted for a new strategy for the LAS, which envisages establishing design offices, scientific and technological information processing centres, artificial intelligence centres, testing laboratories, prototyping and analytical laboratories under the auspices of the LAS. The LAS should become the focus in the creation of a Latvian Silicon Valley, transforming itself into a platform where Latvian scientists meet entrepreneurs and assist them in the innovation process. The LAS plans to make the LAS high-rise building a centre for science, research and innovation by adapting the use of the historic building (1951–1961, architects O. Tīlmanis, K. Plūksne, V. Apsītis) to a new mission. The strategy envisages development of LAS capacities so that it becomes the main centre for popularisation of scientific achievements in Latvia, making extensive use of the possibilities of digital technologies. A New or Future Academy is being established as a bridge leading the youngest talented scientists to a world-renowned scientific forum, such as the LAS.

The LAS continues to discharge its principal function – strengthening its capacities in the role of providing scientific expertise and representation of the interests of national scientific entities. This will ensure balanced decision-making in the legislative and executive branches. The new management team of the LAS looks to the future with optimism and great expectations. 75 years of experience demonstrate that the Latvian Academy of Sciences, together with Latvian scientists, is able to overcome difficulties and meet challenges. Our strength is knowledge and unity!

Ivars Kalvinš

President of the Latvian Academy of Sciences

