news bulletin

Åbo Akademi University
Spring 2016

"Islam has never been a problem for me as a scientist. However, what is a big problem is industrially-oriented thinking; the subordination of science to money, which in detail regulates what we should do research on.

Bioinspired science

SMALL PHARMACEUTICALS, GREAT EFFECTS | ÅBO AKADEMI UNIVERSITY 100 YEARS
NOBODY IS BORN A JIHADIST | HARMFUL ANTIDEPRESSANTS? | WHY IS ICE SLIPPERY?

© PHOTO: NICKLAS HAGEN

The coral reefs of the Baltic Sea

A long, band-like plant that can grow up to one metre tall grows under the surface of the Baltic Sea. Common eelgrass (*Zostera marina*) is a seed plant of marine origin.

Eelgrass grows in extensive meadows on the sea bottom, at a depth of one to eight metres, along the coast of the Baltic. In Finland eelgrass often grows together with other seed plants of sweet water origin. This is something unique to the Northern Hemisphere, where eelgrass meadows usually consist of eelgrass only. Fields with several species are normally found only in the tropics.

In his research, Docent **Christoffer Boström**, lecturer in marine biology at Åbo Akademi University, studies the function of coastal ecosystems, specifically the flora and fauna of eelgrass beds.

“A considerable proportion of all eelgrass meadows in the Northern Hemisphere are found in Scandinavia. Recent estimates show that there are over 2,100 km^2 of eelgrass in the Nordic region and the Baltic Sea. Probably there is much more. Eelgrass grows on open sand bottoms and sways slowly with the movements of the water. It is a very beautiful and peaceful environment to dive in,” says Boström.

The eelgrass meadows are called the ‘coral reefs’ of the Baltic Sea, and they are both important and beautiful.

“The many roles of eelgrass in the marine ecosystem make the green meadows very fascinating. At first sight the meadows might seem uninteresting, but on looking closer, you will see that they swarm with life. Eelgrass is a so-called ‘key species’ that gives shelter and nutrition to many organisms and provides humans with a number of ecosystem services, such as coastal area stabilisation, oxygen production and carbon and nutrition sinks. The ecosystems in the Baltic might not be as colourful as the coral reefs, but they are all the more interesting when you learn what to look for,” says Boström.

Eelgrass is a very important plant in the ecosystem in the Baltic Sea, but it is threatened by human activities. For example, nutrients that cause eutrophication, and dredging and anchoring at unsuitable places cause eelgrass to disappear. Globally seagrass beds disappear at a rate of 110 km^2 per year, which is even faster than the pace at which coral reefs and rainforests are disappearing.

The largest losses of seagrass have been noted in Denmark, Germany and on the Swedish west coast. There are no long-term studies in Finland, but it is obvious that eutrophication, muddy waters, overfishing and drifting algal mats constitute the main threats to the meadows in the Archipelago Sea and the Åland Islands. In addition, the Finnish eelgrass beds are usually a hundred- to a thousand-years-old giant clones, which makes them particularly vulnerable. If one clone disappears in an oil catastrophe, it will never return.

Boström carries out his research using the Korpoström Archipelago Centre in Finland as his base. He has supervised several doctoral students working on seagrass themes, and he acts as an expert within a campaign of the World Wildlife Fund (WWF) which aims at making the distribution and biology of seagrass meadows better known.

Text: Mia Henriksson
Photo: Teemu Koppa / Lehtikuva

intro

Universities carry a considerable responsibility in the form of providing education, the development of new experts and the creation of new knowledge. As societies have been built and developed, a central position has been – and still is – given to the establishment of strong university environments which contribute to continued development. In the Nordic region higher education has so far been free and the universities have to a large extent been funded by state resources.

THIS IS, however, no longer a given. Term fees have been introduced for students from countries outside of the EU/EFTA; the number of universities has decreased and there is increasing competition for funding. These changes are caused by diminishing state finances and government cutback programmes, as well as political trends.

LOOKING AT this development from the perspective of university history, we can see that over the years universities have undergone many reforms and have been influenced by various passing social trends. This goes to underline the role of universities as key actors in society. The centennial history of Åbo Akademi University will be published in time for the university's 100-year anniversary in 2018. It will contain interesting reading and analyses of how a university is created and how it develops. More on the history can be read in this issue of the *News Bulletin*.

A UNIVERSITY lives and survives thanks to students who thirst for knowledge, teachers who are enthusiastic and researchers who are innovative. The central values that inform the activities of Åbo Akademi University are diversity, openness, courage, participation and sustainability. In this issue you can also read about Parvez Alam, one of our international researchers, who truly stands for diversity and courage as a researcher and as an individual.

WISHING everybody an interesting read!

Thurid Eriksson
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news bulletin

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GRAPHIC DESIGN: PETER SIEGFRIDS

CIRCULATION: 3.500 copies
Printed by FRAM OY

ISSN 1796-7147

Published by Åbo Akademi University communications

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Cover photo: Marcus Prest.

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in brief…

GRIEF KILLS: ANNIVERSARY EFFECTS ARE STRONG AMONG MOTHERS

RESEARCH AT Åbo Akademi University shows that the death of a child increases the risk of death of the mother. A study carried out by **Jan Saarela**, professor of demography, demonstrates that the risk of death among mothers who have lost a young child is particularly high around the anniversary of the child's death. Such anniversary effects, or a concentration of ill health around certain dates, have been frequently debated and analysed in international literature for many decades, but have now for the first time been quantified by rigorous analyses of a larger population.

The study shows that the risk of death among mothers who have lost a child is increased by almost 50 per cent during the anniversary week. In cases where the child died after infancy the effect is even larger: almost 90 per cent higher than would be expected if mortality was evenly distributed over the calendar year. No heightened risk of death is observable among fathers, or around the anniversary of the child's birth.

The results indicate that grief might have a causal effect on people's ill health, and thus that previously observed connections between the poor health of children and parents do not necessarily only depend on environmental or genetic similarities between parents and their children.

The study was published in the *European Journal of Epidemiology* and it is the result of continuous cooperation with researchers at the Centre for Health Equity Studies, the Harvard School of Public Health, the Karolinska Institute and Stockholm University. ◆

TEXTBOOKS ALSO GIVE VISIBILITY

DMITRY MURZIN, professor of industrial chemistry at Åbo Akademi University, published his second textbook on chemical engineering in late 2015. He had been contacted by a large German textbook publishing house as his first textbook on catalysis, published in 2013, had received a positive response all over Europe.

"We don't have a common educational system in Europe, but what we do have is many different countries and a common labour market. This means that although we as teachers mainly train our students for the Finnish market, we also have to make sure that the educations our students receive qualify them for international posts. And therefore we must be aware of what is taught at other universities," Murzin explains.

Chemical engineering is a specialised science which is often focused on products – on what processes are needed in order to make a certain product – while the subject of chemistry is a fundamental science. Murzin wanted to write a book that would overlap both these areas of chemistry.

The books are richly illustrated.

"I also took care to include my own experiences, from both industrial and academic environments, in short inserts which took the form of interludes within the actual text. This has proved to be a very popular feature."

Another example of a textbook written at Åbo Akademi and intended for an international audience is *Chemical Reaction Engineering and Reactor Technology*, written by **Tapio Salmi**, **J-P Mikkola** and **Johan Wärnå**. It was published in the USA in 2011 and was very well received.

"Textbooks give us visibility and showcase our expertise. We shouldn't be shy to admit it. I think the teaching we provide here is of a world-class quality. But it's quite difficult for people, particularly from abroad, to find their way here if they aren't familiar with the quality of the teaching and research that we carry out." ◆

BETTER TREATMENT OF ALLERGIES

ALLERGIES ARE one of a number of new and widespread diseases in the Western world. Close to 20 per cent of our teenagers are estimated to suffer from allergic colds, asthma and other conditions related to hypersensitivity.

"There are half a million patients in Finland suitable for immunotherapy – known as 'hypo-sensitization' – but we only use this treatment in about 1,500 cases per year. Of course patients can take antihistamines and use cortisone spray, but these do not work for everyone," says **Johannes Savolainen**, head physician and professor of allergology at the University Hospital of Turku.

Allergies are primarily treated with antihistamines and cortisone spray, but the effect of these is often inadequate. Hyposensitization has more impact, but with 50 injections needed over three years this long-term treatment demands extensive resources and patients have to wait for up to two years to receive it.

For almost ten years a cooperative project, conducted by Åbo Akademi University and the University of Turku, has worked on developing a way of making hypo-sensitization more effective. As in traditional hypo-sensitization, injections with allergens are used, but these are combined with a so-called 'adjuvant'; a component which stimulates the immune system and actively supports its 'appropriate' reaction to pollen.

The project's research work has now reached a stage where the compound can be tested on humans.

"Our aim is to reduce the number of injections needed and the amount of allergen used. Instead of 50 injections, five might be sufficient, which would also reduce the side effects," says **Reko Leino**, professor of organic chemistry at Åbo Akademi.

"In countries with a healthcare system similar to that of Finland, one physician could treat ten patients instead of one, which would both make treatment more efficient and reduce the amount of sick leave taken." ◆

Small pharmaceuticals, great effects

Nanomedicine can potentially result in more effective drugs with fewer side effects. But the road to that end is lined with challenges.

TEXT & PHOTO: NICKLAS HÄGEN

Within nanomedicine size is everything. This field is all about working with synthetic particles which are so small that the characteristics of the material are changed. The utilisation of these characteristics in a controlled way is called nanotechnology, and nanomedicine consequently means 'the medical application of nanotechnology'.

"The characteristics that change can be electric, magnetic or chemical, but they always pertain to size," says **Jessica Rosenholm**, professor in pharmaceutical development at Åbo Akademi University and a specialist in nanomedicine.

"When the particles become small enough, they acquire characteristics that the bulk material does not have. As the size of gold particles, for example, shrinks to under a hundred nanometres their colour starts to change because their capacity for light refraction changes. The optical features of nanomaterial can be utilised in, for instance, contrast agents for medical examinations."

Nanoparticles are smaller than can be discerned with the naked eye, but they are counted as material. Roughly speaking this means that they are considerably larger than single molecules – or amalgamations of molecules, which in turn, to put it simply, are formed of bonds between atoms of various chemical elements.

While the particles are larger than both molecules and atoms, they are so small that they are not influenced by gravity to any significant degree. And compared to body cells, the nanoparticles are tiny.

One reason as to why its chemical characteristics change when a particle becomes sufficiently small is that a relatively large proportion of the atoms are situated on the surface of the particle instead of being bound to each other inside it. With many atoms on the surface, a particle is very reactive (to such an extent that it might even cause so-called nanotoxicity, i.e. health risks). In very small particles most atoms can, in fact, be situated on its surface.

"We are interested in nanoparticles because they are approximately as small as the body's own biomolecules. This means that they can circulate around the body. The body might not recognise nanoparticles as foreign material, as they are small enough and they can be designed in such a way that the immune system doesn't recognise them," says Rosenholm.

"Nanoparticles can be accumulated in tissue and absorbed by cells. That is why we're interested in using them as drug carriers. We can fill them with pharmaceuticals – for example cytostatics that are aimed only at the tumour and not at healthy cells, as this leads to side effects. If we're able to send the drug exclusively to the cancer cell, only that cell is affected by the cytotoxin."

Not a utopian dream

Nanopharmaceuticals are not a new invention and not a utopian dream, either. Research has been carried out since the 1980s and the first nanodrug was launched on the market in 1995. It was a cancer drug based on liposomes, small fat-like bubbles made of the same material as the cell membrane.

As technology has developed and improved, researchers are now able to start realising the potential of nanomedicine. Nanopharmaceuticals are being developed for various therapeutic purposes and there are already, for example, vaccines in nanoform and nanodrugs for diabetes, cardiovascular diseases and neurodegenerative diseases at various phases of development. The most common, however, are cancer drugs.

"Nanomedicine gives many, many so far unexploited possibilities. Pharmaceutical development is a slow process. It takes about 15 years from the date of a new discovery to a new product being launched on the market. After the boom of nanotechnology a number of new and different nanomaterials have emerged which have not yet reached the market. But they're on their way," says Rosenholm.

"The pharmaceuticals already on the market, that is, the first generation of nanodrugs, are not entirely selective. They do transport more effectively around the body than if the medical substance was given on its own without the liposome as a carrier system, but they could be more selective and more effective, and include more functions, for example abilities such as actively seeking their target, visualising and circumventing drug resistance."

Carrier systems

The possibility of targeting the delivery of traditional drugs in the body is limited. After a pharmaceutical substance is dissolved into the body from, for example, a pill, its subsequent fate is dependent on the chemical and physical characteristics of the drug molecule. The possibilities of prior manipulation of the drug molecule in order to direct it towards the destination where it is intended to have an impact are small, since every operation changes the molecule and thus also its medical effect.

Nanopharmaceuticals provide an opportunity to direct the movements and absorption of the drug in the body. There are, nevertheless, several difficulties involved in doing this. First of all, the immune system must be 'cheated' into not recognising the drug-carrying particle as something foreign to the body, but rather allowing it to circulate for long enough to find its way to the place where it is intended to have an effect. Secondly, the substance must be efficiently accumulated and released in the appropriate place in the body. And thirdly the destination of the pharmaceutical molecule is often a protein in the cell, and therefore the aim is that the cell shall absorb the drug, which is to find its correct place in the cell.

In order for this to succeed a so-called 'carrier system' is created, consisting of particles with the appropriate chemical and physical characteristics for all three aspects to function. These particles are then 'loaded' with the molecules of the pharmaceutical substance – there might be room for millions of them in one nanoparticle.

Chemical design provides many opportunities for giving the carrier particle the desired characteristics.

"We try to make the carrier system behave in the way we want it to. After that we can basically load the particle with any drug molecule without affecting the carrier system. The system takes the drug molecule to its set destination and releases it there," says Rosenholm.

"The exact way of doing this is a question of nanoparticle design, which is what we focus on in our daily work at the lab. It involves playing with chemistry," Rosenholm explains.

One way of creating the particles is to start concretely with a large block of the material, which is ground into small particles, but Rosenholm's research group starts from the opposite direction, building their particles molecule by molecule. The carrier systems they create usually consist of porous ceramic silicon dioxide particles.

"We begin with solutions that we mix together. The components included in the solution are molecular and separate from each other, but when they are mixed, they start to accumulate and react with each other, becoming linked to larger and larger elements, particles. By playing with temperature, solvents and pH values we can see to it that they don't grow too large," says Rosenholm.

"Our silicon dioxide particles are porous. When the particles are completed, we put the drug substance into the pores. We prepare a solution of the drug, add the particles and let the two merge overnight. It's crucial that the surface chemistry of the particle pore walls is such that it attracts the drug substance. By using a 'poor' solvent the drug molecules will rather be absorbed by the particles than stay in the solvent. Then we can remove the particles from the solution using a centrifuge, vacuum dry them and – voilà! – we have a completed nanopharmaceutical. ◆

Tissues and contrast agents

In addition to the development of pharmaceuticals, nanomedicine comprises two other research areas. One is diagnostics, where nanotechnology is used to create contrast agents. The other is regenerative medicine, where various tissues or organs are created in a laboratory environment – so-called tissue reconstruction. Professor Jessica Rosenholm is also involved in research projects at Åbo Akademi University which are connected to both of these areas.

The aim of tissue reconstruction is 3D printing of organs or tissue to be used, for example for prostheses or wound healing. These can be implanted with cells and nanodrugs in order for them to grow into the body.

Niklas Sandler, professor in pharmaceutics at Åbo Akademi, studies printable pharmaceuticals. In cooperation with him, Rosenholm has already been able to print 3D model prostheses made of synthetic polymers. The aim, within a collaborative project with **Stefan Willför**, professor in wood and paper chemistry at Åbo Akademi, is to expand materials to include natural, biocompatible polymers such as cellulose and hemicellulose. For further applications cooperation is carried out with **Cecilia Sahlgren**, group leader and senior scientist at the Turku Centre for Biotechnology and one of a group of experts on tissue regeneration at the Eindhoven University of Technology in the Netherlands.

"Nanoparticles are mixed with biodegradable polymers and the pulp with the particles is then printed. The particles can contain pharmaceutical substances which regulate the regeneration of the tissue around the prosthesis by making sure that the cells differentiate in the appropriate direction and develop into the cells we want them to be. Regenerative medicine can be about regenerating any organ or tissue, but the cell differentiation must be regulated so that the right cells are created for the right organ," Rosenholm explains.

Rosenholm's research group also makes nanodrugs which can both be visualised and carry pharmaceutical substances. As these can be studied in both cells and animal models, they give research a new dimension as the drug can be traced and its effect can be followed up.

At the same time contrast agents are developed that can be monitored using several different methods.

"The different imaging techniques supplement each other as to resolution and sensitivity, that is, they are crucial for the level that can be looked at. This makes it possible to study the same sample at various levels: with optical methods at the cellular level and with, for example, a microscope or magnetic resonance imaging at organism level."

Is there a risk of getting different results if using different samples for different methods?

"Yes, there is. You can never get an exact copy of biological systems." ◆

Jessica Rosenholm (pictured right) and doctoral student Didem Sen Karaman.

IS and al-Qaeda

New security threats challenge slow state bureaucracy

Attacks on nightclubs, sports arenas, parks and streets, in editorial offices, youth camps, refugee housing, the metro and on board aeroplanes. Are the decision-makers able to keep up with these threat scenarios?

TEXT & PHOTO: ARI NYKVIST

The threat from various extreme movements, paramilitary forces and pure terrorist organisations, which so far might have seemed rather diffuse to us in Finland, is coming closer to home. Can the Finnish decision-makers keep up with the rapid changes and new threat scenarios that challenge the security of civil society?

"Unfortunately, they can't."

This is the answer given by Doctor **Lars Nicander** who is the Director of the Centre for Asymmetric Threat Studies (CATS) at the Swedish Defence University in Stockholm. He received his doctorate in political science in late 2015 at Åbo Akademi University in Vaasa, Finland, with his thesis *New Threats – Old Routines. Bureaucratic adaptability in the security policy environment*.

CATS focuses on studying asymmetric threats in the age of information. The centre's main areas consist of terrorism studies, intelligence studies and information operations such as cyber security, cyber defence and influence operations.

For his thesis at Åbo Akademi University Nicander particularly explored the fundamental question of how quickly authorities, for example government offices, respond and make new concrete decisions based on various reports and other signals from their intelligence and security services.

"The cold war up to the 1990s created a very stable world. There was no great need for rapid responses, but there was time for slow and bureaucratic decision-making on investing in, for example, new weapon systems such as aircraft, tanks or warships. But in the 1990s it was soon realised that the new and increasing use of various IT systems made the new information society entirely vulnerable and easy to influence, beyond and despite all existing military security measures. We acquired what is called a 'critical infrastructure'," Nicander explains.

New social values to protect

The new and often unpredictable security threats spread their tentacles further and also into civil society. There were suddenly a large number of new values in society to be protected against an increasing interest among various groups, movements and organisations in manipulating, threatening and attacking these values. At the same time several countries, such as Sweden, had to a large degree adjusted to a new form of state government, which is usually called 'New Public Management' where just-in-time delivery and narrow security margins were the norm.

Lars Nicander, Magnus Ranstorp and defense chairperson Steve Lindberg.

"And in the 2000s, after '9/11' in 2001, direct threats and attacks from various terrorist groups increased in number. We haven't yet seen more extensive, competent attempts from such terrorists to also attack the USA or European countries through cyber space. They probably do not so far have the resources or the know-how that such attacks require."

There are not many pre-existing theories, or much empirical material on the issues explored in Lars Nicander's doctoral thesis, which include how closed monopolies in the state apparatus, such as intelligence services and various independent authorities, collaborate in order to respond to new threats.

On the other hand, there have been rapid changes in the way in which, among other organisations, the Islamic state, or IS, acts and operates. Only recently it was commonly believed that IS would not follow al-Qaeda's example and attack civil targets outside of its own area and region. According to Nicander, the only solution for countering this new threat is better and more adjustable intelligence services with sufficient powers.

> "There is no coordination of resources that could be used much more efficiently than presently in order to respond to, among other things, the new security threats.

"In this respect, the former NSA employee **Edward Snowden** has contributed to creating a situation where many intelligence services are more or less blind, at least for the time being. But on the other hand, many countries also have themselves to blame. As all questions and problems pertaining to security and external threats to the security of the citizens, for example in Sweden and Finland, have been treated in a tightly closed system without qualified and competent, independent second-opinion functions, there is a lack of what in Britain, for example, are called 'critical friends'. Therefore the readiness to change and the will to cooperate are weak and in that case relatively self-sufficient authorities become stronger, as is the case in Sweden."

New secure but open think tanks are needed

A far-too-strict secrecy thus leads to a kind of incrementalism: authorities continually add new talents to the battle against, for instance, terrorism, but at the same time nobody is prepared to reduce or even adjust the existing talents and tools. This results in there being even less money than before left for concrete and rapid measures.

"There is no coordination of resources that could be used much more efficiently than presently in order to respond to, among other things, the new security threats," says Nicander.

His suggestion for increasing pluralism and adaptability in security policies is therefore to facilitate the creation of more so-called independent think tanks in the form of 'universities without teaching'. These think tanks could be partly modelled on the international Chatham House, but in these new bodies security classified persons from various open positions and spheres of interest in society could evaluate and analyse the security situation and recommend new government measures.

"This would perhaps challenge and present a competitive edge to the old and somewhat self-conceited knowledge monopoly in this area. As it is, there are simply too many muddled bottlenecks which obstruct the process."

Such bottlenecks can be cleared by increasing government offices' willingness to quickly adopt reports from intelligence services and other signals of new security threats. And to more swiftly include counter measures in budget negotiations and then implement these in a competent manner.

Naturally, Nicander respects the slow but democratic decision-making process where the rule of law is the guiding principle, but he would like there to be a governmental unit that in a professional way could provide comprehensive risk evaluations and focus on long-term planning of defence measures and general security. These are missing today.

"Above all, our government offices need better procurement skills. They must know how to steer and focus the executive social activities in order to create incentives to overcome the inability to change which is innate to bureaucracy." ◆

Nobody is born a Jihadist

"Introducing new strict laws against increasing terrorism is not enough. Deeper and more extensive preventive work, including numerous local measures in countries such as Sweden and Finland is more important than ever in this situation," says Doctor **Magnus Ranstorp**, one of Europe's leading experts on terrorism and militant Islamic groups such as IS, al-Qaeda, Hamas and Hezbollah. He is Research Director at the Department of Security, Strategy and Leadership at the Swedish Defence University, Head of Terrorism Studies at the university's Centre for Asymmetric Threat Studies.

According to Ranstorp, we in the West have relativised the significance of religion and ideology in the increasing occurrence of terrorist acts.

"In our secularised and individualised countries we find it difficult to understand that the rest of the world is much more collectivised and religious than we are. In Sweden our politicians have failed to admit this, and have therefore also to a large degree failed in the Swedish integration policy."

Totally stopping the flow of asylum seekers to Sweden and Finland because a small number of Jihadists might enter among them, is, according to Ranstorp, not a good solution. Instead, it should be possible to identify these people more easily and more quickly than before, by better cooperation between the authorities in the EU concerning, for example, passport information and other ID biometrics.

And all refugees and new asylum seekers cannot be lumped together. There are sectarian tensions also between various refugee groups: different Islamic viewpoints and groupings, the attitude of Christian refugees to Islam and vice versa.

"This is a veritable mosaic of totally different individuals with ongoing dynamics between the groups they are part of. And it is a fact that some extreme groups seem to be increasingly inclined to violence. But the colours and patterns in the kaleidoscope are constantly changing. The prime colours can be made up of socio-psychological factors, such as country of origin, adventure-seeking, religious and ideological pondering and various family ties, but also of purely social and political factors."

"Nobody is born an extremist. Together we can counteract violent extremism through preventive work aiming at strengthening individuals and society. We have not yet seen any larger scale, well-planned attempts at systemically smuggling in Sunni Salafist fighters in Sweden. But when the passports of such fighters are confiscated in countries such as Belgium and France, they instead try to enter Europe on falsified Syrian passports."

It is difficult to identify any clear and simple profile for those who tend to be recruited to IS. The engine of radicalisation has many cylinders and they may consist of strong group dynamics, a few good friends, a person's own family and, increasingly today, of social media, where various symbolic values provide life with meaning.

More preventive measures at the local level with various knowledge centres and citizens' forums, counselling and support for traumatised persons and their families, and a more effective follow-up of correctional treatments are needed as a complement to stricter legislation and longer punishments.

"I'm deeply concerned because of the increasingly marginalised position that immigrants and refugees are forced to live in in Sweden. The infrastructure in immigrant-dense areas contributes to the growth of social gaps and soon society will no longer be able to endure the severe social pressures which will consequently emerge." ◆

Parvez Alam shows an echinoderm – an organism he describes as a primitive eye.

BIOPUNK

Parvez Alam is a docent in natural materials at Åbo Akademi University. He plays a central role in fifteen different advanced bioinspired projects. He is a biohacker. He is married and the father of two children. He is the founder of the world's largest charity organisation within combat sports. He is an ex-professional skateboarder. He is an ex-punk rocker. He is a practising Muslim. He recently turned forty.

TEXT & PHOTO: MARCUS PREST

The whale cranium has disappeared. This is weird. The cachalot whale cranium – which **Parvez Alam's** colleague **Derek Ohland** a few years ago sawed off an animal that had strayed into shallow waters, beached and died – is the size of a small car. Alam and his colleague, Professor **Anusuya Chinsamy-Turan** have tried to find the cranium in the basement of the zoological museum all morning. On the floor in Professor Chinsamy-Turan's office at the university campus in Cape Town, South Africa, there is now instead the cranium of a giraffe. This feels like something of an anticlimax. Parvez Alam had wanted to show me the whale cranium. He would also have wanted to study it further, since it is not the hardness of the whale's cranium – the bone of a cachalot's cranium is softer than that of a human cranium – but something in the structure of the bone that enables the whale to dive down to 3,000 metres. Parvez Alam is interested in exploring how its construction and pressure distribution are connected.

But now it is the giraffe cranium that Parvez Alam and Chinsamy-Turan are talking about. Parvez Alam cannot take the cranium with him back home to Turku, Finland, since it is, first of all, too unwieldy to transport, and secondly, it would take too long to acquire all of the permissions needed. Although it's a matter of skeleton parts and not living material, the bureaucracy required to move a cranium from one continent to another is massive. What Alam can, however, use, is data from a scan of the giraffe cranium.

"What kind of scan, a CT scan?" Chinsamy-Turan asks.

"Yes, CT is good. I can go down to 10 microns with my own gear," Alam answers.

"Is that meaningful? Shouldn't you try and keep it on a scale where you can see the larger patterns?"

"When I go down low enough, I can see various layers and whether the layers have different structures."

"But you must at least stay on a scale where you can see how the tissues interact."

The hypothesis about giraffes (which is relevant for dinosaur researcher Chinsamy-Turan's work) is that long-necked dinosaurs and giraffes have directly related fight tactics which in turn relate to sexual selection. And that the aggressive behaviour displayed in the fight between two male giraffes could correspond to the way in which male dinosaurs fought each other. For Alam, the interesting features are the construction of the cranium and the composition of the skeleton – that is, the structure of the bone. The bone of the giraffe's cranium does not consist of solid material; the inside of it looks rather like fused sugar.

"Look at these channels that go through the skull; these have not been studied before."

Alam shows me a part of the cranium.

"And check this out: the same zipper-like binding between different skeleton parts as those that I've showed you on the piece of whale cranium I have in Turku."

From a material technological perspective it is interesting that the giraffe skull is light, while it also seems to exhibit great durability; male giraffes use their skulls like sledgehammers in their fights.

"This kind of meringue-like structure, which is not solid, has proven to be good at dispersing the energy from impacts, but it's not so good at withstanding static strain and continuous wear."

✦ ✦ ✦

PARVEZ ALAM is a bioscientist specialising in biomimetics and natural materials science. He is a docent at Åbo Akademi University. During his visit to Cape Town he collaborates with Professor Chinsamy-Turan since she is a leading expert on pre-historical organisms, specialising in dinosaurs and their bone structures.

Parvez Alam, Anusuya Chinsamy-Turan and part of a giraffe cranium. Middle: Parvez Alam points at a zipper-like joint in the giraffe cranium. Below: Parvez Alam, Derek Ohland and the wet, still stinking, cranium of a cachalot whale. Photo: Private.

In Cape Town and South Africa Alam also does biosampling: he goes out into nature looking for organisms and biomaterials with interesting characteristics. In his office and the lab in Turku Alam analyses what the materials consist of and based on data from the analyses he makes digital models of the materials' hierarchical structures at molecular level and above. Some materials display characteristics and opportunities which make them of interest for synthetic production – not for making exact copies of the material, but for imitating its characteristics.

One of the basic objectives of Parvez Alam's research is an attempt to identify green, sustainable processes for the manufacture of high-performance materials. The three main areas in his research are materials science, biomedicine and process technology.

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HAVING TALKED talked to Professor Chinsamy-Turan we go for a walk. We walk through the university campus at the foot of Table Mountain. Large, grey trees line the footpath – Parvez Alam feels their trunks; he doesn't know what kind of trees they are, and neither do I. Parvez Alam recently turned forty. He is friendly but also somewhat watchful and he walks in a self-confident, energetic style with a low centre of gravity; in addition to biosciences, combat sports are his great passion. Before he got into research and combat sports, punk music and skateboarding dominated his life. He played in a number of punk bands in his previous home country, England. As a skateboarder he had sponsor contracts and was ranked among the top 10 in Britain in the vert ramp and concrete parks.

"Why did you become a scientist and how did you come to specialise in bioscience and biomimetics?"

"Oh, you go straight for the difficult questions. Let me answer why I work within biomimetics and bioscience: it's one of my great loves, my passion and my great interest."

"But if we look at science instead, as well as being characterised by fundamental research, which is based on curiosity and the wish to understand, science has its roots in industry. When I've worked on the industrial side, it's been in order to earn money for my family. So: the need to earn money is part of the answer to the question of why I have chosen to work within science. I've worked directly in the industrial sector, but most of what I did before that at universities, including Åbo Akademi, was connected to industry in one way or another."

"But as things got difficult with getting funding for the paper-converting projects that I was involved in at Åbo Akademi, I went back to my passion, to what I had started studying when I first came to university twenty years ago – that is, the biosciences. I suppose that for your own sake you must do what makes you happy, if you can."

"Being a scientist is meaningful; it's an ideal. So in 2012 I applied for a grant from the foundation *Ella och George Ehrnrooths stiftelse* in order to study the molecular characteristics of cobwebs. I got 9,000 euros – I took the money and since I was entering something that I loved to do, I went wild. Since then I have pushed on. I've never had as many students as I have now and I've never published as much, either."

Since 2013 Alam has had 18 articles published in scientific journals and 12 more are waiting to be accepted.

"Where I've got to now, within biosciences, is a place where I can bring together my former experiences and the knowledge I've gathered over the years. Paper converting and materials technology have, for example, taught me a lot about fluid mechanics – which is very useful for me just now."

"Within biomimetics and bioscience I learn something new every day. I also learn to appreciate the world. And my mode of working gives me quite a few close-to-death experiences. Particularly when encountering snakes, venomous octopuses and other marine animals that you come across in the course of gathering materials."

"What does your family think of that?"

"Of course they're not always all that enthusiastic about that side of things. But my wife understands this aspect of my character. I seem to have a problematic relationship to adrenalin. I broke my neck and was temporarily paralysed when I was skateboarding, but that doesn't seem to have slowed me down. I think I get a kind of natural high when things are a bit dangerous."

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WHAT IS CALLED called the *Second Scientific Revolution* (and regarded as having taken place between **Nicolaus Copernicus'** publication of *De revolutionibus* in 1543 and **Isaac Newton's** publication of *Principia* in 1687) was, according to the historian of science **Richard Holmes**, characterised by a common ideal of an intensive, even reckless, personal engagement for the sake of making scientific discoveries. During my two years of sporadic contact with Parvez Alam I have often come to think of Holmes' descriptions and stories of these strenuous journeys into previously unknown territories. In his hunt for insects, plants and other organisms Alam goes on long expeditions for many months in the Indonesian jungle, travels over vast areas of East Africa and seems unconcerned with his own comfort and often also apparently unconcerned about his own safety. He says that it looks and sounds more dangerous than it actually is. He also expresses something that on the surface sounds like fatalism ("when you meet your destiny, there's nothing to be done"), but when talking with him in more detail, I realise that his attitude is about taking well-judged risks, analysing which problems he is likely to encounter and how he can overcome them, and deciding whether the endeavour is worth the risk. If the answer is yes and things go wrong despite all preparations and planned actions – then they go wrong.

During the expeditions it is not only animals, particularly poisonous ones, which might cause surprises – Alam has also fallen victim to jungle diseases and parasites in the few years that he has been active as a field bioscientist. However, humans have proven to be the most dangerous creatures. Alam and his various groups have on several occasions been the target of aggression; sometimes he has even been involved in fights. At times it is Parvez Alam's ethnicity that triggers aggression. On other occasions, it is pure opportunism on the part of the attackers.

"There are two things that I believe we as humans can't control to any great extent. One is that we are born. The other is when we will die. Of course there are meaningless ways of dying; carelessness, thoughtlessness and so on. People who look down at their mobile phones while walking or driving take far greater risks than I do. But if you've done everything you're supposed to correctly and you still meet your destiny, they you'll just have to accept it."

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HIS PASSION FOR combat sports has also brought him into interesting situations – within the organisation *Fighting for Lives* Parvez has come into contact with two gentlemen who are involved in the gangs in the Cape Flats area of Cape Town. He has tried to organise an interview with them for me. These two men are former gang members who have been impressed by Fighting for Lives, an NGO of which Parvez Alam is the driving force. Like this organisation, they work with teaching children and young people outside the gangs to defend themselves against criminality. Parvez, for his part, is fascinated by the knife-fighting techniques used by the gangs on Cape Flats.

He has asked me to put on a thick jacket, so I'm wearing a leather coat despite the night being warm. This is because the two gentlemen, who remain nameless, in all friendliness stabbed him twice last time he met them – partly because they were demonstrating knife training and partly as an initiation rite. They persist in training with sharp blades, which more or less inevitably means that at least one of the parties will bleed. Parvez demonstrates techniques for me; he shows how the stabs are delivered at close range using the body as the centre of gravity, their intimate proximity resembling the right and left hooks and uppercuts of boxing.

"They're good guys; they'll stand by you until the end – but they're also a bit moody and easily excited, so don't ask them too much about tactics and techniques. Try sticking to social issues, questions about the history of the area, things like that," Parvez advises me.

"They always carry knives, and if you ask them about technique, they'll want to give you a demonstration of how they do it."

Thus the leather jacket. We are heading to a place in Cape Flats which functions as a demilitarised zone between rival gangs. I'm thinking of techniques we learnt in passing in the army for blocking and taking the knife off an attacker. They don't seem useful. I'm also thinking of my time running the 400 metres. That feels much more relevant. These and other thoughts run through my head as we walk. But then the two gentlemen withdraw from the interview – they send a text message to let us know. They say that they are doing so partly because they don't want to be photographed and partly because there is unrest in the area at the moment; a person was killed last night in one of a series of xenophobic murders and attacks that have spread like a plague through South Africa during the past month. The atmosphere in the area is tense and it might be dangerous for somebody who is conspicuously white to be there. Parvez tries to coax them into a new meeting, but that, too, comes to nothing. There is no point in going, without a clear plan, to Cape Flats in the dark, just to have a look.

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SOMEHOW the association Fighting for Lives, which started when Parvez Alam and a small group of combat sport fans in Turku arranged events to collect funds for street children, has grown into the world's largest organisation in combat sports for street children. The organisation gathers resources for clinics, has built a school for street children in Kenya, takes children on excursions, provides them with food and clean water and teaches them combat sports. Combat sports give the children a feeling of physical integrity that they have never experienced, having slept, perhaps, under a bridge for the last five years; and the sport provides them with an opportunity to defend themselves against adults who often try to abuse them sexually. At the moment the organisation is active in Indonesia, Sierra Leone, Kenya, Ghana and Malaysia. The film star *Cecep Arif Rahman*, who features in *Raid 2* and plays a role in the new *Star Wars* film participates in the activities of Fighting for Lives.

Parvez began his charity work in the field of combat sports by teaching groups in his own children's primary school. First he taught them what he knew; that is, various types of East Asian knife-based fighting methods. Then he realised that this was perhaps not the best thing to teach to primary school children, so he turned instead to the Brazilian combat sport *capoeira*, which contains quite a lot of acrobatic dance elements and is thus fun for children. Since then, Parvez has learnt to combine a number of various combat styles. He and his Fighting for Lives troupe often teach street children self-preservation tactics under the name of *Raw Combat*.

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PARVEZ ALAM'S parents originally came from Bangladesh. They moved to England in the 1960s. Parvez was born in 1975 in Dorchester, Dorset. He tells me about his childhood while we walk along the dark streets. He does not want me to write much about it. He wants me to avoid the adjectives that spontaneously come to me when I try to succinctly describe his childhood in a sentence that is not too revealing, but sufficiently suggestive. Parvez Alam's childhood was, to a large extent, characterised by the fact that he was the only one in the neighbourhood with an Asian ethnic background. He learnt to fight. He got deeply involved with the underworld – which became his home for a few years. His situation did not look good. One way of freeing himself from that situation was skateboarding. He trained a lot. He also got help from friends who were Muslims. Their Muslim faith helped them to control themselves and maintain their dignity in difficult circumstances. At the age of 19, Parvez had a contract as a professional skateboarder representing Great Britain. He was at a warm-up event for a competition in Northampton: as the participants were doing their trial runs on the ramp, one misread the situation and left his board in the way of Parvez who at that moment was in the air above the ramp. Parvez crashed into the board, and fell five or six metres, landing on his neck, prolapsing two cervical discs and exploding one. He was paralysed from the neck down. The surgeons who operated on him happened to be among the best neurosurgeons in Europe. Parvez would have been permanently paralysed had they not tried a method which was experimental at that point and involved taking material from his

Parvez Alam

1975 Born in Dorchester, Dorset, England.

1994 De Montfort University (biomedicine). Misses his last exam and does not complete his degree.

1996 Reaches the final in the English skateboarding championships in Northampton. Breaks his neck and is totally paralysed. Recovers entirely after expert surgery.

1996 Bachelor's Honours programme at the University of Bath (materials science).

1998 Works within product development at the building material company BPB Gypsum in East Leake Nottingham.

2004 Completes his doctoral degree in building engineering at the University of Bath.

2004 Having met his future wife Catharina in England, he moves with her to Finland. On his first day in Turku he is employed within paper converting at Åbo Akademi University.

2012 Applies for and receives a grant from the foundation *Ella och Georg Ehrnrooths stiftelse*. Returns to biosciences.

Left: School building project in Kenya funded by *Fighting for Lives*. **Right**: Combat sports training in Indonesia. Photos: Private.

hip bone and connecting it with his vertebrae by operating through a cut in his throat. After lying for two weeks in hospital he could not take it any more. Rising from his bed, he walked out of the ward and into the city without letting the staff know. He didn't know how to take the support collar off.

Skateboarding was his only plan before the accident; after the accident he continued skateboarding but also took up studying again. He was admitted to a college where he read biosciences – and received the highest grades in all the exams. Due to very weighty family reasons he missed his last examination and was expelled before graduating. He changed to another college and entered onto a course in building and materials technology. His old college phoned up when they realised they had expelled one of their top students. They wanted to offer him the opportunity to return. Parvez told them to go to hell. He completed his studies and started working.

"While finishing my doctoral thesis I suddenly realised how lucky I had been in having that team of surgeons operate on me. Otherwise I would be paralysed now. And I also realised how badly I'd behaved by just walking out without thanking those who had saved me. I dedicated my thesis to the surgeon who had led my operation team. I travelled to the hospital and gave him the thesis personally. We had a good long conversation."

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BIOSAMPLING. In the morning we drive out toward the Cape Point National Park but avoid the official entrances. We find a place right by the sea. Out on the point we see penguins gathered on the beach. This time Parvez is not looking for anything in particular. He just wants to see what he might find. We take off our shoes. In front of us the Atlantic is breaking against the cliffs in foamy waves. Parvez immediately identifies a number of organisms on the cliffs.

At the moment Parvez Alam is leading or participating in 15 different projects within the natural sciences. All 15 projects are in various phases of development. Some of them are at an advanced stage while others have just commenced or are waiting for the time, money and right circumstances to combine in order to be activated again.

One of the ideas he is working on is related to coastal environments and is inspired by corals and sponges. Corals are animals with soft bodies and organs that produce a skeleton of biominerals as a protective shield against its surroundings. Sponges are similar to corals, but they create spicules of glass which form a defence against predators, as well as the pressure of living underwater, and this enables them to anchor onto the sea bottom. The spicules provide the organism with a structural stability and the ability to fasten onto stones.

"I have a third article within this project which has been published in the journal *Composites Part A*."

One of the reasons why Parvez is interested in these organisms is that a problem with green engineering is that it becomes less green when it is applied on an industrial scale. Achieving the specific characteristics of the material to be produced requires the use of energy and chemicals. What Parvez has explored is the production of natural fibres and natural fibre composites – and how materials can be fastened to the composite matrix. Corals and sponges strengthen and stiffen their bodies by using silica, calcium carbonate and proteins. Silica and calcium carbonate exist everywhere; they are among nature's most common building blocks. No harmful effects are associated with either of these materials.

"Somehow corals and sponges manage to create these materials at room temperature and in sea temperatures. My question is why we shouldn't be able to copy this process," Parvez shouts over the noise of the waves.

Preliminary data from experiments conducted by Parvez's natural fibre/composite group show the following: By using a specific amino-acid for making a model of the crystallisation and a model of how calcium carbonate grows on natural fibres, they achieve a one hundred per cent improvement of the durability of the composite in question. And this is, literally, only the beginning. This is one of the numerous projects that Parvez has applied for funding for over many years – with no great success. His basic assumption is that nature has organised things in the most appropriate way, and what we need to do is find ways of decoding its processes. And these processes are totally green, in the concept's fundamental sense: they do not require any extra added energy and the chemicals they use are harmless minerals.

Parvez's group in the natural fibre project has achieved good results. They have managed to grow glass on natural fibres by using unicellular organisms – without adding any extra energy. They have simply let the organism do its job. Nobody else on the planet has so far succeeded in doing this. The basic problem with other methods for transferring glass onto natural fibres is that glass melts at 1,500 degrees Celsius. The fibres will have decomposed long before that temperature is reached. But Parvez's group has overcome this problem.

The three basic characteristics achieved by growing natural glass onto natural fibres are increased strength, stiffness, and topographical features which enable it to fasten onto other materials. The process Parvez's group has developed is biologically degradable from its raw materials to the final product. The material created can be used in various types of green high-performing composite materials, purposes for which conventional fibre glass and carbon fibre – two materials which are not environmentally friendly, particularly not fibre glass – are currently used.

Another of Parvez's fifteen project areas which are connected to coastal and marine organisms is bioadhesives. Bioadhesives are of interest in wound healing, but also within materials science in order to attach different materials to each other. To illustrate this he tries to pull a limpet off a cliff. To no avail. He tries again, very carefully, with another limpet before it has time to react to his presence. No success this time, either. He pulls with all his strength – to no effect. He tries to pry it loose with a sharp stone. The limpet stays put.

"As you can see, bioadhesives are potent. On top of that, these geezers cling to the surface when they sense somebody is near them. It's called *Stefan Adhesion*; a combination of clinging ability and slime. And this slime is simply made up of polysaccharides – in other words, nothing disgusting."

He tries to pry the limpet loose again.

"I'm not giving up until I get one of these loose."

He doesn't manage to loosen any of them. Eventually he finds a floating limpet in a puddle. Triumphantly he picks it up.

We move on along the cliffs and find a small pool, a place where sea water has gathered between the boulders. Small fish are swimming in the clear water. Various types of algae are growing on the stones and along the bottom. Parvez lays down on one of the boulders and tries to see underneath it. He exclaims happily:

"Come over here and take a look at this guy!"

When I lie down flat on my stomach, support myself against a cliff wall on the opposite side and lower my head towards the water I can see a bright lilac coloured sea urchin.

"Don't touch it," Parvez shouts.

He runs to get a few sticks to use for lifting out the urchin. On the second try he manages to get it out of the pool. He lays it down on the cliff in front of us and bends down on his knees to study it.

"That was an amazing piece of luck, wasn't it? But you must be careful – some of these are venomous."

He touches it with his bare hand, but quickly pulls back.

"There you go – I just touched it lightly, but that was enough. Some of these have, as I say, quite a potent neurotoxin in them."

He continues studying the urchin, happy as larry, although his left hand is slowly numbing.

"I don't know what to do with this one. I didn't come here to get this chap specifically, so I don't feel like taking it out, because then it'll die. I'll look at it for a while and then put it back where it was, minding its own business."

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BACK AT the university Parvez takes out his laptop, which he calls *The Beast*. It is powerful enough for running advanced molecular simulations. He is going to show me what the molecular structure of cobwebs looks like. Cobweb research was the first area in which he was given a grant.

Cobweb research can be used, among other things, to make wound-healing material, to make composites for biomedical use based on the molecular structure of cobwebs, and for other types of composites for use in almost any area.

The third article that Alam's group published on cobwebs was submitted directly after a research group in Panama had published an article in *Nature Scientific Reports* which demonstrated that cobwebs actually move towards insects flying in, and take hold of them. The group showed that an electric charge in the insect's body triggers the web, which is pulled towards the insect when it is close enough.

"We weren't even aware that these people in Panama existed or that they worked on something similar. Our study differs from theirs in that our work shows how this functions at the molecular level. The molecules in the web organise themselves so that the cobweb stiffens and becomes immensely strong because of the electric charge carried by the approaching insect. This is why the web is not damaged when the insect hits it. When looking at a cobweb in slow motion it looks like it's a living organism."

Parvez's group carried out its study using *Molecular Dynamic Simulation* (MDS), which is based on the principles for how the atoms in individual molecules behave when exposed to various types of influence, primarily electrostatic forces.

The simulation showed that when the cobweb molecules are exposed to an electric charge, they stretch themselves out because of the electric chain reaction.

"Our hypothesis concerning the durability of cobwebs pertains to this stretching effect. We checked out beta sheets, that is, organised secondary structures that cause crystals to form in biopolymers. We checked the polyalanine segments that form the beta sheets. We checked the hydrogen connections which are electrostatic secondary forces – in cobwebs large numbers of these emerge."

There are seven different types of cobweb. The flagelliform type is a gluey web which forms the radial web. It has a high yield stress and is very glutinous. Parvez's group identified the amino-acids that render this web type gluey and, based on that data, they constructed a biological adhesive for wound healing by introducing the material with bacteriological nanocrystals.

"By controlling the amino-acids we can adjust the characteristics of the composite adhesive."

In cooperation with a colleague at the University of Turku Parvez is working on a project which aims at connecting two different types of cobweb in order to combine the stiff qualities with the adhesive qualities – this would be a material that does not exist in nature. This kind of bioscience is called synthetic biology. Here, too, the purpose would be to construct improved biomaterial for the healing of wounds.

Currently Parvez himself is trying to understand the SCD elements in cobwebs. SCD stands for *semi-crystalline domains*. Since the 1970s five scientific studies have been published, all of which are based on the hypothesis that the SCDs are crucial for the durability of cobwebs.

"The various kinds of cobwebs are classified into three different durability types: hard, soft and medium-hard."

"As far as I know nobody has ever seriously studied how these SCDs are formed in cobwebs. I have a few hypotheses that I'm exploring. The first one is that SCD is formed in the connection between the crystals. The crystals influence the amorphous materials so that they turn into crystals and vice versa."

"My second theory is that if the crystals shear over each other, SCD is formed."

"It's this third phase of a cobweb that gives it its huge capacity to absorb energy."

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WHEN PARVEZ ALAM travels, he always takes with him his powerful laptop, and when going to third-world countries he also brings along another laptop so that students can use both his computers.

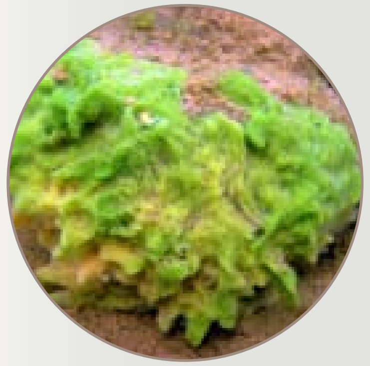
"What they don't have a lot of in the third world is good computers."

Presentations of some of the research projects

Parvez Alam's research is bioinspired – meaning that he looks in the natural world for the structures and characteristics of materials. Marine organisms seem to be the dominant source of inspiration.

Coral and sponge mimetics for advanced composites

ENVIRONMENTALLY-friendly materials are currently an object of great interest within green industrial engineering, but the development of environmentally-friendly green materials has not yet managed to achieve products that would either improve on or be comparable to the performance of synthetic materials. Corals and sponges form hard, rigid and strong skeletons that support and protect the soft organism within it. By imitating corals and sponges Alam thinks it is possible to attain the standards of synthetic materials, and sometimes even exceed them. Alam regards coral and sponge mimetics as a realistic means of developing genuinely 'green' materials.



Left: *Colpophyllia natans*, coral. Photo: Wikimedia Commons.
Right: *Spongilla lacustris*, sponge. Photo: Wikimedia Commons.

Bioinspired biomaterials for healing wounds and growing skeleton parts

A NUMBER of biological materials have a basic biocompatibility with the human body. Many of these materials can easily be bioactivated; that is, made reactive to the cells in the new environment into which the material is introduced. Many of the materials are also developed for integration with cells and are therefore compatible at the cellular level. Some are also able to eliminate harmful strains of bacteria and can improve blood coagulation and cell production. Many of the biological materials also have mechanical characteristics that are compatible with human tissue and human bone. The research group that Alam is cooperating with studies the development and production of biological materials for optimising the wound-healing process and the development of high-performance, environmentally-friendly biomaterials originating in nature. The basic materials include bacteriological nanopulp (from the bacteria *Acetobacter xyllinum*) and natural biosilica (diatoms).

According to him travelling to different places in the world, and above all outside of the Western world, gives perspectives that are necessary for a scientist. In other cultures one encounters different ways of thinking, and very different conditions for both everyday life and research. Different points of departure create alternative approaches to problems.

"I believe that one way of opening your eyes in your job as a scientist is to travel, to not just stay in Finland and attend a conference every now and then. I believe you develop your creativity by working in different cultures."

"It's not about any spiritual journey, although it might include that, and for me it has included that aspect, too. It's about there being such an enormous amount of uncommitted and unused talent waiting to be discovered. What I meant when I said that you encounter different ways of thinking, is that scientists in the third world are often very free in their thinking and not committed to certain structures in the way we are. Of course, they have all kinds of problems, both in their organisations and in the lack of material and equipment, but they often have an open curiosity, thanks to which they might find very interesting and unexpected solutions within basic research, in discovering new areas, applications and in improvising when it comes to equipment and processes. They often find that science is fun."

"Has your Muslim faith ever created an obstacle for you as a scientist?"

"Islam has never been a problem for me as a scientist. However, what is a big problem is industrially-oriented thinking; the subordination of science to money, which in detail regulates what we should do research on."

"There are a number of prejudices and perceptions concerning what religiosity must entail. Such as, for instance, that you cannot believe in evolution if you're religious or Muslim. Evolution is an area where everybody thinks they're experts. And there is a fundamental view of the role of evolution in the history of science. When people have read something by **Charles Darwin** they think they've reached point zero. They know nothing of what was going on much earlier. As if people hadn't been able to think and make observations before that. And nobody seems to know philosophers such as **Ibn Khaldun** (1332–1406) who described human development phase by phase and hypothesised that humans originated from apes, or **Al Jahiz** (776–868) who actually sketched natural selection in a way similar to Darwin's theory a thousand years before Darwin."

"But speaking at a more general level, the lack of a philosophical background among natural scientists results in there being many researchers who are simply not able to think outside of the box, since they aren't aware that they are in that box. To put it another way, they haven't realised that their thinking, within science, is culturally limited to the society they live in and to their social circles. They are unable to see that there are questions and methods that they can't even consider, since the framework for their thinking is too narrowly defined and, furthermore, they haven't noticed that there is a framework in the first place."

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WE FINISH OFF the day by going into the countryside outside of Cape Town to see if we can find any venomous spiders. On the slopes scorched by forest fires Parvez pokes cobwebs and turns over decayed tree trunks. He finds no spiders. Nor any snakes. But he does find the skeleton of a wildcat. The skeleton fascinates him; he thinks we have been extremely lucky in finding it. He takes the cranium home with him. ◆

Parvez Alam testing a cobweb, hoping to find an interesting spider.

Research on diatoms

Transport agents for pharmaceuticals: Concepts that Alam's silica group has discovered in diatoms have given us new ways of delivering pharmaceuticals. One of the advantages that have been discovered is the energetic stability of pharmaceuticals that are surrounded by, rather than immersed in, a transport substance, and the objective of Alam's group is to create a degradable skeleton which forms a capsule around the pharmaceutical substance. Skeletons that occur in nature are optimally adjusted to the molecules or cells that they surround. Alam's group is trying to emulate that same process.

Biotechnology: Biotechnological solutions for developing glass surfaces around natural fibres and other materials. The biotechnology researchers whom Alam collaborates with are exploring and trying to biomimic the chemical and physical structures of the crab species *Naxia tumbida* in order to find suitable fibre treatments that would enable diatoms to fasten onto the material. Alam's group is developing specialised reactors in order to improve the way silicon algae arrange themselves onto fibre surfaces. The aim is to develop high-performance natural fibre composites.

Building engineering inspired by the mechanism in dragonfly wings

Alam's group has studied the morphology and mechanics of the structures of several different types of dragonflies from various parts of the world (including Finland – where native dragonflies have unique development characteristics). Based on their insights into the function of the joints attaching a dragonfly's wings to its body, Alam's group has designed models for durable joining mechanisms to be used in the building of earthquake-safe houses.

Amphibious fish (mudskippers) – biomechanics and robotics

Mudskippers are strange fish that can climb trees and have even been spotted sitting on tree branches. They are capable of breathing above water, creating a water bubble for oxygen diffusion and transporting the contents through their gills. Alam's mudskipper group has studied the fish's movement patterns, slime secretion, clinging capacity, morphology and biomechanics in order to design a robot able to mimic the characteristics of the fish. The first two steps of characterisation have been done – what remains for the group is to understand the musculature and its lines of movement before they can start constructing robot functions.

Bioadhesive technologies

Primarily marine bioadhesives and cobweb-based bioadhesives. There are specific protein structures and amino-acid sequences (and alternatively just specific amino-acids) that give bioadhesives based on proteins a very strong adhesive ability. Alam's group has already succeeded in emulating the adhesive qualities in the flagelliform type of cobweb and is currently exploring polysaccharide-based slime as well as extracellular polymeric substances (EPS) that have a very strong adhesive ability.

Cobweb research

Eco-composites: Development of green composites based on cobweb biology. Includes research into trying to breed a venomous and aggressive spider species in East Africa. It is commonly believed that spiders cannot be bred since they have a cannibalistic nature – but Alam's spider group thinks they have found a species which might be successfully bred. Alam returned to East Africa in August to see how the spider breeding is advancing. The research of the cobweb group also includes the study of how the *Bombyx mori* larvae degummify and regummify their cocoons through low-energy processes and with a minimal quantity of chemicals. The larvae use sericin to glue back the fibres of the cocoon weave to a usable form.

Biomechanics: The biomechanics of cobwebs is a fundamentally important research area in order to understand how the web should be copied for use in synthetic materials. At the moment Alam's group is studying the semi-crystalline molecules of cobwebs – an area which has so far hardly been studied at all. Alam believes the semi-crystalline molecules might be the key to understanding why a cobweb has such an enormous ability to absorb energy.

Synthetic biology: Alam's group combines amino-acid sequences with various types of natural webs to develop a 'super web' with combined qualities from different types of cobweb (there are at least seven different types of cobweb).

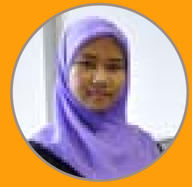
A dragonfly and a dragonfly wing. Photo: Parvez Alam.

A selection of researchers involved in Parvez Alam's projects

Adeleke Amoda. Focuses on implants based on diatoms.

Alex Morin. Studies how the *Bombyx mori* larvae gummify their cocoons.

Immanuel Sanka. Research work includes diatomised fibres, gene technology based on diatoms, bridge construction based on diatoms, replication of diatom surface, EPS analysis and biomodelling, and the pistol shrimp project, analysis of octopus ink. Biohacker.



Siti Fauziyah. Works on architecture based on the dragonfly wing-body mechanism.

Erly Sintaya. Explores the biomechanics of cobwebs and the modelling of cobweb polymers, anti-HIV, octopus ink, biorocks (fast grown corals), pistol shrimps.

What damage is caused by long-term use of antidepressants?

Depression places an increasingly heavy burden on society, although we have an effective medicine for it. The reason might be that long-term use gives unwanted side effects.

TEXT & PHOTO: NICKLAS HÄGEN


Mira Karrasch.

Anti-depressive drugs experienced a boom at the end of the last century with the development of selective serotonin re-uptake inhibitors, or SSRIs. After a few decades during which frequent prescriptions have been routinely dispensed to individual patients, there are many who have begun to question the long-term use of these antidepressants.

The reason for this is a paradoxical result emerging from statistics from Western countries. There is a drug that is effective; it helps and cures people suffering from depression. But despite this the costs of incapacity and disability benefits keep increasing.

"Of course, working life has become more demanding and it's difficult to assess the impact of that aspect. But in general the burden of a disease should diminish and not increase when an effective remedy is discovered for that illness," says **Mira Karrasch**, head of research in psychology at Åbo Akademi University.

The current care guideline in Finland is that treatment with SSRIs should continue for several months, sometimes even years . It is estimated that close to 450,000 Finns took antidepressants in 2012. Of these over 100,000 had taken these medicines continuously for several years.

"The criteria for diagnosis have changed over the years. The threshold for fulfilling them has been lowered and antidepressants are also being prescribed for other problems than depression," says Karrasch.

"In Britain the care criteria and recommendations concerning depression have been adjusted. Drugs are used in cases of acute crisis, but combined with a plan for otherwise supporting the person suffering from depression and for gradually discontinuing the medication. They have abandoned the practice which still continues in Finland, according to which antidepressants are something treatments are started with and the drugs are also regarded as a form of maintenance therapy."

A great deal of research has been conducted on SSRIs, but most medicine studies only last for four to eight weeks, so it is difficult to know what the long-term effects are. However, clinical studies do demonstrate that the risk of recurrence is greater for those who have used antidepressants than those who have been given a placebo.

"There are many medical treatments that have proven to be good or even necessary in the short term, but which cause complications when used for a long period. This is the case with, for example, certain anti-inflammatory drugs. The problem is that there are so few long-term studies on the effects of antidepressants," says Karrasch.

> "
> Most clinical trials are carried out or financed by the manufacturer, and it's natural to limit the trials to six-week studies.

Why is that?

"Mainly because a long placebo-controlled follow-up study would be very expensive and because the authorities do not require long-term studies in order to acquire a licence to put the pharmaceuticals on the market. Most clinical trials are carried out or financed by the manufacturer, and it's natural to limit the trials to six-week studies."

In 2016 the department of psychology at Åbo Akademi University will start a study on how continuous use of antidepressants affects cognitive functions. These include memory, concentration, perception, linguistic, arithmetic and executive functions. The study will mainly focus on working memory, a central guiding function enabling, for example, flexibility in problem-solving situations and the ability to simultaneously process various aspects of everyday life.

"It is known that working memory and the executive functions in general are reduced when a person suffers from depression. The question is to what extent this is caused by the depression as such and to what extent by something else, such as anti-depressive drugs. This is what we aim to answer, and particularly whether the duration of the use of antidepressants is connected to the person's cognitive ability," says Karrasch.

The study is made up of two parts. The objective of the first part is to explore whether there is a connection between the number of years a person has used antidepressants and the function of their working memory. The research is conducted in cooperation with the University of Turku in Finland, Swinburne University in Australia and Harvard University in the USA. The aim of the research group is to get 2,000 participants for their study.

In order to achieve such a large sample, the study is carried out on the Internet, using a web-based cognitive testing platform that has been developed within BrainTrain, an internal centre of excellence in research at Åbo Akademi University, headed by professor of psychology **Matti Laine**.

"If the results turn out to show that those who have used antidepressants for a longer period have a weaker working memory, the question of the causal connection will still remain. Could it be the case that those who primarily have a weak working memory function are more inclined to be depressed and are therefore also more likely to start using antidepressants? This is an option and therefore a forward-looking research approach is also needed," Karrasch explains.

In the second part of the study new students will be recruited for conducting the same web-based questionnaire and working memory test. The results will be followed up after two and four years, in order to collect comparable data and potentially make it possible to answer the question of whether a weaker working memory capacity has existed prior to the occurrence of depression and the use of antidepressants. This latter part of the study will start in the autumn of 2016 at the earliest.

Åbo Akademi University 100 years

A history in three parts of the 100 years of Åbo Akademi University will be published by its centennial year, 2018. The history will present a broad perspective on Åbo Akademi University and will also contain a number of in-depth studies based on issues that current historians are particularly focussing on.

TEXT & PHOTO: NICKLAS HÄGEN

Åbo Akademi University was founded in Turku, Finland in 1917 and the university commenced its activities in 1918. The university's centenary will be commemorated in 2018 with celebrations including the publication of a 100-year history. One part of this history will be a traditional synthesis, written by **Nils Erik Villstrand**, professor in Nordic history at Åbo Akademi. The two remaining parts will take the form of anthologies, one of which approaches the history of the university from the perspective of the history of science and ideas, while the other explores the relationship between Åbo Akademi and society. The former is edited by researcher **Laura Hollsten** and the latter by researcher **Anders Ahlbäck** and docent **Henry Nygård**; all the editors work within the department of history at Åbo Akademi University.

According to Nils Erik Villstrand, one aspect of working on this centennial history is to look at things that do *not* exist today.

"As historians we should shift the focus away from teleology; things did not necessarily have to develop in the ways they have. We should point out the fact that there have always been alternatives and active subjects making specific choices. We mustn't deny that many positive things have been done and something valuable has been created, but at the same time we will represent a critical perspective," Villstrand says.

According to him, the general overview will take the form of a good local history, saying something on everything. Villstrand's aim is to situate the establishment of Åbo Akademi University within a larger context: the break-up of empires and World War I. In Russia the Tsar abdicated as a result of the February Revolution in 1917, which for Finland led both to independence and civil war. In the wake of World War I the Austro-Hungarian Empire collapsed into a number of European national states where one nationality dominated each population.

These new nations sought to strengthen their identities and legitimise their existence by emphasising their characteristic features. One of the functions of the universities in the new, considerably smaller states was to contribute to the project of nation-building.

"In the entire Habsburg or Romanov Empire, perhaps with the exception of Helsinki, it was possible to work as a German- or Russian-speaking professor and travel within a large area. And then suddenly there were, instead, many small countries where the university was to play a totally different role from that of being part of an empire – it was to form the basis of a national state," Villstrand explains.

"The university was to build the nation while also being at the forefront within the world of science. It was like a donkey between two haystacks. The combination of these two aspects is an interesting question to explore."

While the general part of the history is to say something on everything, the anthologies will contain in-depth studies of a number of narrow fields. In order to create focus an exclusive selection was necessary, according to Laura Hollsten, and therefore some subjects and faculties are not included in the anthologies at all.

This selectiveness is to a certain extent compensated for by the extensive background of the anthology authors. The history working groups include researchers and professors from the subjects of history, folkloristics, comparative literature, philosophy, sociology, information technology and chemical engineering at Åbo Akademi University.

"We'll conduct various case studies asking how new knowledge emerges at a university and what the contributing factors are. One example being explored is the first Rector of Åbo Akademi, **Edward Westermarck**, his network, and specifically how the theory of relativity was received. In this case certain individuals are the objects of study, and therefore the narrative is not characterised by a broad perspective," Hollsten says.

Nils Erik Villstrand and Laura Hollsten.

So how was the theory of relativity received here at the university?

"Well, it could be said that Åbo Akademi was not part of the avant-garde, at least. But it might have been a wise decision on the part of a professor with the sole responsibility for a small department not to immediately declare himself to be an advocate of something that would perhaps prove to be a passing trend," Hollsten says.

Despite the focus on narrow areas, can you identify a certain general mode of operation at Åbo Akademi University? Is a broader pattern discernible?

"One defining factor is the small size. Subjects were small, and the fact that this was a small university meant that the professors to a very great extent set the tone and dictated the research profile of their subjects," Hollsten says.

"Another factor is its Swedishness. This is a minority university in Finland, which meant that the orientation towards the Nordic region and Sweden was key, not least in the recruitment of staff. The Faculty of Theology has attracted personnel from Sweden to such an extent that we could call it a 'Swedish diaspora.' Overall, the number of Swedish members of staff has been very large.

Focus on internationalisation

One issue that the history researchers pay attention to is the nature of international networks over the years. According to Villstrand, this is connected to the attempts on the part of present-day scientists to be good Europeans.

"While it was previously taken for granted that researchers had contacts with colleagues that they found interesting, today we call it 'internationalisation," says Villstrand.

What is the reason for this change? Is nationalism taken as a point of departure today, as something one moves away from by being international? Internationalism as such is not anything new?

"Not at all. It's just a question of naming and paying attention to the phenomenon, that's the difference," Villstrand says.

"Transnationalism is currently a buzzword within history research and the history of science, just as globalisation was a few years ago. But universities do have a national mission and nationality research has always been very important. While the tendency today is to deconstruct the nation, it has always been taken for granted that universities have a public duty, too. Today it is perhaps mainly a financial one, but also one of creating a basic identity," says Hollsten.

During its early years, Åbo Akademi was very international. In order to safeguard Swedishness in Finland, the university was very much oriented towards the other Nordic countries, a tendency which is still in evidence today in the names of some subjects within the humanities, such as 'Nordic history' and 'Nordic folkloristics'.

> "It could be said that Åbo Akademi was not part of the avant-garde, at least. But it might have been a wise decision on the part of a professor with the sole responsibility for a small department not to immediately declare himself to be an advocate of something that would perhaps prove to be a passing trend.

"I think that the natural scientists at Åbo Akademi University too have had more contact with colleagues in Sweden than is the case at other Finnish universities. It's difficult to measure and compare these things, but looking at the correspondence of individual professors at Åbo Akademi University, it proves to be very international," Hollsten says.

"Before World War II it mainly looked to colleagues in Sweden, but also in Germany and other countries in continental Europe. After the war the orientation increasingly turned towards the USA. This was the trend in the entire academic world, but it is obvious that Åbo Akademi was very international at an early stage – perhaps even more so than later."

What is the significance of the 100 year anniversary of Åbo Akademi University?

"Jubilees are a good reason to stop and reflect on why and how things have developed in a certain direction, on what we currently have and on the way forward. This is something every organisation needs," says Villstrand.

"And not a single university history has been written without an anniversary. It just does not happen," Hollsten points out.

What function will the history fulfil once it is completed?

"I hope that the anthology texts will be at a good level scientifically and also interesting to read, that they will be based on high-quality research and can be rewritten for publication in an international journal on university or science history. Thus they could contribute to strengthening the research environment on the history of science at Åbo Akademi University," Hollsten concludes.

"We have managed to create new interest in the history of universities and have been able to attend conferences on the subject. This has had further impacts and strengthened both our own and other subjects." ◆

Why is ice slippery?

BENJAMIN ALM

When you are ice-skating you make use of friction in two ways – you glide forward and press sideways and outwards so that the blades of the skates cut into the ice in order to gain speed. But why do the skates glide so effortlessly on ice? Although this seems to be a simple question, it is only fairly recently that physicists have been able to provide a satisfying answer.

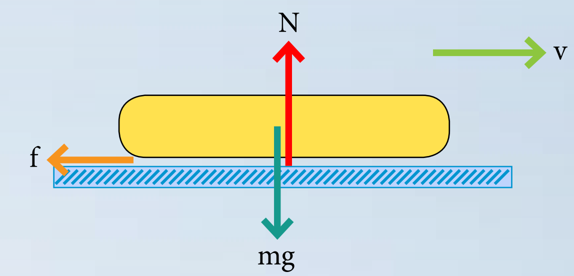
"We haven't really understood why ice is so slippery, and there still remain some unclear aspects to the question," says **Johan Lindén**, lecturer in physics at Åbo Akademi University.

He himself was once taught that the skate blade exerts enough pressure on the ice during skating to melt the topmost layer of the ice, but this has since been demonstrated not to be the case. Another mistaken theory is that it is the friction which melts a thin layer of ice and which is consequently diminished as the meltwater then functions as a lubricant. There might actually be some truth in that explanation, according to Lindén; but it is not the whole truth.

Recently it has been discovered that the outermost layer of ice is always made up of a thin 'quasi liquid'. The topmost layer has no neighbours above it, and thus the water molecules can move more freely. Lindén compares the phenomenon to the surface tension of the top layer of liquid water. The layer is extremely thin, only 10–20 nanometres thick, but it is enough to make the ice slippery.

As skis have a larger contact area with the surface that is skied on, does that mean that they have less friction than skates?

"No, not at all. Friction is caused by two factors: a friction coefficient specific for the material in question and the weight of the burdening object, which is measured in Newtons. The fact that skates and skis are differently constructed is due to other factors, and I imagine that the way in which you sink into the surface is significant. That is to say, the size of the contact area does not affect friction. Skis do, nevertheless, always have a larger movement resistance in the form of loose snow which is pushed aside during skiing."



$f = \mu * N$

- f – friction force, opposite to the direction of movement.
- μ – friction coefficient, for ice approximately 0.005.
- N – the supportive force of the surface, equal to mg on a plane surface.
- mg – the weight of the burdening object (measured in Newtons).
- v – speed.

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in brief...

FARMING CHEMICAL MAY BE AFFECTING THE REPRODUCTION OF FISH

A GROWTH HORMONE commonly used within cattle breeding in, for example, the USA, Argentina and Australia, has been demonstrated to affect the behaviour of fish in a way that might have ecological and evolutionary consequences. A low concentration of the hormone in water is sufficient to impact on the reproductive behaviour of fish.

Researchers at Åbo Akademi University, in cooperation with colleagues at, for example, Monash University in Melbourne, Australia, have found that the steroid 17β-trenbolone, used for enhancing muscle growth in cattle, changes the reproductive behaviour of guppies – also known as millionfish (*Poecilia reticulata*).

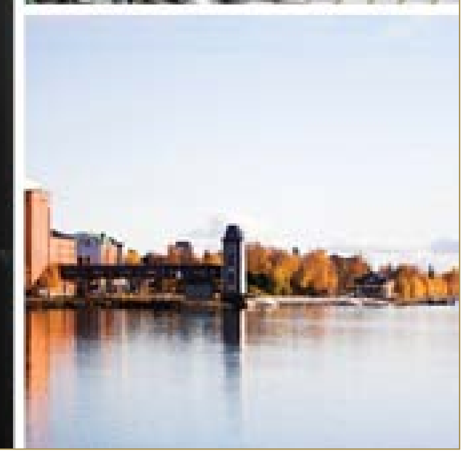
Their research results have been published in the scientific journal *Hormones and Behavior*. Dr **Minna Saaristo**, researcher in environmental and marine biology at Åbo Akademi University, is one of the main authors of the article. At the moment, she is stationed at Monash University.

"This steroid is part of a group of endocrine-disrupting chemicals (EDCs), which find their way into the environment along various channels, from household waste to farming discharges and industrial emissions. There has been increasing concern about these chemicals for the last few decades. The way in which they pollute and affect aquatic environments is a serious environmental problem," says Saaristo.

These research results have for the first time shown that exposure to a quantity of the hormone 17β-trenbolone which is realistically found also in the environment – about 22 nanograms per litre – might be enough to negatively change the reproductive behaviour of male fish. It appears that male fish exposed to trenbolone stop courting female fish and instead use a so-called 'sneaking' strategy, where they sneak up behind the female and thrust in their sperm. This sneaking strategy is far more ineffective than the courting strategy and research has shown that female fish prefer male fish that perform a mating dance with them.

"Within the EU, trenbolone is banned in cattle breeding, but researchers in Denmark have measured high levels of the chemical in sewage water from gyms, since it is a popular hormone among bodybuilders," Saaristo explains. ◆

Åbo Akademi University



Åbo Akademi University (ÅAU) is a multidisciplinary and an internationally acknowledged research university in Finland. Åbo Akademi University, with two main campuses in Turku/Åbo and Vaasa/Vasa, offers high quality education in Swedish and English for approximately 7 000 students and has a very low student teacher ratio – class size is often small and teachers have time to assist students individually. Around 1 000 international students study and conduct research at ÅAU.

Internationalization is an important part of all activities at the university and ÅAU offers International master's programmes taught in English. In a national comparison graduates of ÅAU generally have excellent employment prospects. ÅAU provides a unique, inspiring and international environment for research and education.

For more information, please visit **www.abo.fi/en** and **www.abo.fi/master.** ◆

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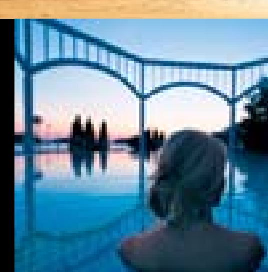

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