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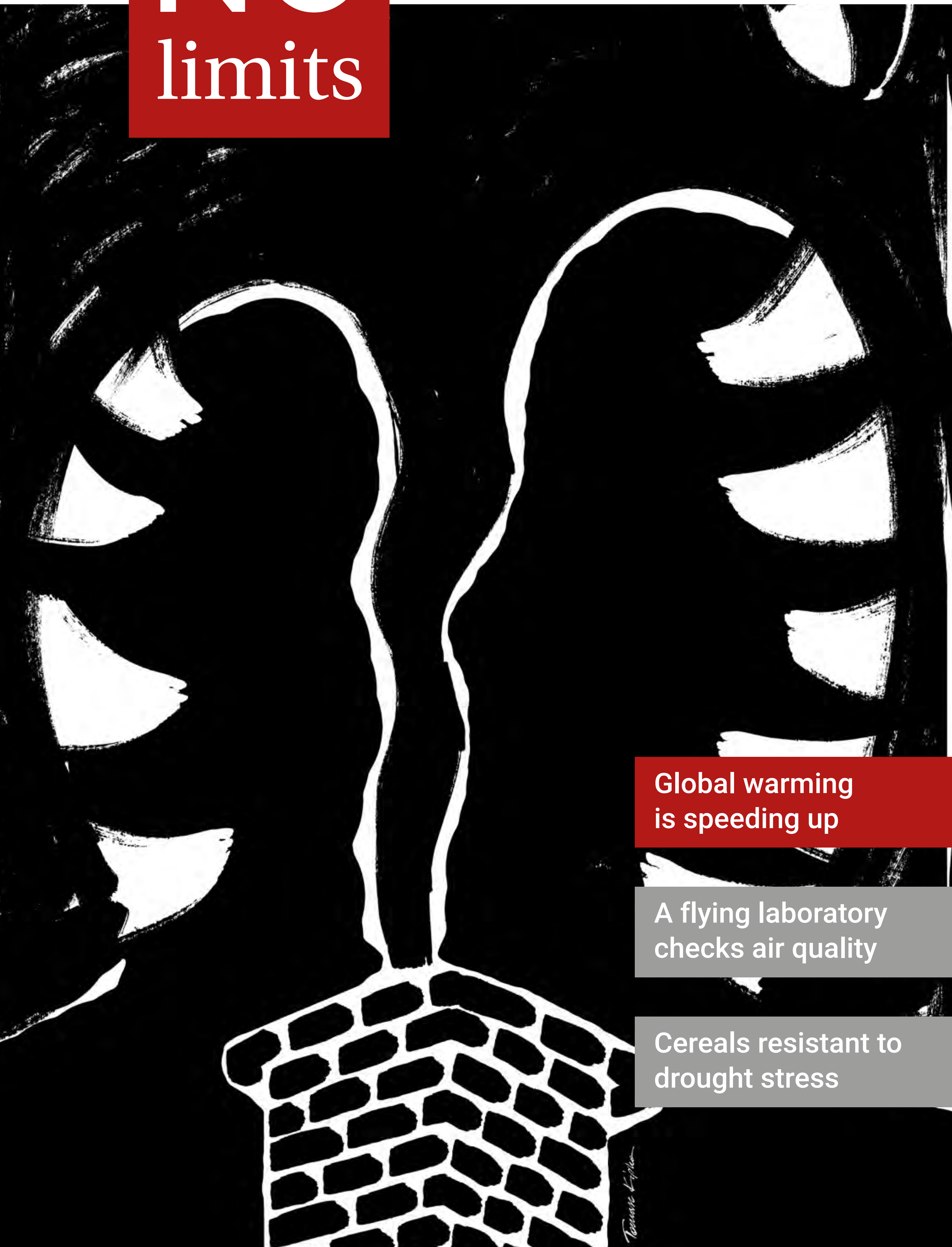
UNIVERSITY OF SILESIA
IN KATOWICE



Global warming is speeding up

A flying laboratory checks air quality

Cereals resistant to drought stress

THIS ISSUE'S THEMES

IN THIS ISSUE AS WELL

DEAR READERS!

The scientists at the University of Silesia in Katowice, including our students and postgraduates, lead and manage numerous research projects which focus on topics pertaining to e.g. climate change, biotechnology, environmental protection and water management, information technologies, nanotechnology, new materials and technologies, energy sources, cultural change, art, and the national heritage as well as legal, social, and educational issues. Many of them put a strong emphasis on innovation and practical application. Our scientists participate in the search for solutions with regard to problems considered as priorities for the development of civilization in Poland and all around the world. Their research contributes to the fight against poverty and hunger, enhances the quality of people's lives, builds the society of the future, and supports environmentally-friendly activities.

We present you with the first issue of our new popular science magazine which provides more detailed information on the scientific work and research conducted at the University of Silesia. We hope that this type of medium will enable us to show to a wider audience, and not only to those who are professionally involved in science, what kind of work we perform in our laboratories (and outside). I wish you a pleasant reading!

Prof. Andrzej Kowalczyk
Rector of the University of Silesia in Katowice, Poland

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Editor-in-Chief:
Agnieszka Sikora

Editorial Secretary:
Tomasz Płosa

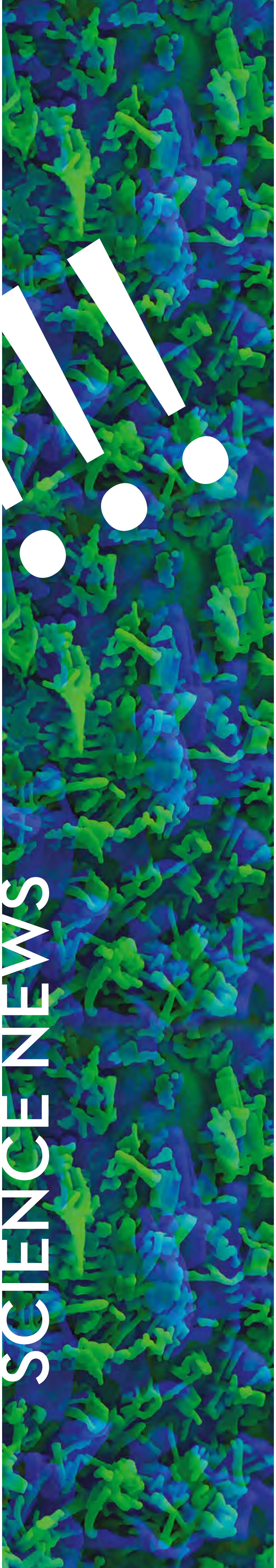
Text Authors:
Małgorzata Kłoskowicz, Jakub Morawiec, Maria Sztuka, Agnieszka Sikora

Cooperation:
Martyna Fołta

Proofreading:
Katarzyna Wyrwas

Translator of the English version:
Mikołaj Iwanicki

Graphic design, preparation for print:
Patrycja Warzeszka



MEMBRANES BASED ON NANOMATERIALS

Scientists associated with the Institute of Chemistry at the University of Silesia have developed a method to create special membranes from graphene oxide (or its derivatives) and cellulose. Due to the high graphene oxide content (in relation to the membrane's cellulose) and increased absorptive capacities, these membranes can remove residual amounts of heavy metals (e.g. cadmium, lead, or cobalt) from water solutions and, with the use of spectroscopic methods, mark the ions of these metals contaminating, among others, water and soil.

Previous solutions made use of graphene but displayed significantly smaller absorptive capacities with regard to heavy metal ions. Moreover, toxic compounds were used in their production process. Thanks to the new solution, the manufacturing of membranes from graphene oxide or its derivatives and cellulose will become easier, quicker, and cheaper. Most importantly, however, this will permit to produce homogeneous materials with good adsorptive qualities, retreated multiple times, durable and stable in acidic, neutral, and, what has previously been rare, basic environments. These qualities permit to use them in more diverse ways, e.g. in analytical chemistry – in spectroscopic techniques; in order to mark or concentrate even residual amounts of heavy metal ions.

NEW SUBSTANCES IN THE FIGHT AGAINST ALZHEIMER'S DISEASE

A group of scientists including chemists from the University of Silesia developed two new carbamate derivatives which can be used in pharmaceutic drugs designed to alleviate the symptoms of Alzheimer's disease.

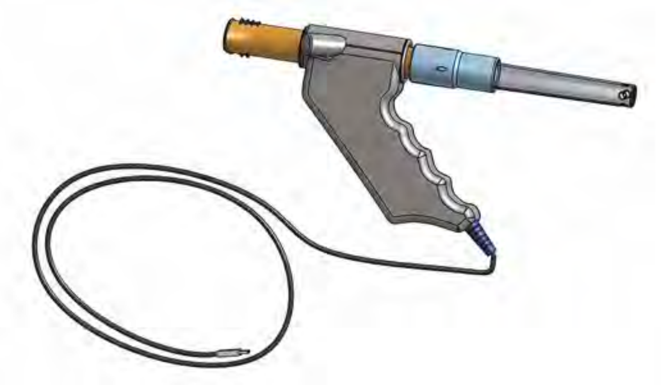
In patients' brains, proteins (betaamyloids) are deposited and form so-called senile plaques. The deposits grow and cause neurons and synapses of the cerebral cortex to gradually disappear, which in turn reduces the person's intellectual capacities. In the currently used drugs, which merely alleviate the symptoms, enzymes responsible for the breakdown of acetylcholine are predominantly used. Due to the blocking of this process, the neurotransmitter's level in the patient's brain rises, and this compensates for its decreased concentration caused by the death of cholinergic neurons. Carbamates belong to the group of substances responsible for blocking their breakdown.

By modifying their structure, a selective or non-selective substance interacting with certain enzymes can be obtained. Depending on the stadium of Alzheimer's disease, the concentration of enzymes responsible for the breakdown of acetylcholine changes. In early and middle phases of the disease only three substances are used, however, they show low bioavailability, poorly pass the blood-brain barrier, and can cause numerous adverse effects. Moreover, on the drug market, there is demand for substances which will regulate the breakdown of acetylcholine in more advanced stadiums of the disease.

The new carbamate derivatives were obtained by scientists from Poland, the Czech Republic, and Slovakia. The end goal is to study these compounds as active substances designed to alleviate symptoms of Alzheimer's disease by means of interacting with enzymes responsible for regulating the breakdown of acetylcholine in early and advanced stadiums of this condition.

BREATH-BASED DIAGNOSTICS

The importance of breath testing in the diagnostic of numerous diseases, such as bacterial infections, allergies, respiratory insufficiency, liver failure, or even tumor-related changes, is becoming increasingly important in research. Such analyses are patient-friendly, non-invasive, secure, and do not cause adverse effects.



Scientists from the University of Silesia, the Jerzy Kukuczka Physical Education Academy, and the Medical University of Silesia developed a special device for diagnosing squamous cell carcinoma of the upper respiratory tract and pulmonary hypertension by means of a breath test. The device, which collects and stores gas phases, was granted protection for the industrial design in the European Union.

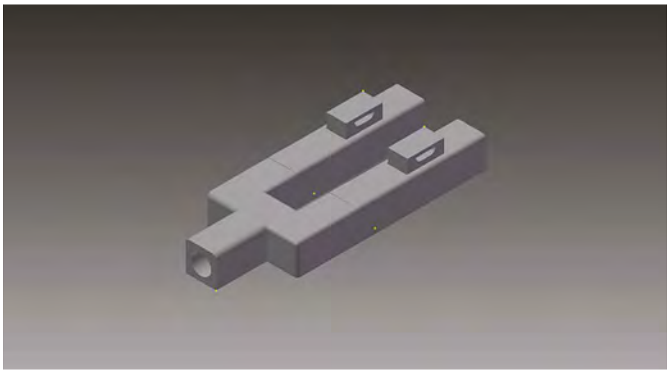
In a human breath sample, there are up to several hundred volatile compounds, and their analysis permits to identify e.g. cancer markers. The device consists of a short tube where porous carbon is placed. The carbon adsorbs markers which are of interest to the diagnostician. Subsequently, the carbon itself is placed in the analyzing device where further tests are performed and permit to differentiate between various compounds. The device also features an exchangeable mouthpiece which can be repeatedly used (after being sterilized each time).

– Thanks to our mouthpiece, it will be possible to perform e.g. screening tests for asthma in schools. It is sufficient to carry out breath tests by means of our newly designed device, and the laboratory diagnostician will be able to quickly and effectively provide diagnoses for a large group of people on the basis of the collected material, explains Dr. Andrzej Swinarew, Materials Engineer at the University of Silesia and co-author of the device. – We will get to know how many children can contact bronchial asthma in the future, and this will provide opportunities for specific actions and enable us to introduce therapeutic measures in early stages of the disease when it is fully curable. This also applies to cancer markers. The earlier an illness is diagnosed, the greater the chances for curing it.

A MOUTHPIECE WHICH WILL HELP TO DIAGNOSE E.G. LUNG CANCER

Scientists from the Faculty of Science and Technology at the University of Silesia developed a special mouthpiece which can be applied in diagnostics of upper and lower respiratory tract diseases, including lung and laryngeal cancer as well as bronchial diseases.

The growing importance of early cancer diagnostics leads scientists to look for new ways to quickly recognize disease symptoms. Modern, non-invasive analyses of the chemical composition of exhaled air are used with increased frequency. Due to analytical chemistry tests, a relationship between certain types of proteins and lung or laryngeal cancer can be identified and determined. Cancer markers are collected by means of so-called Tedlar bags into which the exhaled air containing proteins is blown in. The downsides of this solution are a small amount of air, low concentration in the samples, and the risk of damage in transport. Therefore, the scientists decided to replace the bags with porous polymer materials featuring a complex inner structure and to use special mouthpieces.



The patented two-corner mouthpiece can be produced from modified polyester by means of 3D printing. It has antibacterial properties, is reusable (after being sterilized each time), and will meet all requirements to be approved for medical application. Moreover, it will be possible to filter the inhaled air and to direct it to the porous material, a process which will reduce the contamination of the sample and make it possible to target more cancer markers in a single test.

text: Dr. Małgorzata Kłoskowicz

Rescuing

the Most Valuable Relics of Medieval Libraries

When we take books in our hands that were published a couple of years ago, loose pages which once were glued to the spine fall out, and the print on the crinkled pages has become faint and illegible, it is hard to believe that some printed books have survived more than half thousand years. And yet it turns out that approximately 6 million of such works have managed to withstand the turmoil of war, climate catastrophes, or numerous relocations. Incunables (prints from 1455 to 1500) and old prints (in Poland from 1501 to 1800) are extremely precious treasures; vigilantly protected testimonies of our common cultural heritage.

Photo. Agnieszka Biały

A team of scientists lead by Prof. Leonard Ogierman from the Faculty of Humanities at the University of Silesia has worked since over a dozen of years in order to bring back to life medieval book treasures.
– In the past, the preservation of books was the effect of trial and error of the person who decided to perform the task, says Professor Ogierman. – Nowadays, conservationists use a broad range of analyses and measuring instruments.
The first step is the diagnosis i.e. a careful examination of the paper, parchment, and the skin with which the book was bound. Moreover, the glue, the printing paint, and the pigment are carefully looked at. Interdisciplinary knowledge is the prerequisite for such an analysis.
Physical chemistry, materials science, microbiology, virology, etymology, mycology as well as history, including the history of art – this is only a selection of scientific disciplines necessary for a conservator's work.
Professor Ogierman is an analytical chemist and microbiologist who possesses extensive knowledge of conservation materials science, the kinetics and the mechanism of the aging process of materials of natural origin, including antique books. The work results of Professor Ogierman's team can be admired, among others, in the invaluable libraries of the Pauline Fathers at the Jasna Góra Monastery and the Skałka Monastery. In the monastic archives in Cracow (Kraków), the scientists were able to restore 4,279 volumes and 680 antique wooden cases of library books, performed conservation works on four priceless incunables: *Rationale divinorum ofiiciorum* by Guillelmus Durant; *Summa theologica* by Antoninus Florentius printed in 1485 in Basel, Switzerland, at Michael Wenssler's publishing house; *Decretales...* of Gregory IX published in 1511 in Paris, France, at Thielmann Kerrver's publishing house; *Missale Romanum* printed in Venice, Italy, at Lucantonio Giunta's publishing house.
The renovation of the incunables took six months, and the most difficult step was the rinsing of the old glue, since after a few baths the pages look like delicate blotting pa-

per which can very easily be damaged. Mistakes would have been irreversible. It is therefore often the case that a conservator's work requires the patience of a Benedictine monk and the precision of a watchmaker.

For the purposes of cleaning and conservation, the scientists use, among others, electric erasers, and the disinfection (destruction of fungi and bacteria) is performed in a fumigation chamber by means of concentrated ethylene oxide. Due to the properties of handmade paper, which was used in medieval times, and because of the fact that they have been kept in cases, old prints have managed to withstand the jaws of time quite well. Much younger prints from the end of the 19th and the beginning of the 20th centuries, when so-called acid paper came in use, have to cope with enormous problems, despite the fact that they are slightly more than 100 years old. It is very unlikely for them to live as long as incunables.

In 2008, Professor Ogierman's team performed conservation works on a copy of the oldest Polish printed Bible, the so-called *Biblia Leopolity (Leopolita's Bible)* from 1577. The old print was kept in the Special Collections Laboratory of the Library of the University of Silesia, since the degree of damages did not permit its exhibition or even digitalization. Due to the fragmented spine, loose pages with numerous losses, torn seams, soiling, and traces of incompetent repair work, this highly valuable book was doomed to be forgotten. The specialists, however, were able to bring the old print back from a state of nonexistence. Each of the 600 pages of the Biblia Leopolity underwent conservation work. After a water bath, which permitted to remove the old glue, soiling, and traces of previous repair work, the scientists added the missing paper mass and glued the torn fragments together. After additional gluing and ironing, the pages were transferred to a bookbinder.

Palpable results of work performed by the conservators from the University of Silesia are also present in Lviv, Ukraine, where a group of researchers (in partnership with the Ivan Franko National University of Lviv and the Department of Culture at the Ukrainian Ministry of Education and Science) carried out research projects in the collections of the Library of the Wiktor Baworowski Foundation. During several years of work, the 16th century prints were sorted out from the collection, processed in a complex fashion, rated with regard to their state of preservation, and subsequently the catalog was designed.

Professor Ogierman's team faces enormous challenges. In August 2019, an agreement between the Order of Saint Paul and the University of Silesia was signed. It regulates issues regarding the processing of old prints, their preservation, also in electronic form, and providing access to the research results in form of a printed catalog (in electronic form as well). In the collection of the Jasna Góra Library, 274 incunables were identified. The majority of them originate from German typography centers and from Venice, Italy. At first, the incunables will be processed and digitalized; subsequently, all of the more than 2,500 prints from the 15th and 16th centuries are to follow.

Professor Ogierman held every one of the 13,000 books from the collection at Jasna Góra in his hands; he touched several hundred incunables, is able to correctly identify prints by at least 10 printing persons, and yet, as every true book lover, has to admit the following:

– Every meeting with those who created the book, read it, and held it in their hands, is a profound and unforgettable experience for me.

The durability of computer print is disputable. According to specialists, contemporary books have the chance to survive no longer than 150 years.

text: Maria Sztuka

Prof. Leonard Ogierman
University of Silesia, Faculty of Humanities
leonard.ogierman@us.edu.pl

Leopolita's Bible – left: state before the conservation, right: state after the conservation / Photo. Marzena Smyłła

THE HOLY

Viking

The Viking epoch was an important time in Europe's history, especially with regard to Scandinavia. A number of new phenomena, such as the centralization of power, far-reaching trade, and Christianization, contributed to significant political, cultural, and social changes in the entire Scandinavian region. They would not have happened if it had not been for the activities of numerous distinguished and charismatic persons. It is not surprising that the vast majority of them belonged to political and economic elites who could afford an unceasing and uncompromising rivalry for power due to having recourse to extensive military and financial means. Olaf Haraldsson, the Norwegian Viking, monarch, and saint, is a very good example in this context.

OLAF'S VIKING CAREER

Information regarding Olaf's early life remains unclear and has been severely distorted in the later hagiographic tradition. It is assumed that he was born around 995 and spent at least a part of his young life in Ruthenia. In then-contemporary accounts, Olaf is first mentioned at the point when he dwelt in England. There, he joined the infamous army of Thorkell the Tall which could not be vanquished and harried the country in the years 1009–1012. Similarly as Thorkell, Olaf made peace with Æthelred, King of the English, accompanied the latter in his exile to Normandy, and offered support when he was regaining power in his kingdom in 1014.

At that time, Olaf managed to demonstrate his prowess and efficacy as a leader, since he raided various parts of contemporary France and Spain. Moreover, Olaf gained his first political experiences in these years as well. This part of his life was marked by the most significant and far-reaching event, that is, his conversion to Christianity, which most probably took place at the Duke's court in Rouen, contemporary France, in 1014. At that time, the jarl of Norway (jarl – the Scandinavian equivalent of the English earl) Eric of Hlathir (Eiríkr Hákonarson) participated in Cnut the Great's conquest of England, and Olaf used this opportunity for an attempt to seize power in his homeland.

OLAF AS THE KING OF NORWAY

Olaf did not have enough determination, talent, or military and financial means to take over power from the hands of the Hlathir jarls, the main pretenders to the Norwegian throne. His status as a sovereign was mainly respected in the Southern and Eastern parts of the country. The powerful people from the West (above all the mighty jarl Erling Skjalgsson) remained neutral with regard to the new ruler or even showed hostility towards him. Olaf's attempts to make them subordinate contributed to his eventual fall. The new King decided to use the Christian doctrine as the basis for his rule. An interesting fact is that while former accounts regarding Olaf's reign focus on his missionary attempts, contemporary sources provide very little information on this issue. However, historians have little doubt that Olaf tried to introduce a new law in Norway, which was based on the principles of the Christian faith, and brought members of the clergy to the country. What is more, the ideological background accompanying his reign contained references to the concept of a just ruler (rex iustus) who introduces new laws and defends the subjects against all who break the law and stand up against the legitimate sovereign.

Olaf tried to strengthen his position in the region. Subsequently, he joined forces with the King of Sweden and attacked Denmark in 1026, however, Cnut not only managed to defend the country but also challenged the attackers in a naval battle which took place at the mouth of the Holy River in Southern Scania. From that moment on, Cnut became aware that the only way to maintain long-term supremacy in the region and power over his vast territory was to eliminate Olaf. In 1028, the King of England and Denmark left with a strong fleet for Norway and was supported by the local elites who still opposed Olaf. The latter one was well aware of the enemy's superiority and found refuge in Ruthenia. He was accompanied by his son Magnus, who was almost five years old at that time. In 1030, Olaf gained knowledge about the disappearance of Hakon of Hlathir on the North Sea and decided to attempt to regain power in Norway. He reached his homeland the same year but had to face the local elites, who were financially supported by Cnut the Great. On 29th July, both sides faced each other at the Battle of Stiklestad. Olof was killed in combat, and Norway found itself again under Danish rule.

St. Olav's statue in a cathedral in Uppsala, Sweden / Photo. Jakub Morawiec

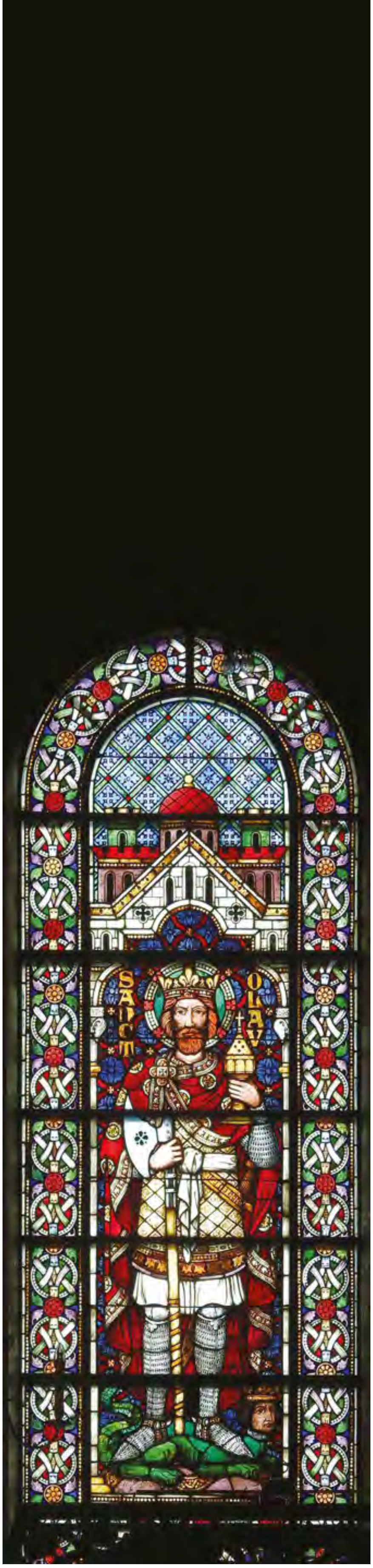
SAINT OLAF – THE DEVELOPMENT OF HIS WORSHIP

In spite of what was traditionally claimed, it is almost certain that the worship of St. Olaf had been initially either stimulated or adopted by the Danish rulers of Norway. After the Battle of Stiklestad, Cnut chose to give the Norwegian throne to his juvenile son, Swen, who was accompanied by his mother and a group of experienced advisors. In order to strengthen Swen's positions, they decided to present the young ruler as a spiritual successor of the late King who already at that time was becoming increasingly popular as a martyr and saint. This idea was not particularly original, as similar cases can be found in the history of tenth century Bohemia and England. However, it was of little avail to Swen. Around 1035, he and his mother were forced to flee the country.

The Norwegian elites decided to pass the throne on to Olaf's son Magnus, who had hitherto lived in Ruthenia. The new ruler based his reign entirely on his father's worship. Olaf, who had become Rex Perpetuus Norvegiae (Norway's Eternal King), was to be an exemplary Christian monarch for his son and the Norwegian people. Olaf quickly became the most popular and eminent saint of all Scandinavia. In 1053, Pope Eugene III decided to set up a new archdiocese in Nidaros (Trondheim) with St. Olaf as its patron. This fact significantly contributed to the emergence and development of writings dedicated to Olaf, including a few sagas and accounts regarding his miracles and martyrdom. Olaf was pronounced the entire kingdom's patron saint. Whoever wanted to legally rule as a King of Norway had to recognize this saint's unique status. Olaf's symbol, an axe held by a lion, which is also the symbol of royal power, has been a part of Norway's coat of arms until today.

text: Assoc. Prof. Jakub Morawiec

Assoc. Prof. Jakub Morawiec
Institute of History
University of Silesia, Faculty of Humanities
jakub.morawiec@us.edu.pl



St. Olav's portrayal on a stained-glass window of a church in Ålesund, Norway / Photo. public domain

TRACKING THE FORGERS OF PAINTING SIGNATURES

Studies of handwriting belong to the oldest crime-related fields of study. Documents such as testaments or letters containing threats are most frequently dealt with in specialists' opinions. Painting signatures are an interesting example of handmade signs which permit to identify their authors. Although evaluating the authenticity of art requires computer analyses of style and material, the efficacy of the process can be further enhanced by using various graphologic methods to study graphisms featured on the given work.

Hans van Meegeren was one of the most famous forgers of paintings from the 20th century. Works created by him, mainly sold as paintings by Jan Vermeer, were so brilliantly painted that experts could not recognize them as falsifications. One of the works found its way (illegally) into the collection of Hermann Göring. When it was spotted by the allies, the inquiry brought them to Hans van Meegeren. The latter, being accused of collaboration with the Nazis, admitted that he was responsible for the forgery. In order to determine whether he was telling the truth, a special committee was appointed, led by Paul Coremans, the director of the chemical laboratory at the Royal Museum of Fine Arts in Brussels. Among others, the two following chemists were invited to participate in the project: Wiebo Froentjes, employed at the Danish Ministry of Justice, and Martin de Wild, a scientist specializing in microscopic analyses of paintings and in the use of X-rays for creating expert opinions.

Hans van Meegeren's career as a forger brought him fame, and his later paintings, bearing the authors actual signature, were popular and expensive. Unsurprisingly, some brave people attempted to create forgeries of Meegeren's works, who presumably was the best-known forgers of the 20th century. This is illustrated, among others, by the collection of Hans van Meegeren's genuine and counterfeit painting signatures compiled by his biographer Frederik H. Kreuger.

The authenticity of works of art can thus be studied in a calm expert's office, where historians of art perform their stylistic analyses, as well as in laboratories in which specialist opinions are drawn up on the basis of physical and chemical analyses of the object. The study of graphisms, e.g. notes on drawings or painting signatures, is an interesting aspect of assessing the authenticity of a work of art. Due to the fact that a methodology for compiling specialist opinions regarding signatures has not yet been devised, current studies are based on a modified graphological approach known from criminalistics. These studies are performed by Prof. Tadeusz Widła, criminologist at the University of Silesia.

A signature, a word of Latin origin, indicates a sign left by the author on a given

Illusory signatures evoke the impression of being an element of the painting / Photo. Tadeusz Widła archive

Not all painters consistently use slanted handwriting. As an example, Claude Monet can be named, whose handwriting was interchangeably tilted to the left and to the right / Photo. Tadeusz Widła archive

work of art. It can take the form of a monogram, a geometrical figure, or even an animal or plant form. Most generally speaking, a signature is a sign which permits to identify the work's author.

When artists decide to sign their work, they most frequently use their first name and surname, written in full, initials, an abbreviation of their name, only the name or surname, or a pseudonym. Monograms, that is one or more letters somehow connected with each other, are also resorted to. Moreover, it is common that some artists sign their works in more than one way, and this circumstance has also to be taken into account when an expert's opinion on signatures is compiled. Another important element are dates, which might refer to the depicted event or to the completion of the work of art. They are also legally protected and cannot be modified. Other used graphisms are the work's title, data concerning the depicted persons, or dedications. Sometimes, descriptions of the circumstances associated with the painting process can also be encountered.

The richness and diversity of painting signatures provides interesting material for graphological studies which belong to the oldest disciplines regarded as a part of criminalistics.

– In order to determine the authenticity of a work of art, extensive analyses are required. If we want to obtain a result backed by the authority of science, we additionally have to perform material testing. For the purpose of analyses performed in our laboratory, we resort to methods developed by graphologists, says Prof. Widła. The expert opinions are predominantly compiled for judiciary authorities, antique dealers, or museums, but sometimes we are contacted by private collectors who have doubts concerning the authenticity of the works of art in their possession.

– Among others, we studied works allegedly painted by three famous artists of the Kossak family e.g. grandfather Juliusz, father Wojciech, and son Jerzy. It was discovered that all three signatures had been forged by the same person, the expert adds.

A painting which is to be analyzed should be regarded as a document whose authenticity is questioned. A graphical-comparative approach has turned out to be the most effective in this context. The description of characteristics used to determine the author's writing habits is one aspect to be taken into account. Among others, experts pay attention to the position of letters, spaces between them, proportions of signs, or the tilt of the handwriting axis. However, the writing habit itself is a key factor. When a person's signature is being forged, the forger is struggling with own habits, and this becomes apparent on the paper or on the canvas. A study's success also depends on the quality of the material which is at the experts' disposal. In 40 years of research, Prof. Widła has collected photographs of more than 10,000 painting signatures, a fact which provides an excellent basis for empirical research.

In this ample collection, there are, among others, photographs of Titian's genuine and forged signatures, who belongs to the favorite artists of Prof. Widła.

– Once it happened that somebody bought a genuine work of art but decided to put an additional signature on it to prove its authenticity beyond doubt, says the scientist.

As this situation illustrates, studies of the authenticity of painting signatures are not only a passionate search for the true origin of the respective work, but can also reveal very strange stories pertaining to it.

text: Dr. Małgorzata Kłoskowicz

Prof. Tadeusz Widła
University of Silesia, Faculty of Law and Administration
tadeusz.widla@us.edu.pl

Marc Chagall, signatures on painting / Photo. Tadeusz Widła archive

text: Maria Sztuka

A FLYING LABORATORY

CHECKS AIR QUALITY

In 1952, the Great Smog of London caused approx. 4,000 deaths within a week, and in the subsequent weeks, 8,000 more people died. The accumulation of several factors led to this ecological catastrophe. An increased use of lower quality coal for heating flats caused thick fog and lower temperatures. Subsequently, temperature inversion blocked the vertical mixing of air in the atmosphere. It took the wind 5 days to disperse the deadly cloud of gases and dust emitted by heating stoves, power plants, factories, and vehicle exhaust fumes. 67 years have passed since these dramatic events, and smog has remained a crucial threat to humanity. According to data provided by the European Environment Agency, 46,000 people die due to smog per year. Of the 50 most polluted cities in the European Union, 36 are located in Poland. Scientists from all over the world join the comprehensive fight against smog-related threats.

Start of the University balloon / Photo. Agnieszka Szymala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The obtained results permit to assess the impact of the pollution on the environment and on the inhabitants' health, and thanks to collaborations with physicists, mathematicians, and computer scientists, this phenomenon can be modeled / Photo. UŚ TV

From the beginning, scientists from the University of Silesia employed at the Institute of Earth Sciences at the Faculty of Natural Sciences have researched environmental pollution. It is therefore not surprising that, since 2016, they use the first and nationwide only aerial laboratory in the basket of a manned hot-air balloon. The balloon takes the University Laboratories for Atmosphere Control (ULAC) to a height of 4 kilometers. It flies in circles above the cities of the Silesia agglomeration and collects comprehensive data regarding the quality of the air which its inhabitants breathe. This project features participants from numerous disciplines: meteorologists, climatologists, mineralogists, biologists, physicists, chemists, hydrologists. The work of the team is coordinated by Assoc. Prof. Mariola Jabłońska, a geochemist, mineralogist, and environmental protection specialist.

The balloon permits not only to analyze air quality, but also helps to identify sources of pollution and to detect in which directions they spread. Due to the fact that the balloon does not have an engine, its horizontal movement corresponds to the natural movement of the air, and this creates the unique opportunity to collect samples in areas of the atmosphere which have not been interfered with by mechanical devices.

Although drones have already been employed to assess the quality of air, their capabilities are very limited, especially in comparison to the balloon, which is able to lift a weight of 1,200 kg. The crew (4 people and a pilot), gas cylinders, and the basket constitute the most substantial load, and specialist equipment makes up the remainder. Therefore, using this balloon with a capacity of 3400 m^3, a full-fledged laboratory is able to embark on a trip. One of its most important elements is a nanoparticle analyzer (from 10 to 300 nanometers) equipped with an additional device which enables the scientists to collect nanoparticle samples to be analyzed by means of transmission electron microscopy. Subsequently, their contents and sizes are studied in laboratories on the ground. Another device is a dust analyzer which is able to determine the concentration of microparticles in a range from 0.3 to 10 micrometers and provides information regarding the percentage of e.g. respirable dusts which penetrate the respiratory system. What is the importance of this research for the inhabitants of the surrounding areas?

– Both nanoparticles and microparticles of less then 0.5 micrometers, that is, 500 nanometers, behave like gases. This means that they directly reach the bloodstream and constitute an enormous threat, since they enter our bodies as we breathe, the scientist explains.

The balloon also carries aspirators used to draw in air onto special dust filters which are subsequently analyzed under electron scanning microscopes in order to determine their type and size.

Biologists use their own equipment, that is, devices used to collect plant pollen and fungus spores as well as a device which collects microbiological samples. The containers are filled with fluids which permit to securely collect bacteria so that they are not killed in transport. Later, they are forwarded to a laboratory where scientists grow them and study them under the microscope. A team of geochemists specializing in organic matter identify harmful compounds and determine their origin. Chemists place a high-flow aspirator (2.5 m^3 per minute) in the balloon. Its filters permit to determine the chemical composition of the collected dust. Another newly acquired analyzer is used to study the concentration of gases: nitric oxide and dioxide, sulfur dioxide, ammonia, ozone, and benzene. In the nearest future, an analyzer permitting to determine the concentration of volatile organic compounds and carbon dioxide, the last missing gas measurement device, will be included as well.

A weather station is another indispensable element of the balloon's equipment, since it collects information regarding temperature, humidity, and atmospheric pressure. Devices which register the direction and speed of the wind belong to the aircraft's standard equipment. In order to avoid contamination from the burner, all devices are placed under the balloon basket.

The data collected during the flight, which lasts from 1 to 3 hours, permit to gather extensive information. The analyses are performed in cycles every 4 seconds, and, according to the project's coordinator, this guarantees a very precise detection time. Due to the fact that the GPS remembers the route and height of the flight, geographers compile a precise map which shows where pollution occurs, determine its sources, and identify situations which favor its accumulation. This knowledge will be passed on to medical doctors, city administrators, and the municipalities.

The fight against smog demands a full mobilization of all scientists. In the balloon, there is still much space left, and the flying laboratory is open to innovative ideas.

Assoc. Prof. Mariola Jabłońska
Faculty of Natural Sciences
at the University of Silesia
Institute of Earth Sciences
mariola.jablonska@us.edu.pl

Katowice, seen from the balloon basket (March 2017) / Photo. UŚ TV

Smog over Silesia (October 2019) / Photo. Mariola Jabłońska

text: Maria Sztuka

GLOBAL WARMING IS SPEEDING UP

On 18th August 2019, when Europe was being scorched by a record heat wave, in Iceland, in the vicinity of Reykjavík, a symbolic "burial" of the Ok Glacier (Okjökull) took place. Iceland's Prime Minister Katrín Jakobsdóttir participated in the farewell ceremony, alongside numerous government and UN representatives, scientists, and journalists. In the bare rock where the glacier once throned, a plaque containing the following message to the future was installed: *Ok is the first Icelandic glacier to lose its status as a glacier. In the next 200 years, all our glaciers are expected to follow the same path. This monument is to acknowledge that we know what is happening and what needs to be done. Only you know if we did it.*

Southern Spitsbergen / Photo. Centre for Polar Studies US archive

Record heat and disappearing glaciers are the consequence of climate change and confirm the trend towards global warming which, according to scientists, is constant and has unfortunately sped up. Observation and research of glaciers, the Earth's biggest freshwater reservoir, are becoming an indispensable source of information regarding the current climate change in the polar environment, and thus indirectly on the entire planet. The Svalbard Archipelago and its glaciers around the Hornund Fjord constitute something which could be called a researcher's laboratory, since it is a place which very strongly reacts to changes in the environment and therefore serves as a model region for processes taking place on a global scale.

Polish explorations of the Arctic began in 1932 with the Poland's first expedition to Bear Island on the Barents Sea and gained momentum after the Polish Polar Station was established at the Hornund Fjord in 1957. After its renovation in 1978, it has remained open throughout the entire year. It is also the place where scientists working for the Institute of Earth Sciences at the University of Silesia do their research.

Jacek Jania, Professor at the same Institute, said the following regarding their work: "In a sense, they are ahead of our times and set the newest trends in Arctic research." Professor Jania is a researcher of glaciers and the Polar environment, head of the Centre for Polar Studies US, and a member of the European Polar Board. – We belong to the pioneers of modern glaciology in the Arctic. Our work began in 1977, on the south of Spitsbergen, the biggest island of the Svalbard Archipelago.

Systematic glacier studies by expedition members working for the University of Silesia have yielded numerous and innovative results. The most important ones pertain to the reaction of glaciers to climate warming and their influence on the climate in their surroundings. The team from the Institute of Earth Sciences, who collaborated for the Centre for Polar Studies US with the Institute of Geophysics and the Institute of Oceanology of the Polish Academy of Sciences as well as with numerous other partners from various countries, studies glaciers terminating into seas. They are not only the biggest glaciers, but also the most numerous ones, since they constitute more than 65% of Svalbard's ice covering and have the most significant impact on their sea and land surroundings.

The most important and best-studied of them is the Hans Glacier. In the last two decades, the Hornsund Fjord has increased its volume by 3 km^2 at average per year, a fact caused by the recession of glaciers terminating into seas. Constrained glaciers recede less rapidly, since their icy cliffs do not break off into the

We belong to the pioneers of modern glaciology in the Arctic. Our work began in 1977, on the south of Spitsbergen, the biggest island of the Svalbard Archipelago.

Southern Spitsbergen / Photo. Centre for Polar Studies US archive

sea. Accoring to the results obtained by the University of Silesia research team, an accelerated deglaciation occurs with climate change. Its intensity is three to four times bigger than the rise of temperatures in Central Europe (+1,2°C/10 years for Hornsund, Norway; +0,4°C/10 years for Katowice, Poland).

Smaller glaciers "die" less spectacularly than the big ones which terminate into seas. They disappear relatively less quickly, since they contain smaller masses of ice. Professor Jania adds that some of the small mountain glaciers are almost dead, as they do not exhibit an important attitude of glaciers – the movement caused by the force of gravity.

Numerous glaciers of the world, including a very big number of Svalbard's glaciers, is characterized by an unstable flow of ice from the area where snow accumulation mainly occurs to the tongue and to the head. This sudden acceleration of movement is called surging. It happens around every dozen or several dozen years and causes the glacier's rapid advance. The population of surge-type glaciers on Svalbard is very numerous.

Currently, the Silesian scientists are testing the following hypothesis: a warmer climate → slightly increased snowfall in the lower parts of glacier valleys → a faster filling of the reservoir → more thaw water (and rainwater) → the waters reach the glacier's foundation → a higher chance that a surge occurs. Due to the fact that the glacier's general volume diminishes, each surge is smaller than the previous one. The "quiet" periods of surges between their active phases also appear to be increasingly shorter. As a result, huge ice masses on Svalbard disappear and "die" in the surge's convulsions, whereas small mountain glaciers become dead incrementally, without any spectacular phenomena. The warming of Svalbard's climate causes an increased number of glacial surges. The underlying mechanism could be that a warmer climate results in more thawing, larger quantities of thaw water enter the ground, and thus the glacier skids with higher velocity.

Glaciers terminating into the sea are most likely to be affected by rapid and significant loss of mass due to surges, and the glaciologists from the University of Silesia specialize in research pertaining to them. The glaciers monitored on Spitsbergen are models of what is happening in regions which are more difficult to study, such as Greenland.

Can phenomena occurring more than 3,000 kilometers away constitute a threat to the inhabitants of Central Europe? The mechanism of an accelerated movement of ice from the land to the sea, resulting from a surge's "convulsions", and an increased melting of glaciers cause a slow rise of global ocean levels. This applies to the Baltic Sea as well. "Svalbard's glaciers are too small to threaten our beaches and harbors," assures Prof. Jania, "but a similar loss of mass from Greenland and West Antarctica are a real danger not only to the Netherlands, Florida, Bangladesh, and the low Pacific atolls, but also for all regions with low- level beaches, including the depressions of the Żuławy Wiślane, the Szczecin region, and other areas close to the sea," warns the glaciologist.

Paierla glacier / Photo. Centre for Polar Studies US archive

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Prof. Jacek Jania
Institute of Earth Sciences
Faculty of Natural Sciences, University of Silesia
jacek.jania@us.edu.pl

Spring barley / Photo. Agata Daszkowska-Golec

Geneticists from the University of Silesia are looking for new barley crop forms which will show a better reaction to various stress factors, such as long-term water shortage. Their research has significant potential for application. This type of cereal is ranked at fourth position with regard to the cultivated area and can be used for the production of groat or flakes, in the brewing industry, and as animal feed.

The best type of barley should have a high yield, good grain quality, and be resistant to plant pests, various environmental and weather-related conditions, including drought, excessive precipitation, or frost. Scientists are looking precisely for these types and, as a first step, analyze the plant's genetic code. Some genes are responsible for its reaction to various stress factors, whereas other ones indirectly determine yield or seed value defined as the amount of nutrients present in the plant.

– At first, the genes linked to the plant's response to e.g. drought stress must be identified. Subsequently, we check how mutilations of these genes could contribute to the improvement of the tolerance indicator e.g. to long-term water shortages. We also compare them to the performance of the control group, that is, the genes without mutations, says Dr. Agata Daszkowska-Golec, who studies defense mechanisms with regard to drought stress in barley (*Hordeum vulgare*) and in the thale cress (*Arabidopsis thaliana*).

Although the described actions may seem simple, they are extremely complicated and time-consuming. In general, a mutation of any gene also influences other parameters. Varieties that are more tolerant to pests can have a lower seed quality or yield, whereas high-yield varieties are frequently more sensible to flooding stress. Therefore, the new forms developed by scientists are introduced to cross-breed programs.

– In practice this means that we will cross plants with a high tolerance to drought with elite, high-yield varieties recommended by growers, says the geneticist from the University of Silesia.

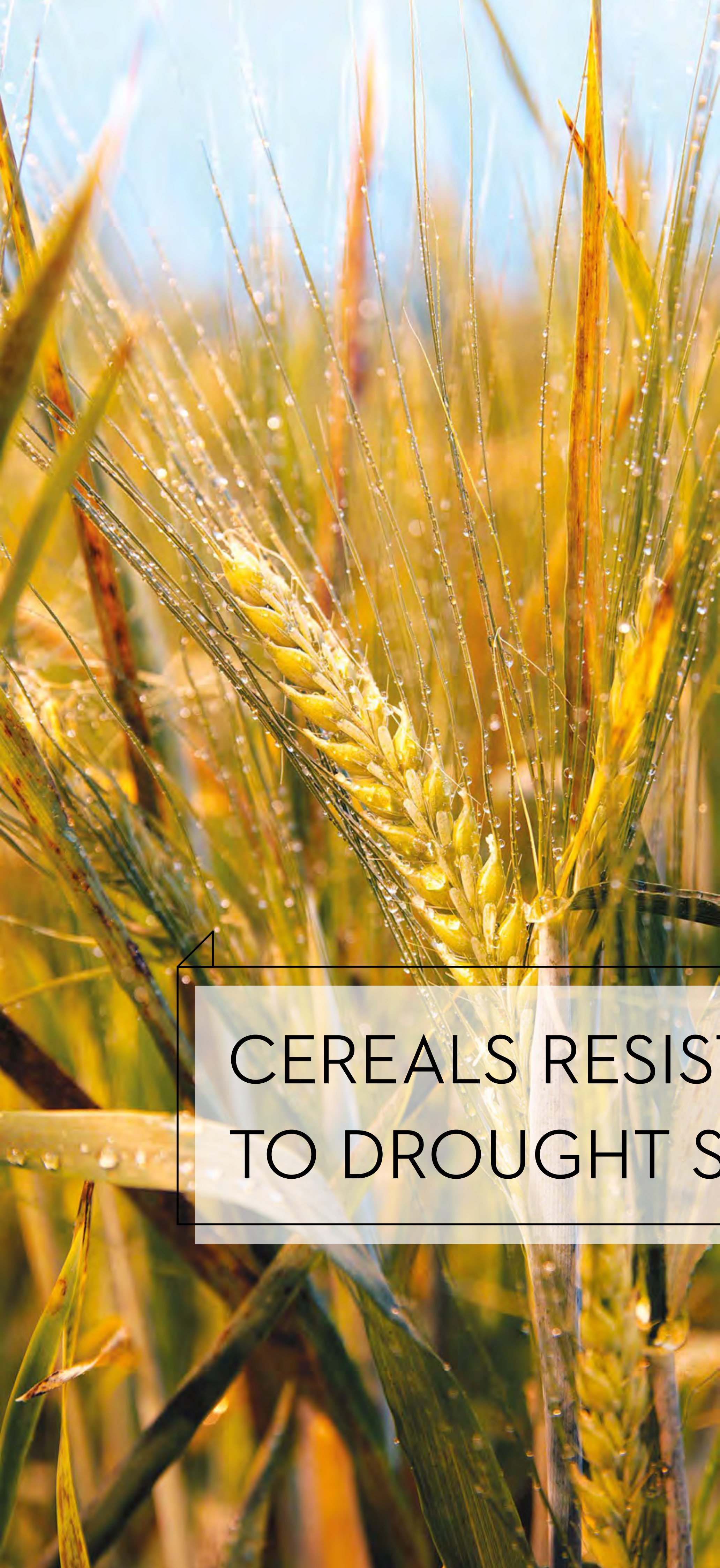
So far, two barley varieties with the following gene mutations have been described: CPB20 (Cap-Binding Protein 20) and ERA1 (Enhanced Response to ABA1). Both forms show a better tolerance to drought stress in the plant.

– The next step will be a more detailed examination of the regulatory role of these genes in situations in which a response to water shortage is required.

Barley mutants are thus an interesting tool to analyze the functions of particular genes, however, it should be borne in mind that the genetic engineering techniques with regard to this crop are complicated.

– We are very experienced in the use of mutagenesis techniques on barley and have a worldwide unique HorTILLUS population, an extensive collection of barley mutants. Scientists working at institutes from all over the world ask us to generate a mutation in a specific barley gene. We are of course open to such a cooperation, says Dr. Daszkowska-Golec, who is also the leader of the Polish team conducting research within the framework of the project "Advanced Tools for Breeding BARley for Intensive and SusTainable Agriculture under Climate Change Scenarios" (BARISTA), in which scientists from Poland, Italy, Finland, Spain, Germany, Denmark, Britain, and Estonia are involved.

So far, research findings are promising, and thanks to the cooperation with the growing station DANKO Hodowla Roślin, the sowing phase of new barley varieties has already begun. Over the course of several years, the newly obtained barley genotypes will be observed in their natural habitat, so that the knowledge acquired in laboratories and controlled greenhouse conditions can be verified in practice.



text: Dr. Małgorzata Kłoskowicz

Dr. Agata Daszkowska-Golec
Faculty of Natural Sciences
of the University of Silesia
Institute of Biology, Biotechnology
and Environmental Protection
agata.daszkowska@us.edu.pl

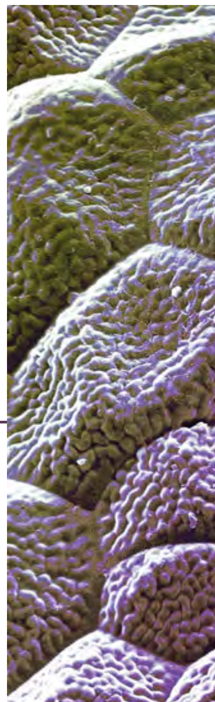
CEREALS RESISTANT TO DROUGHT STRESS

Structure of a rose quartz clump, magn. 200× / Photo. Jagna Karcz, Bartosz Baran – colorized

FASCINATING MICROWORLDS

text: Dr. Agnieszka Sikora

Scanning electron microscopy is a kind of electron microscopy which uses a much shorter light beam than the wavelength of visible light, that is, a beam of electrons, in order to study the structure of a material's surface as well as its chemical composition and is thus able to provide a significantly better resolution than light microscopy (optical microscopy). A electron microscope is used to observe and to analyze various objects – organic and inorganic matter – from the micrometric to the nanometric scales.



Seed coat surface of the common evening-primrose (*Oenothera biennis*), magn. 1000× / Photo. Jagna Karcz, Bartosz Baran – colorized

However, light microscopy, which was the first one to be developed, still remains the basic and most widely used microscopy technology. The first very simple microscopes were already built in the 16th century. At the end of the 17th and at the beginning of the 18th centuries, the first optical microscopes were constructed. Contemporary microscopes are devices with a high degree of automatization which are integrated with computers. Optical microscopy is not a relic of old times, since it has remained the starting point of an observation - in electron microscopy as well. When observing matter, a scientist's first steps are accomplished by means of an optical microscope in order to initially evaluate the material at hand, and subsequently, after appropriate preparation, an electron microscope is resorted to. Scientists use various optical microscopes e.g. fluorescence microscopes which rely on the phenomena of fluorescence and phosphorescence. An innovative solution in light microscopy are confocal microscopes, as they use a laser light beam to scan probes. This analytical technology permits to research living or chemically preserved biological preparations and to create three-dimensional (3D) reconstructions of the studied object. Another kind of microscopy is scanning probe microscopy. This technology features devices which use a scanning probe in order to obtain images of the sample's surface. An example are atomic force microscopes, which permit to achieve a three-dimensional surface image with a resolving power at the dimension range of a single atom. Due to the continuous improvements of microscopy technologies, scientists are able to achieve increasingly higher magnifications of the analyzed objects and a more detailed three-dimensional visualization of the structure of the matter.

In the case of electron microscopy, instead of a light beam, a beam of electrons is used. As a result of the interaction between the beam of electrons with the surface of the studied sample, different forms of energy are emitted. Every kind of the emitted energy is registered by means of special detectors, and subsequently it is converted into the sample's image or into the X-ray spectrum. This very image is referred to as photomicrography, and in the case of electron scanning photography the term electron micrograph is used. The displayed image is a digital gray-scale image which is rendered by means of different techniques used to register signals emitted by the sample. It is important to emphasize that, with regard to its contents, photography refers to the nature of scientific research and is the most objective image creation technique available.

In electron microscopy, structures of plant and animal cells are analyzed at very large magnifications. The most modern electron transmission microscopes provide magnifications of several million. Due to a great sharpness depth and a very high resolution reaching 1 nm, electron scanning microscopes permit to produce almost three-dimensional images. At this point, it is expedient to add that scientists use photo editing software which enhances the effect of a 3D structure. Computed microtomography is

Druse with calcium oxalate crystals in *Hacquetia epipactis* ground tissue, magn. 5000×
/ Photo. Jagna Karcz, Bartosz Baran – colorized

Scots pine (*Pinus sylvestris*) pollen grain, magn. 500× / Photo. Jagna Karcz, Bartosz Baran – colorized

another imaging technique which enables scientists to achieve very precise three-dimensional images of the studied objects, including their internal structure, and does not require special preparation of the sample. Contemporary scanning microscopes provide magnifications of up to a million, however, state-of-the-art microscopes reach significantly higher values. It is expedient to emphasize that a magnification of 100,000 or 200,000 enables us to see structures in the studied object which are a few dozen nanometers in size. In the majority of cases, such a magnification is sufficient.

Dr. Jagna Karcz from the Institute of Biology, Biotechnology, and Environmental Protection at the Faculty of Natural Sciences of the University of Silesia is the head of the Laboratory of Electron Scanning Microscopy (SEM-Lab), and researches the development and implementation of scanning microscopy with regard to various biological objects, including the surface structure of plant epidermis exposed to environmental factors. Moreover, Dr. Karcz is one of the few specialists in carpology in this country and a popularizer of science. Since 2012, the Laboratory uses a high-resolution electron scanning microscopy with cold field emission, a cryo chamber, and an X-ray EDS spectrometer, one of the most modern microscopes of this type in Poland.

Scientists at the University of Silesia analyze various biological objects, including plant and animal tissue, bacteria, spores, plant pollen, biomaterials as well as polymers, fossil materials, and - most notably - environmental samples collected at scientific expeditions. The studied material must be appropriately prepared – a dry and conductive state is required, since in the microscopic vacuum it is prone to the destructive effects of the device's beam of electrons. Therefore, scientists resort to many chemical procedures, which have been tested on different materials, including preservation, dehydration, drying, and sputtering, and are able to prepare the sample in such a way that the structure of the analyzed object remains intact. The biological material must be conductive, and due to this it is expedient to apply a thin layer of sputter coating consisting of a noble metal (e.g. gold). In addition, the microscope is equipped with the freezing system Cryo which permits to freeze the sample in fluid nitrogen and to observe its intact structure. The information regarding the sample's surface structure is complemented by chemical microanalysis of the studied preparation. Due to the fact that the microscope also has an X-ray EDS spectrometer, it is possible to simultaneously obtain the image of the object's surface and to determine its chemical composition.

An interesting example of research using SEM technology is the analysis of surface degradation processes in plastic materials caused by microorganisms. Microbiologists research, among others, biofilm bacteria, zoologists analyze insect morphologies for taxonomic purposes, and botanists inquire into environmental effects on plant populations e.g. by means of analyzing structures of invasive species in connection with molecular research.

Since many years, Dr. Karcz has been a researcher and photographer of microworlds. It is expedient to add at this point that the original images produced by an electron microscope are black and white, including all shades of gray, and could be obtained due to the secondary electrons emitted by the samples. In these samples, the contrast is linked to their topography – convex parts are bright, concave fragments – dark. The contents of microphotographs refer to scientific research and to didactic courses in various academic disciplines, such as biology, biotechnology, and environmental protection. The themes of these photographs are very diverse. They de-

Fragment of a wolf spider's head (*Xerolycolosa nemoralis*), magn. 300× / Photo. Jagna Karcz, Bartosz Baran – colorized

pict natural surfaces of various objects, that is, how they really look like in their natural environment, as well as structures of plants and animals modified by environmental factors (biotic and abiotic). It is possible to admire the extraordinary structure of cobwebs and their complex spatial configuration. Moreover, they are a perfect material for the production of matrices which enable scientists to grow various animal cells. The photographs also document the process of degradation of plastic materials by microorganisms and the elaborate construction of sponge skeletons which are found in water bodies. In her works, Dr. Karcz demonstrates that science can be an inspiration for and theme of photography, and that the world which surrounds us is both fascinating and mysterious.

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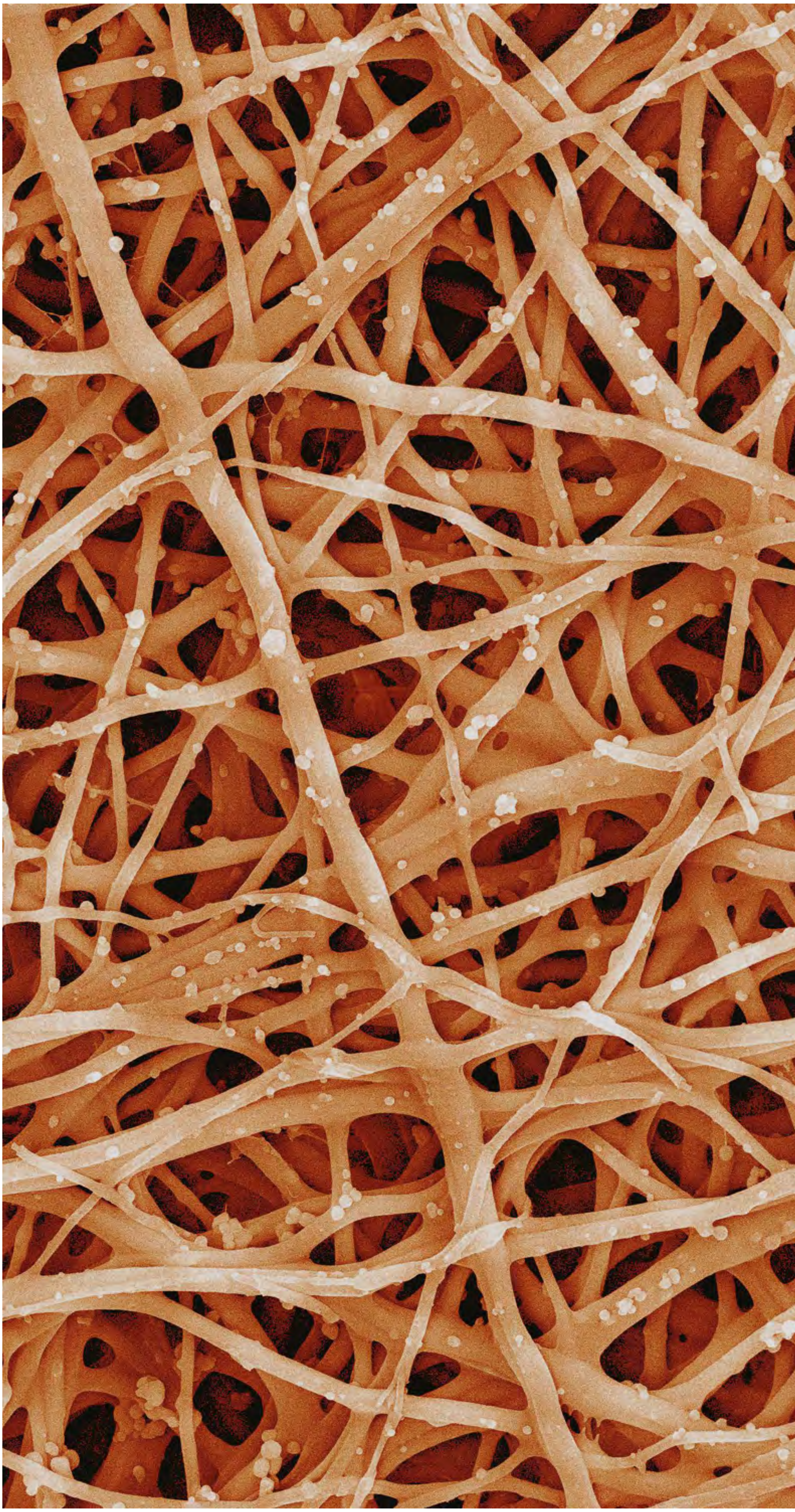
Dr. Jagna Karcz
Institute of Biology, Biotechnology, and Environmental Protection
Faculty of Natural Sciences of the University of Silesia

Upper surface of a common yew needle (*Taxus baccata*), magn. 600×
/ Photo. Jagna Karcz, Bartosz Baran – colorized



Inner surface of a quail's egg, magn. 1000×
/ Photo. Jagna Karcz, Bartosz Baran – colorized

text: Dr. Małgorzata Kłoskowicz

REVOLUTIONIZING THE PHARMACEUTIC INDUSTRY

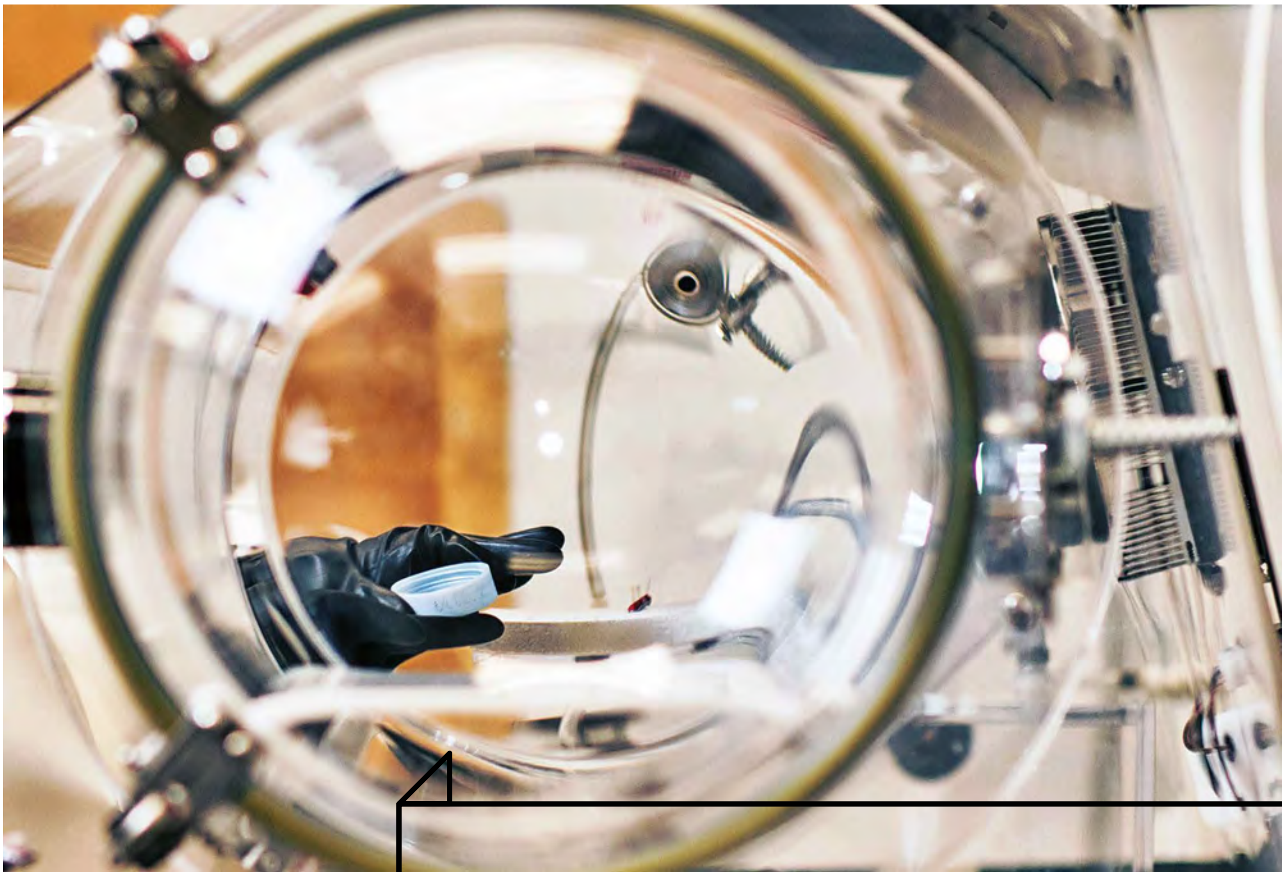


Photo. Szymon Nawrat

According to estimates, over 40% of drugs available in pharmacies and more than 90% of new medicinal substances show poor water solubility. This means that a large number of them will not be absorbed by the patient's body, as a consequence of which stronger drug doses must be prescribed, and the non-absorbed substances enter the environment and thus contribute to its greater pollution.

Prof. Marian Paluch
Faculty of Science and Technology at the University of Silesia
Director of the Silesian Centre for Education and Interdisciplinary Research
marian.paluch@us.edu.pl

The main reason for this poor water solubility is the crystalline form of drugs, and therefore scientists are looking for new solutions. Active substances in amorphous form constitute an interesting alternative. They are also referred to as the main hope of contemporary pharmaceutical manufacturing, since they show good water solubility and permeability of cell membranes. Drugs designed according to this new approach will work more quickly and effectively at smaller doses, which has a key impact on the patients' health. The cause is thus worth fighting for.

Amorphous solid substances exhibit interesting properties which place them somewhere in between solids and liquids. Imagine that we lower the temperature of a "classic" liquid. When we approach its proper solidifying point, the crystallization process begins. The structure obtained in this process is a network of organized molecules. However, certain compounds exist which do not crystallize in spite of being kept at temperatures below the solidifying point. Their structure remains disorderly - as in the case of liquids. They are in their amorphous phase and look similar to honey, which is dense and sticky, and their molecules move more slowly, cautiously, and deliberately.

A typical example of such a compound is glass, since it is sometimes referred to as a frozen liquid.

– Imagine we are looking at a photograph of a typical liquid structure. We would have a certain chaotic arrangement of atoms in front of us. A photograph depicting a liquid at a sufficiently low temperature below its glass transition temperature will also contain such disorderly arranged atoms. The typical observers won't notice any difference, and yet we would be looking at two different physical states, says physicist Professor Marian Paluch from the University of Silesia who has been researching the properties of amorphous structures and their use in the pharmaceutic industry since many years.

The movement of molecules in this phase is also very interesting. Professor Marian Paluch compares it to the Tokyo subway during rush hour. There is a constant influx of new people, they are tired after work and want to get home as quickly as possible. However, they start to slow down in a crowd which is growing bigger, but they can still move. Nevertheless, they have to plan their path ahead, do not move freely, but have to take into account the presence of every neighbor. Their movement has therefore a collective character; my movement does not depend solely on myself but predominantly on what is possible in my surroundings. When a liquid is supercooled, the molecules start to move in a similar way. We do not observe this in classic liquids, nor in crystals.

It is already known that active substances in their amorphous phase are better absorbed and show high permeability of cell membranes. Their use in the pharmaceutic industry, however, is linked to numerous challenges. First of all, not every substance can be easily converted to an amorphous state. Frequently, this process requires complex equipment, and new conversion methods have to be discovered.

Secondly, there are numerous factors determining the physical stability of their amorphous form which must be maintained at least until the drug's best before date.

Thirdly, the properties of a substance in its amorphous phase change over time, and therefore scientists study these changes as well as the entire process.

However, Professor Paluch emphasizes that scientists cooperating with him have already found some interesting solutions which provide answers to all of the above-mentioned challenges.

– We have one of the world's best laboratories to perform tests at high pressure. Moreover, I participated in the construction of similar equipment in numerous research facilities in Europe, Asia, and North America. We also developed various methods for the stabilization of entire systems in order to keep and control the properties of a substance in its amorphous state. This brings us closer to placing amorphous drugs on the market. We are open to collaborations with other research centers and with representatives of the pharmaceutic industry, emphasizes the scientist from the University of Silesia.

Photo. Szymon Nawrat

Scientists from the Institute of Materials Engineering of the University of Silesia work on modifications of biomaterial surfaces, mainly titanium alloys, in order to improve their corrosion resistance and thus to enhance their biocompatibility / Photo. Agnieszka Sikora

Stiff hips, muscle degeneration, a sunken chest, or impaired breathing are only a few examples how a sedentary lifestyle influences our health. If we – on a daily basis – sit a few to more than a dozen hours at work, in the car, at school, and at home, we are prone to obesity and numerous cardiovascular and musculoskeletal diseases.

Therefore, it is not surprising that the demand for newer and more durable implants has grown, since they will help us to minimize the perceived consequences related not only to our lifestyle, but also to those caused by the increasing life expectancy for women and men.

text: Dr. Małgorzata Kłoskowicz

Assoc. Prof. Bożenia Łosiewicz
Institute of Materials Engineering
Faculty of Science and Technology of the University of Silesia
bozena.losiewicz@us.edu.pl

Catheters, contact lenses, hip endoprostheses, or dental implants are only a few products made of biomedical materials. After becoming a part of the human body, they can improve its functioning by replacing some or parts of tissue or organs. As usual, nature is the highest and unmatched standard, however, the designed biomaterials are increasingly able to imitate human tissue. This is not only due to recreated structures and properties of certain systems, but also because of the use of substances which are naturally present in tissue, such as collagen.

How biomaterials used to e.g. produce implants are designed, depends primarily on their future place in the human body. Thus for instance, materials for hip joint endoprostheses require resistance to high mechanical loads, whereas shape-memory alloys are used for the production of coronary stents. When they are applied to narrowed veins, their diameter must be as small as possible. The implants expand to their appropriate size only under the influence of the patient's body temperature and thus open the space between the veins' walls.

In order to better understand what challenges scientists producing biomaterials have to face, let us take a look at dental implants. The results of their work can be observed at the Institute of Materials Engineering of the University of Silesia.

– In our research, we predominantly focus on the properties of titanium and its alloys, says Assoc. Prof. Bożena Łosiewicz who has designed and analyzed biomaterials for many years.

Titanium is the most biocompatible metal. Moreover, it offers high corrosion resistance and is self-passivating

THE NEWEST TRENDS IN IMPLANTOLOGY

which means that, in the presence of an oxygen carrier, it develops a thin oxide layer protecting the surface of the product it is made of from damage. The modification of titanium alloys by means of electrochemical methods also provides interesting solutions. Scientists from the University of Silesia in Katowice mainly resort to electrodeposition of polymer, ceramic, composite, and hybrid coatings and thus enhance the properties of the developed biomaterials.

All implants, including dental implants, which are placed inside the human body are recognized as foreign bodies. As a consequence, inflammation occurs, and the structure of neighboring tissue becomes damaged. This process is, of course, undesirable, since it might lead to various complications, including implant rejection. An interesting solution is the application of thin, porous layers on the implant which become carriers of anti-inflammatory drugs.

Firstly, the implant and the active substance directly get to the spot where inflammation is expected. Secondly, the layers are designed in such a way that the release of the substance can be fully controlled, both with regard to its dose and the administration time, so it is not possible for the patient to miss the recommended dose. Thirdly, the organism is not burdened with additional medicine in the form of tablets, and this is particularly important in the case of elderly people.

Appropriately designed layers also facilitate the placement of dental implants.

– We already patented a solution which makes it possible for the coating to closely adhere to its surface and ensures that the coating is not damaged when being directly administered into the patient's maxilla or mandible bones, says materials engineer MSc Eng. Patrycja Osak, the paten's coauthor.

– Even the best coatings which are abraded or damaged during the procedure simply cease to fulfill their functions. Therefore, the entire implant placement process must be paid attention to, the scientist adds.

In order to achieve the best properties of their biomaterials, scientists from the University of Silesia in Katowice predominantly develop hybrid coatings which combine the properties of metals and polymers. As a result, they obtain substances with even better parameters which favor the osteointegration process, and the implant is no longer perceived by the patient's body as a foreign body, tissue gradually regenerates, and is integrated with the implant.

– We try to imitate the best solutions proposed to us by nature, says Dr. Łosiewicz. – The application of various coatings gives us numerous interesting possibilities. We prefer biopolymers i.e. substances which occur in nature, the scientist adds. As an example, type I collagen can be named, one of the most important proteins in the human body. After being applied onto a dental implant, it accelerates the regeneration of bones and the osteointegration process, a key factor in implantology.

Currently, the team of scientists from the Institute of Materials Engineering of the University of Silesia researches titanium alloys for long-term intraosseous implants, such as joint endoprostheses or dental implants, with the use of appropriately designed coatings predominantly based on biopolymers.

Implant alloy samples of Ti15Mo with hybrid coatings deposited in various electro-chemical conditions / Photo. Małgorzata Kłoskowicz

EXPERIMENTAL PROJECTS

supporting rehabilitation

We mostly associate Virtual Reality with entertainment, however, it is more frequently mentioned in the context of various therapies. Scientists from the University of Silesia designed special games for rehabilitation which make use of VR technology. They are intended for patients needing permanent or temporal rehabilitation of the human musculoskeletal system, with post-traumatic problems as well as neurological, rheumatological, and orthopedic conditions.

text: Dr. Małgorzata Kłoskowicz

Dr. Paweł Janik
Institute of Biomedical Engineering
Faculty of Science and Technology at the University of Silesia
pawel.janik@us.edu.pl

The manufacturers of inhalers care about the visual aspect of medical devices in order to make them child-friendly in particular. Thus, the casings take on the strangest forms and frequently look similar to characters of fairy tales. We thought that the hero of the game could look similar to the form of the device, so we decided to use a happy whale, says Dr. Paweł Janik, as he presents the newly designed device / Photo. Agnieszka Szymala

Dr. Małgorzata Janik presents the rehabilitation game Misiolot (eng. The Running Bear) / Photo. Agnieszka Szymala

The person undergoing rehabilitation embodies the main protagonist of a game. For instance, they try to avoid certain obstacles, collect honeycombs, reache out for apples in an orchard, or move between parts of a spaceship. In order to achieve the goal of the game, they must adapt the position of their hands, legs, or even of the entire torso. This is possible due to the use of non-invasive motion sensors which are placed on different parts of the patient's body. The plot of the game is designed in such a way that the patient must make precisely defined movements in order to provide exercise for specific body parts.

One the numerous advantages of these rehabilitation system is the fact that movement therapy can be personalized. In cooperation with scientists, physiotherapists and doctors can determine the type of necessary exercises, the number of repetitions, the scope of movement as well as its duration. What is more, the system also monitors the functioning of specific body parts so that it is possible to determine whether the exercises were correctly performed.

Another advantage is the fact that the game plot can be designed for target groups of different ages, such as children or the elderly.

– For example, younger patients can embody the flying bear Misiolot or the running bear Misiobieg who, depending on the scenario, either runs and collects honey or flies between various modules of a spaceship, says Dr. Paweł Janik, coauthor of the experimental project.

The scientists also expect to distract the patients attention from the pain which could impact rehabilitation efficacy. There are numerous indications that patients concentrating on the goal of a game can more effectively follow the schedule of their physiotherapy. However, they must be permanently supervised by their specialists.

The developed rehabilitation games are discussed with doctors and physiotherapists. The devices' production costs are also taken into consideration.

– When designing our innovations, we try to take financial factors into account. In the case of a rehabilitation game, we are talking about three elements: the sensor, the router, and an additional device which will receive and transform signals emitted in the system. It can be e.g. a standard computer, the scientist comments. – We also improve specific solutions so that the system can work with increased efficacy and efficiency.

Dr. Paweł Janik's team also work on other new solutions on the field of biomedical engineering.

Among others, the scientists developed a breathing monitor which is to prevent Sudden Infant Death Syndrome (SIDS). Such a device checks on such aspects of breathing as frequency and strength, heart rate, and changes in the position of the child's body. One of the experimental solutions employed in the breathing monitor was awarded e.g. at the 47th International Exhibition of Inventions Geneva 2019 and at the 44th International Exhibition of Inventions "Inova Croatia 2019".

The scientists are also the authors of a solution supporting pulmonary rehabilitation. They also developed a special game which monitors whether children inhale correctly. The game also makes the process, which may even take several minutes, less bothersome for the young patient.

Another equally interesting project is the oscillating vest. This technically sophisticated product, which supports the clearing of the respiratory tract in patients with conditions causing mucus to accumulate in the lung. The size of the device can be adapted to particular target groups, such as children. For a proper functioning of the vest, the control technology must be attuned to the mechanical elements of the specially designed textile structure.

It is expedient to add that Dr. Paweł Janik's team not only devise all electronic and mechanical elements, but also bear in mind the design aspect of their devices.

A rehabilitative oscillation vest used in order to clear the respiratory tract. In particular, it was designed for the physiotherapy of people struggling with conditions causing mucus to accumulate and remain in the respiratory tract, e.g. in the case of cystic fibrosis or bronchial asthma. Eight built-in engines cause vibrations which are sufficiently strong so that patients instinctively cough up mucus from the lungs. / Photo. Agnieszka Szymala

Record heat and disappearing glaciers are the consequence of climate change and confirm the trend towards global warming which, according to scientists, is constant and has unfortunately sped up.

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NO limits

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cover photo: Tomasz Kipka's poster