

The boundaries of science 10

**Lake Geneva's
tsunamis 30**

**Is university just for
the rich?..... 36**

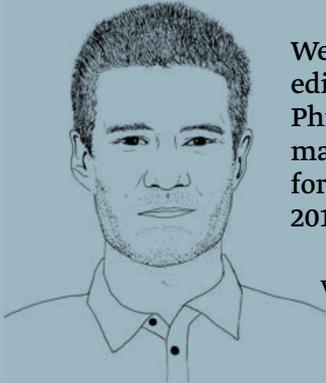
**Dealing with the risk
of breast cancer 44**

Dear readers,

At last we can see you clearly: you're a 58-year-old man from German-speaking Switzerland. At least this is the statistical average according to our reader survey - for which we would like to offer our warm thanks to the 2,349 participants. You are (or were) mostly active in the technology sector, the natural sciences or medicine; you like to read articles that give an in-depth view of a topic, and you're so kind as to give us the overall score of 'good'. We will analyse your answers further and do our best to offer you stimulating articles - especially if you're not an 'average' reader.

Your critical comments have naturally been especially valuable to us - though we cannot fail to mention that you sometimes have very different needs, despite all avowals of interdisciplinarity. But you are clearly united in your desire to have more articles that are critical and self-critical. We are doing our best to comply. So on page 38, you will find a speech by the former Director of the Swiss Arts Council Pro Helvetia, Pius Knüsel, which he gave in September at the science communication conference ScienceComm. Knüsel caused something of a stir among the experts present because he essentially recommended stopping science communication altogether - especially as it is practised in research magazines. And he believes it would be for the good of science.

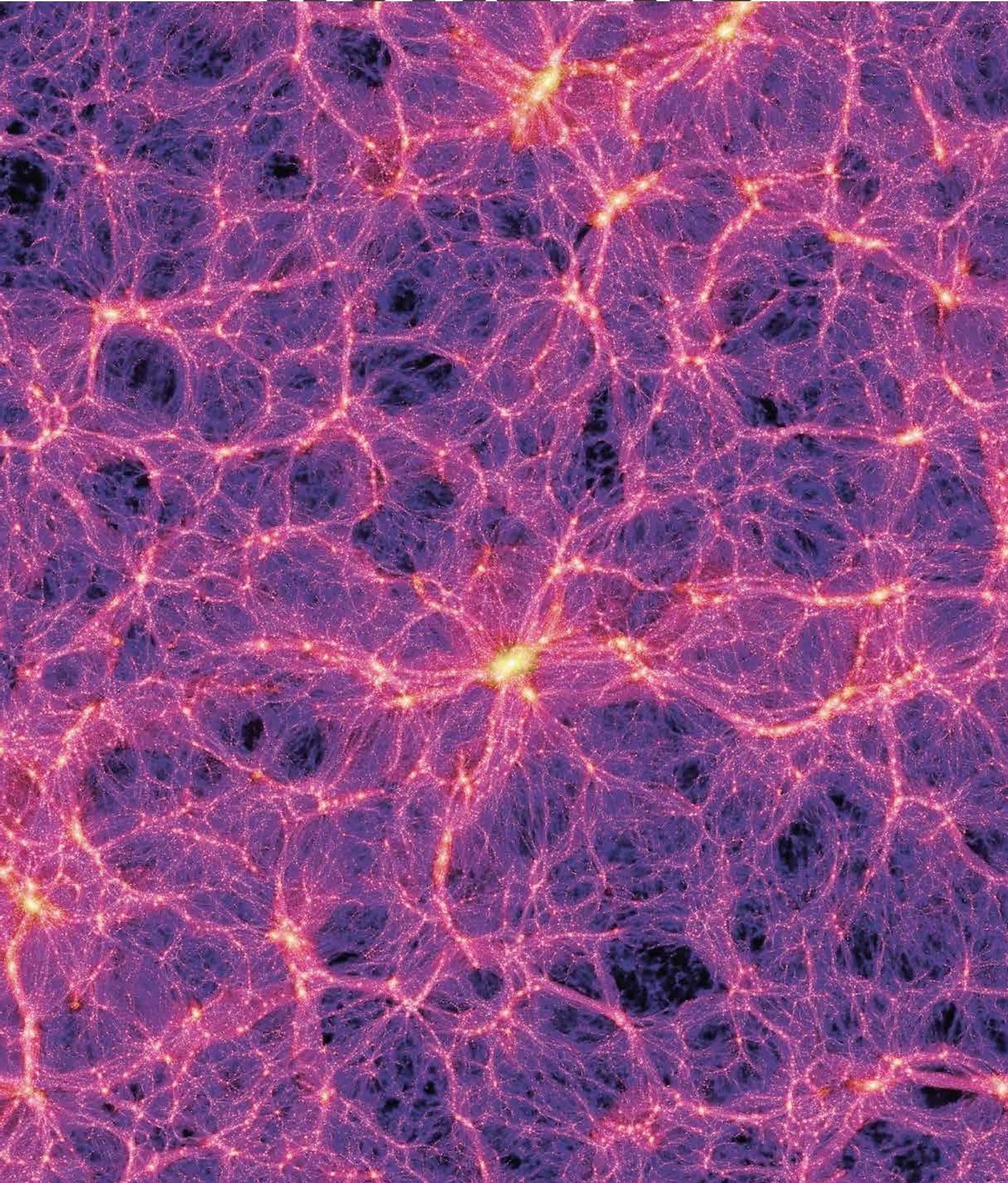
Last but not least, some readers would like a whole page devoted to readers' letters. We would like that too! So please write to us, at: horizons@snf.ch

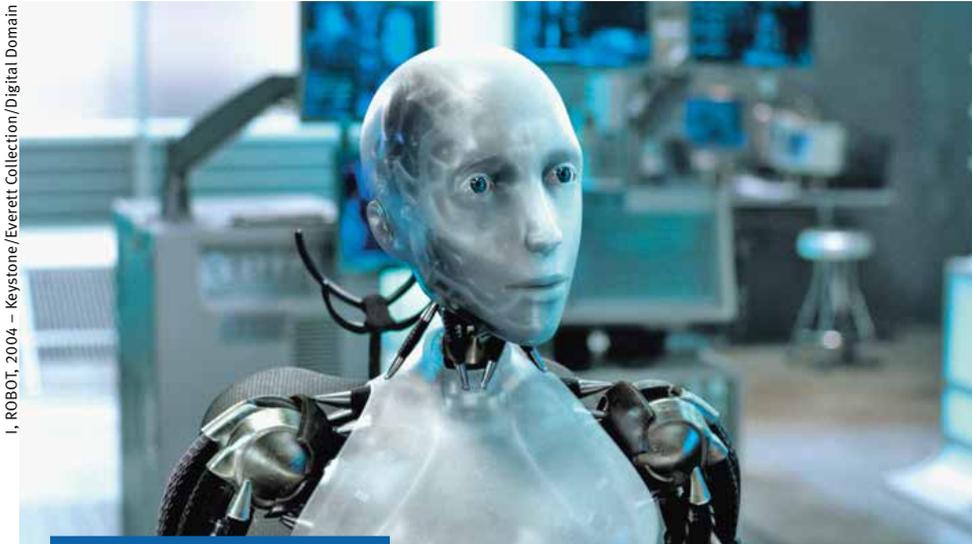


We have just one more piece of information, and it's about us: our chief editor Urs Hafner is leaving the team, along with Ori Schipper and Philippe Morel. They have steered the research magazine *Horizons* over many years, and we would like to thank them and wish them all the best for the future. Our new chief editor Daniel Saraga will start work in early 2015, alongside a partially renewed team.

Valentin Amrhein, Chief Editor (ad interim)

horizons

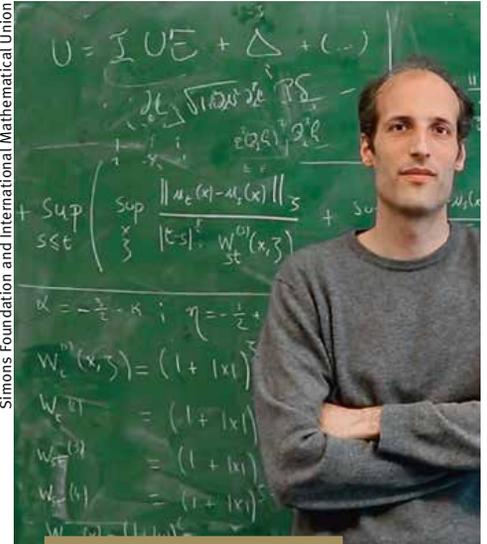




I, ROBOT, 2004 – Keystone/Everett Collection/Digital Domain

Focus: The boundaries of science

26



Simons Foundation and International Mathematical Union

Environment and technology

10 The boundaries of science

What can we know? And do we want to know everything that we can? We discuss the boundaries of knowledge, the ethical boundaries of research, and the breakthroughs that five scientists expect to happen in the next 20 years.

- 13 **Do we know what we can't know?**
- 16 **Boundaries we've crossed – and boundaries we haven't yet**
- 21 **The ethical and legal boundaries of science**

- 26 **The equation tamer**
Martin Hairer makes sense of impossible equations. For this he has received one of the highest awards in maths: the Fields Medal.
- 28 **When vibrations become quantum**
Tobias Kippenberg was barely out of childhood when he began inventing a black ice sensor. Today he investigates quantum oscillation phenomena in micro-resonators.
- 30 **Lake Geneva's tsunamis**
Lake Geneva has experienced tsunamis five times in the past 4,000 years, with waves up to six metres high.
- 31 **A Swiss cross made of 20 atoms**
Rosetta: returning to the solar system's infancy
Monsoons prevent selenium deficiency

◀ Computer simulation of the distribution of dark matter in a section of the Universe (diameter: 824 million light years). Dark matter is not visible to our telescopes because it doesn't transmit any radiation. It probably constitutes some 25% of the mass of the Universe, and its composition is an important, unsolved astrophysical question.

Photo: Keystone/Science Photo Library/Volker Springel/Max Planck Institute for Astrophysics

Image on back cover: The constellation of Cygnus (top left) with the red gas nebula NGC 7000 (the 'North America Nebula'). From top left to bottom right, dark clouds of gas and dust cover part of the bright band of the Milky Way. They obscure the stars behind them and are clearly visible with the naked eye. It's in dark clouds like these that new stars are born.

Photo: Keystone/Science Photo Library/Eckhard Slawik.

32

Wikimedia Commons/Shiny Things



Culture and society

32 **The World Bank's clients are leaving the building**

Many emerging countries are switching to development banks whose majority backers aren't the Western industrial nations.

34 **When helping isn't enough**

Dreadful donation statistics in Switzerland: the role of patient organisations in the debate about organ donations.

35 **Science as a career** **When Basel's newspaper was liberal** **Africa is ageing quickly**

36

Keystone/Marcel Bieri



Knowledge and politics

36 **The university – an institution for the upper and middle classes**

The Swiss scholarship system is a real federal mess. What can we do to ensure equality of opportunity for everyone in education?

38 **"Showcasing damages science"**

Most science communication is propaganda, says Pius Knüsel. It only offends people if you offer them pre-digested signifiers of the importance of science.

41 **Technology: still a man's job**

Careers in technology and the natural sciences have too many vacancies. 3,500 school students offer us possible reasons why.

42

Christian Reistab, Eawag



Biology and medicine

42 **Diversity lost for ever**

Despite the improved water quality of many lakes, their original water flea species will never return.

44 **"Their breasts become threatening"**

The sociologist Maria Caiata Zufferey is researching into how women with a higher genetic risk avoid getting breast and ovarian cancer.

47 **The changing face of the AIDS virus**

With its ability to recombine, HIV is a headache for researchers.

48 **Earwigs: The chemistry has to be right** **The risk of illness in junk DNA** **Fighting Parkinson's with genetic engineering**

In pictures

6
A wandering marker pen

Debate

8
State funding for the media?

Fieldwork

24
Winning a race against time

How does it work?

49
Measuring altitude

Access all areas

50
Only international scholarship can achieve universal validity





A wandering marker pen

Rather like Obelix and the magic potion, the giant day gecko shown here looks like it must have fallen into a pot full of luminescent ink when it was little. In the tropical rainforests of Madagascar inhabited by these 12-inch lizards, the luminescence of their scaly skin plays a role in mate selection. But how do they get these magnificent colours in the first place, ranging as they do from yellow to pea green, and in some cases even stretching to a resplendent, bluish turquoise?

In order to answer this question, biologists and physicists have come together in a project called 'United Living Colors'. Led by Michel Milinkovitch of the University of Geneva, these researchers have made complex investigations and mathematical models of the optical qualities of the day gecko's different skin cell layers. They have shown that it's not just different pigments, but also tiny, transparent crystals in the skin that help to create the lizards' colour.

Whereas the yellow and red pigments absorb a portion of the light spectrum, the precisely ordered nanocrystals scatter the incoming rays of light and use interference to create their blue tint – that's the same physical principle that causes the shimmering of butterfly wings and soap bubbles. In this manner, the day gecko orchestrates a veritable symphony of colours as it roams through the jungle like a wandering marker pen. *ori*

S. V. Saenko *et al.* (2013): Precise colocalization of interacting structural and pigmentary elements generates extensive color pattern variation in *Phelsuma* lizards. *BMC Biology* 11: 105.

Photo: Michel C. Milinkovitch/LANE

Good media, bad media

The media are in a state of crisis. How should the State help them? Otfried Jarren believes that what works for academia will also help the media. He recommends creating a “National Foundation” for quality journalism. Felix E. Müller, however, warns that this would be a national blunder.

Valérie Chételet (photomontage)



Academia, like the media, needs freedom. That is why academic freedom and freedom of the press are firm components of modern constitutions in democratic countries. Universities and research institutions are dependent to a large degree on state funding. Research in Switzerland is in essence financed by the state. The SNSF is a foundation and has a complex system of governance so that the funds provided to it by the state are distributed in a manner that embodies impartiality, promotes excellence, and avoids any direct political influence. That is right and proper. And it works. Active scholars are responsible for allocating this money - which means peers make decisions on applications submitted by peers. Of course, this system has repeatedly been a matter of discussion, for example when support is too high for disciplinary research and too low for interdisciplinary projects. But at the SNSF an internal discourse is complemented by external evaluations. All this helps to maintain the quality of the award practice.

In the media, too, peers are active - in the form of journalists. As professionals with a specific role, they work according to professional standards, selecting items according to newsworthiness. Quality standards may vary, but there are regulations that apply to the media as a whole and to specific branches of it. Ombudsmen, press councils and the independent appeals body for radio

and TV (UBI) engage in discussions and issue reprimands when mistakes are made.

Peer evaluation and peer controls are not as established or as institutionalised in the media sector as they are in research. The reasons for this are also to be found in media freedom - and that is perfectly justified. The media, unlike scholarship, are not state-financed. However, public authorities have created numerous possibilities for funding: fees for public servic-

“The representatives of the sector should participate in deciding on possible support measures”.

Otfried Jarren

es, reduced VAT rates, reduced postal rates for daily newspapers, and financing corporate publications. In a democratic state, there should be no direct promotion of the media. Indirect measures, however, have been up and running for a long time. Direct support would be problematic if it were linked to decisions by the authorities that could have an impact on media content.

Every democratic state has its own media regulations and designs them in order to ensure that democratic objectives are met. In Switzerland, with its several

national languages, its direct democracy and its referenda, the mass media have a special intermediary function. There is a concentration of the press, there are media monopolies on a local and cantonal level, there is a shortfall in providing media and there is increasing competition on the print and TV scene at home and abroad. And all these have consequences. It is obvious to everyone that the non-local daily newspapers are in a state of financial crisis. The Federal Media Commission (FMC) has carried out a scholarly analysis of the situation and suggested a series of measures. Essentially, these constitute a change in policy: instead of a state-dominated media policy, they suggest peer participation, i.e., media governance. The representatives of the sector should participate in deciding on possible support measures. A foundation independent of the state should be created as a central funding instance. The FMC regards the SNSF as a possible role model in the creation of a “Swiss Media Foundation”.

Since 2012, Otfried Jarren has chaired the Federal Media Commission set up by the Federal Council. He is a professor of journalism at the Institute of Mass Communication and Media Research IPMZ at the University of Zurich and is Vice-President for Arts and Social Sciences and a member of the Executive Board of the University.



The Federal Media Commission (FMC) appointed by the Federal Council has recently published proposals on possible ways of assisting the crisis-ridden media sector. In principle this is a laudable exercise, not least because the sector is now undergoing a fundamental structural crisis. At the same time, however, a direct democracy such as Switzerland is dependent on a media system that offers a reliable information service in the interests of voters. The Commission's proposed solution is to use state funding to help the media. The Commission therefore suggests giving financial support to the news agency SDA - an approach that is only in part fit for purpose because it would be the free-of-charge media that would profit most. Furthermore, they say a new foundation for supporting quality journalism should be created with federal funds.

These proposals confirm the old adage about roads paved with good intentions, because there is no scientifically proven way of determining when an article is 'good' and when it is 'bad'. To be sure, there are minimal standards of workmanship to which journalists must adhere. But political convictions and emotions also play a role. These all elude any attempt at scholarly objectification to such a considerable degree that no serious basis can be provided that would justify allocating subsidies.

From my own experience I know that readers tend to find an article good when it

supports their own opinions, whereas they are quick to form accusations of "tabloid journalism" when it does not. A commission appointed by politicians will hardly be able to avoid such reactions. It will find itself faced with the question as to whether the *Weltwoche* - to name one extreme - in fact demonstrates "quality journalism". The Federal Councillor Ueli Maurer believes it does, but others would disagree. Conversely, there will not be many in his party, the

in the media business and choose winners and losers. It's not just fundamental reasons of state that speak against it. It would also hinder the structural changes that are taking place at the moment - changes, admittedly, that are currently a journey with an uncertain destination.

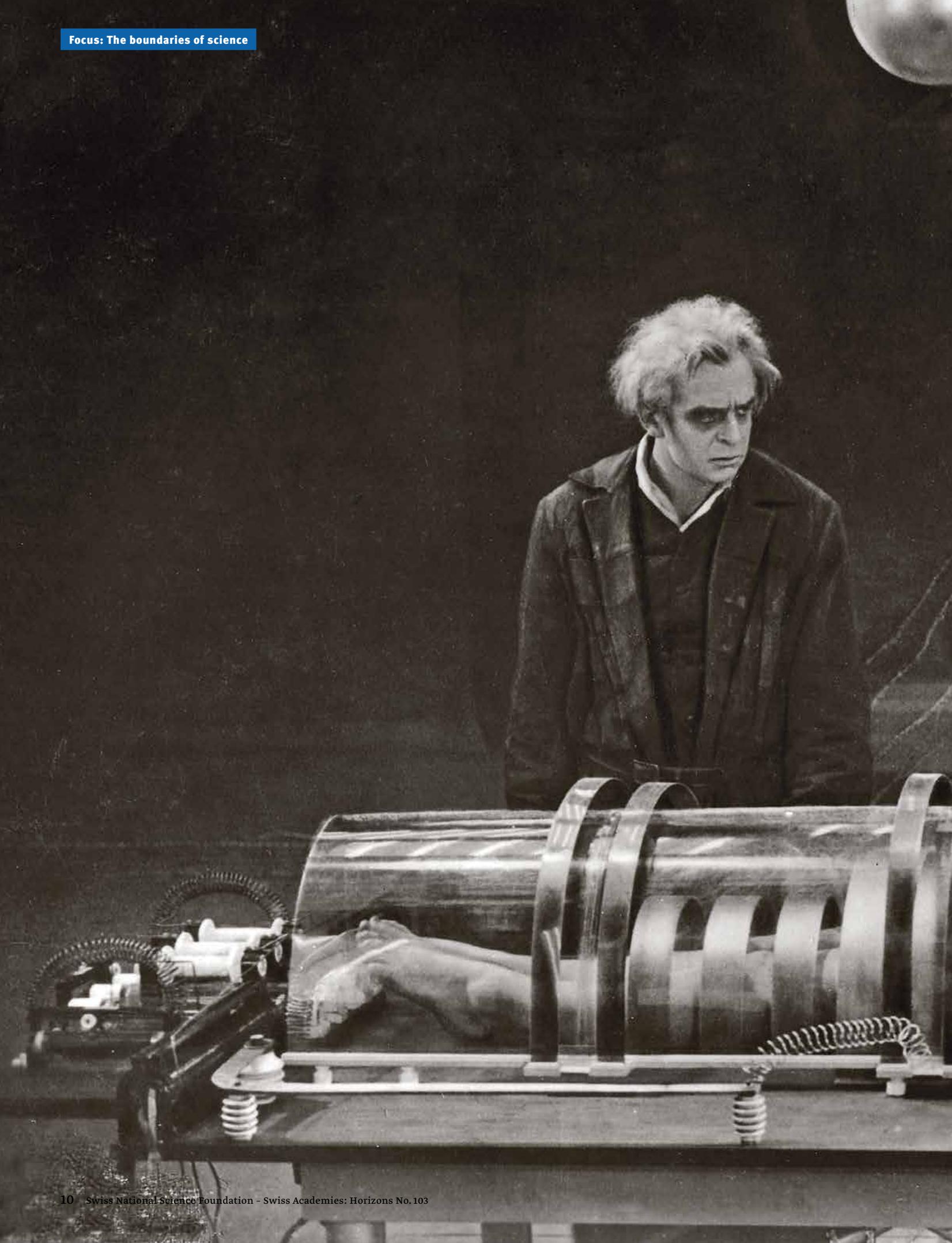
Felix E. Müller has been the editor-in-chief of *NZZ am Sonntag* since 2001. He first studied chemistry, then took his degree in German, musicology and maths.

"There is no scientifically proven way of determining when an article is 'good' and when it is 'bad'".

Felix E. Müller

SVP, who would be in favour of giving state monies to the left-wing weekly *WOZ*. Even in a supposedly non-partisan commission, it will be impossible to eradicate such ideological preferences.

All this would soon turn into a very Swiss solution: there would be a distribution quota based on political or regional considerations. The result would lock the structure of the media sector in its current configuration. That makes no sense. An enlightened state, one that is founded on the basis of a separation of powers, should never dabble



The boundaries of science

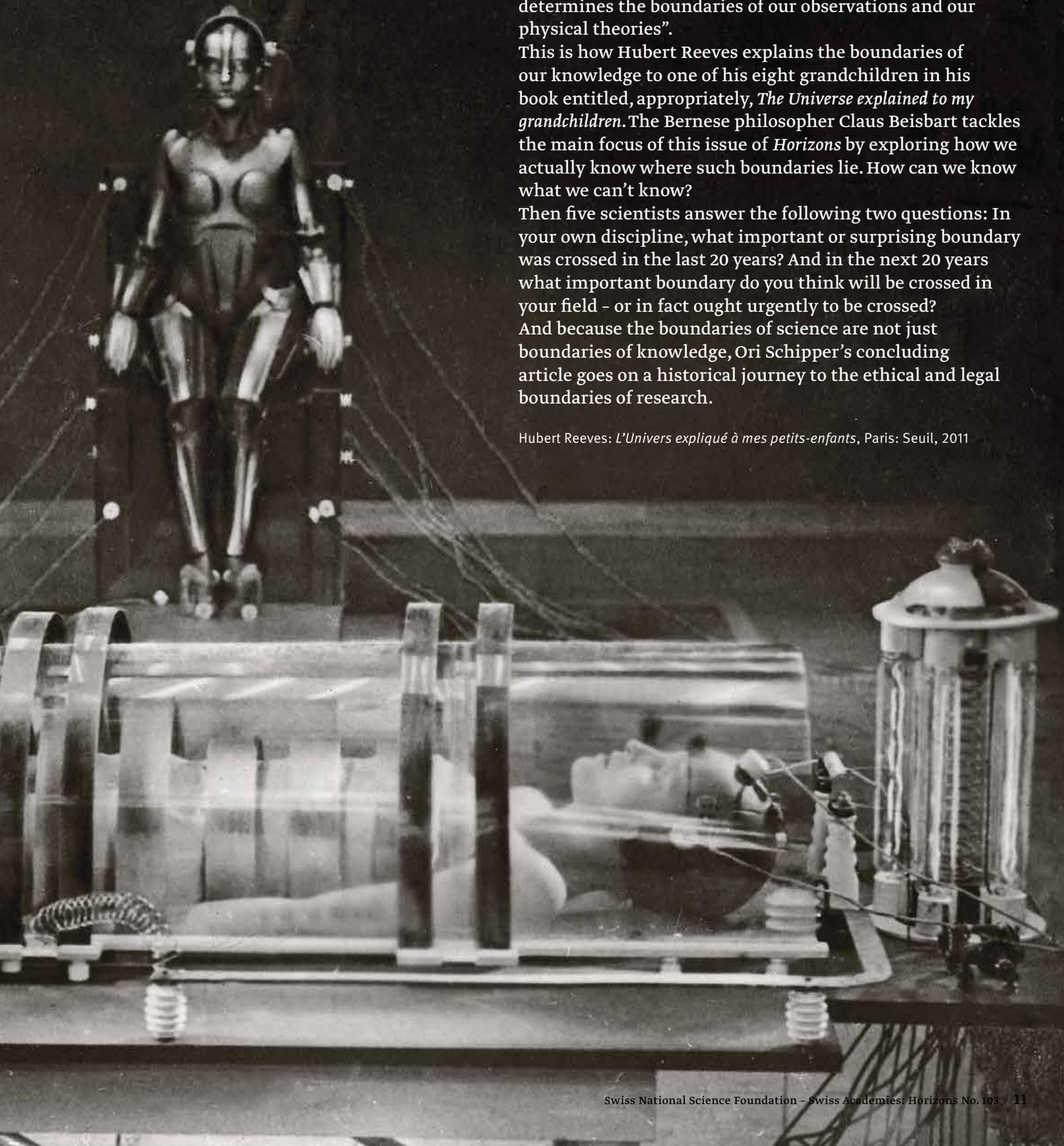
What came before the Big Bang? We don't know. But according to the astrophysicist Hubert Reeves, "that doesn't mean that nothing happened prior to the last 13.7 billion years, only that we know nothing about it. I'd say

that the Big Bang signifies the horizon of our knowledge about the past. It's not a beginning, just a horizon, one that determines the boundaries of our observations and our physical theories".

This is how Hubert Reeves explains the boundaries of our knowledge to one of his eight grandchildren in his book entitled, appropriately, *The Universe explained to my grandchildren*. The Bernese philosopher Claus Beisbart tackles the main focus of this issue of *Horizons* by exploring how we actually know where such boundaries lie. How can we know what we can't know?

Then five scientists answer the following two questions: In your own discipline, what important or surprising boundary was crossed in the last 20 years? And in the next 20 years what important boundary do you think will be crossed in your field - or in fact ought urgently to be crossed? And because the boundaries of science are not just boundaries of knowledge, Ori Schipper's concluding article goes on a historical journey to the ethical and legal boundaries of research.

Hubert Reeves: *L'Univers expliqué à mes petits-enfants*, Paris: Seuil, 2011





◀ Maria in the transparent tube from which her form will be transferred to the 'machine human'.
METROPOLIS, 1927
Photo: Interfoto/CCI

'Beaming' means dismantling matter into its atomic particles, sending them to a different place, and reassembling them there.
STAR TREK, 1966–69
Photo: Keystone/Rue des Archives/RDA

Do we know what we can't know?

“What can I know?” – For Immanuel Kant, this was one of the fundamental philosophical questions. But what does this question actually mean? How can we answer it today? And why is it important? *By Claus Beisbart*

We all know from everyday experience what it's like to reach the boundaries of our knowledge. The examiner asks me sternly: “When did the Battle of Waterloo take place?” Bathed in sweat, I have to admit that I don't know the answer. Perhaps I knew it once but then forgot it; perhaps I've never even heard of Waterloo. And perhaps I don't even know if I ever knew of it.

If, like Kant, we think about the boundaries of our knowledge, we don't usually mean the knowledge of individual people. It's more about our collective knowledge – i.e., what humanity knows. This knowledge has been gathered over the course of the years and stored in the form of books. Just like the knowledge of an individual, the knowledge of mankind is also limited because there is much that we don't (yet?) know. Such as: who will win the next presidential election in the USA? The boundary that separates what we know from what we don't know is called the horizon of knowledge.

Over the years our knowledge changes, and so its horizon shifts. We believe today that we know things that were unknown in earlier times. Conversely, over time knowledge has also been lost. When we search for new knowledge, our current boundaries often exert an irresistible attraction. We want to go beyond those boundaries and fill in the gaps on the map, as it were.

Kant's question goes one step further. He does not ask what we *do* know, but what

we *can* know. His concern then is the horizon of knowledge that we could reach in a best-case scenario. Behind his question lies the supposition that our endeavours to expand our knowledge could come up against real boundaries. Perhaps at some point we won't be able to get any further: the door will remain shut, however much we try to open it.

But is this really the case? Can't we expand our horizon of knowledge at will until at some point we know everything? In order to consider this question it is worth taking a closer look at the concept of knowledge for a moment. In so doing we should restrict ourselves to knowledge whose content we can express in causal sentences. In this sense, I know that: $3 \times 34 = 102$. We like to contrast knowledge of this kind with mere opinions or convictions that something is one thing or another. One important difference is that knowledge can be substantiated. If you know something, then you have good reasons for knowing it, and you have a justifiable claim to knowledge. But anyone who just guesses the right answer in an exam does not really know it. In the sciences, a theory therefore only belongs amongst our “knowledge” when significant proof is in favour of it.

The known unknowns

Knowledge becomes impossible where no reasons can be found, and where proof evaporates. We can perhaps still formulate hypotheses beyond our horizon of knowledge. But we lack the means to prove them. We can decide to accept one idea or another, but we cannot make an informed decision on which one is right.

So let us try to measure the horizon of what humans can know. But even searching for the boundaries of knowledge seems paradoxical. If we ask about the boundaries of knowledge, then we want to know those boundaries. Yet how can we know where these boundaries lie without knowing what lies beyond them? In order to describe what we don't know, it seems, we have to know things that lie beyond what is knowable.

But this is only seemingly paradoxical. Of course we cannot describe in glowing colours what we don't know. Instead we can ask questions that can help us to step a little way into unknown territory. If we formulate a question, then we play with possibilities without pinning ourselves down to any claims about reality. For example, if we ask whether blue tigers exist in the universe, then we consider the possibility of blue tigers but leave in limbo whether

or not they really exist. In this manner, we can explore the boundaries of the knowable by asking questions.

We can also explain it another way. Besides the proverbial “unknown unknowns” - in other words, those things of whose existence we haven’t the foggiest idea and about which we don’t even ask - there are also “known unknowns”; these are questions that have been asked but that remain unanswered. If we can identify questions that we can’t answer, then we can also determine the boundaries of the knowable.

Who was Homer?

There is a manifest boundary of this kind in astrophysics, for we know that we can only observe a part of our universe. All the signals that we receive from the depths of space travel at the speed of light at best. And because our universe is some 13.7 billion years old, we can only receive signals from regions that are close enough for their light to have had time to reach us. We cannot observe how things might look elsewhere. Nor can we make these things accessible to us by the use of reason. That is why questions about distant parts of the galaxy must remain unanswered.

In other fields of knowledge it is much more difficult to determine the boundaries of the knowable. Homer, for example, is still the object of several unanswered questions in the field of literary history. He is traditionally regarded as having been the author of the *Iliad* and the *Odyssey*. But was a single poet truly the author of these two epics? And if so, who was he? How did he write his works? There are different answers to these questions, and assorted arguments can be brought for and against them. But it would be going too far for us to say that we know all the answers already. Can we ever know them? This depends on whether we one day find sources that could prove definitively, for example, that both epics were written by different people. Perhaps it might also be possible to analyse the texts precisely so as to prove beyond doubt that the *Iliad* and the *Odyssey* were written by a single person. Whether or not we stand here before a boundary of what we can know is something that we can judge only with difficulty. To be honest we have to say: we don’t know at present where the boundary of the knowable lies.

Sometimes the question as to what we can know leads to philosophical debates about basic principles. Can we know, for example, what holds the Earth together in its core and what elementary particles

make up known matter? At first glance, it seems that physics has achieved significant progress in this regard. But there are also people who deny that we can acquire knowledge about elementary particles. They adhere to empiricism - a philosophical view, according to which all knowledge is based on what we can experience. They therefore argue that we cannot know about electrons and quarks because we cannot see or hear them. This empirical position, however, is often rejected. For don’t we have very good, indirect proof that electrons exist? Can’t we explain perfectly - with the help of quarks - what we can perceive with our senses? The debate between empiricism and its opponents is still going on. But the real question is this: What really counts as firm proof of knowledge?

Overall, it becomes clear that determining the boundaries of the knowable is often a difficult undertaking. There are indeed cases where the fundamental boundaries of the knowable have been delineated, only for these to be crossed at a later date. It would be very advantageous to know where these boundaries are. Kant believed that we only know what a human being is, when we can say what a human being can know. And if we could know the boundaries of the knowable, then in future we could save ourselves a lot of time and energy that could perhaps otherwise be employed to investigate questions that we can’t even hope to answer. We could then move about, relaxed, in the realm of the knowable, and wouldn’t need to argue about questions whose answers must remain hidden to us.



Claus Beisbart is a professor in the philosophy of science at the Institute for Philosophy at the University of Bern.

At the limits?

On 18 February 2015, Claus Beisbart will give an introductory presentation on “Measuring the limits of human knowledge” as part of a series of public conferences on the topic at the University of Bern. Wednesdays from 6.15-7.45pm until the end of May in the Auditorium Maximum, Hochschulstrasse 4. Free entry.
www.collegiumgenerale.unibe.ch



Using a drug developed from a virus, a scientist carries out tests on apes. His aim is to find a cure for Alzheimer's.

RISE OF THE PLANET OF THE APES,
2011

Photo: Keystone/Everett Collection

What important or surprising boundary has been crossed in your field during the past 20 years?



Christian Körner

“For me, one of the biggest breakthroughs in biology over the past decades has been the molecular reconstruction of the phylogenetic history of life. We now know which organisms are related to each other, going right back to the beginnings of life. For example, fungi belong to the branch that also led to animals - in their phylogeny, fungi have nothing at all to do with plants”.

1994

What important boundary in your field do you think will be crossed - or urgently should be crossed - in the next 20 years?

“One of the biggest unresolved questions in botany is the physiological control of phenology, the seasonal rhythm in the life of plants, such as budding in spring. Plants have to blossom at the same time, for example, in order to fertilise each other. They have to synchronise their flowering over great distances and regardless of all weather conditions. How does that work?”

Christian Körner is a recently retired professor of botany at the University of Basel.

2034



Felicitas Pauss

“In 2012 at CERN, Geneva, proof was found of the existence of the Higgs boson - one of the most sought-after particles in the history of science. The discovery of the Higgs boson could close a chapter in physics that was opened a half century ago. But it might also open up a new era in our understanding of the universe”.



Katharina Henke

“Until the 1990s it was thought that regenerating neurons in the adult human nervous system was impossible. More recent research has proven, however, that humans and other mammals can produce neural stem cells and create new neurons into old age. This regenerative process depends on mental and physical activity. The young cells change the processing of information in certain regions of the brain, for example in the hippocampus”.



Ernst Fehr

“Twenty years ago, people thought it impossible for economics and neuroscience to be able to benefit mutually from each other. Today, they enjoy an exchange of ideas and research technology. Economists use non-invasive brain stimuli and imaging methods in order to study economic behaviour. Neuroscientists use behavioural experiments developed by economists in order to gain a better understanding of the brain and of psychiatric diseases”.



Mirjam Christ-Crain

“For me, one important boundary shift in clinical medicine in the past 20 years has been the breakthrough in research into HIV and AIDS. Within the shortest space of time the virus was discovered, the development of the disease was investigated and a new therapy established. Today, HIV is a relatively treatable disease”.

“In the coming decades we expect new findings that will enable us to open up an entirely new perspective on the principles that govern the cosmos. We hope to answer fundamental, as yet unresolved questions such as: why didn't matter and anti-matter simply destroy each other completely after the Big Bang? What makes up the mysterious dark matter that we find in our Universe?”

Felicitas Pauss is Professor of Experimental Particle Physics at ETH Zurich.

“It will probably be possible in the coming years to use imaging techniques to make thoughts and memory traces in the brain visible and readable”.

Katharina Henke is a Professor of Experimental Psychology and Neuropsychology at the University of Bern.

“One important breakthrough for the future would be to understand economic decision-making behaviour in the language of the brain - deriving mathematical behavioural models from the interaction between neuron populations”.

Ernst Fehr runs the Department of Economics and is the Director of the UBS International Center of Economics in Society at the University of Zurich.

“People are getting older and older and are therefore being confronted increasingly with senile dementia. For me, an effective treatment for dementia would be one of the most urgently needed breakthroughs in the next 20 years”.

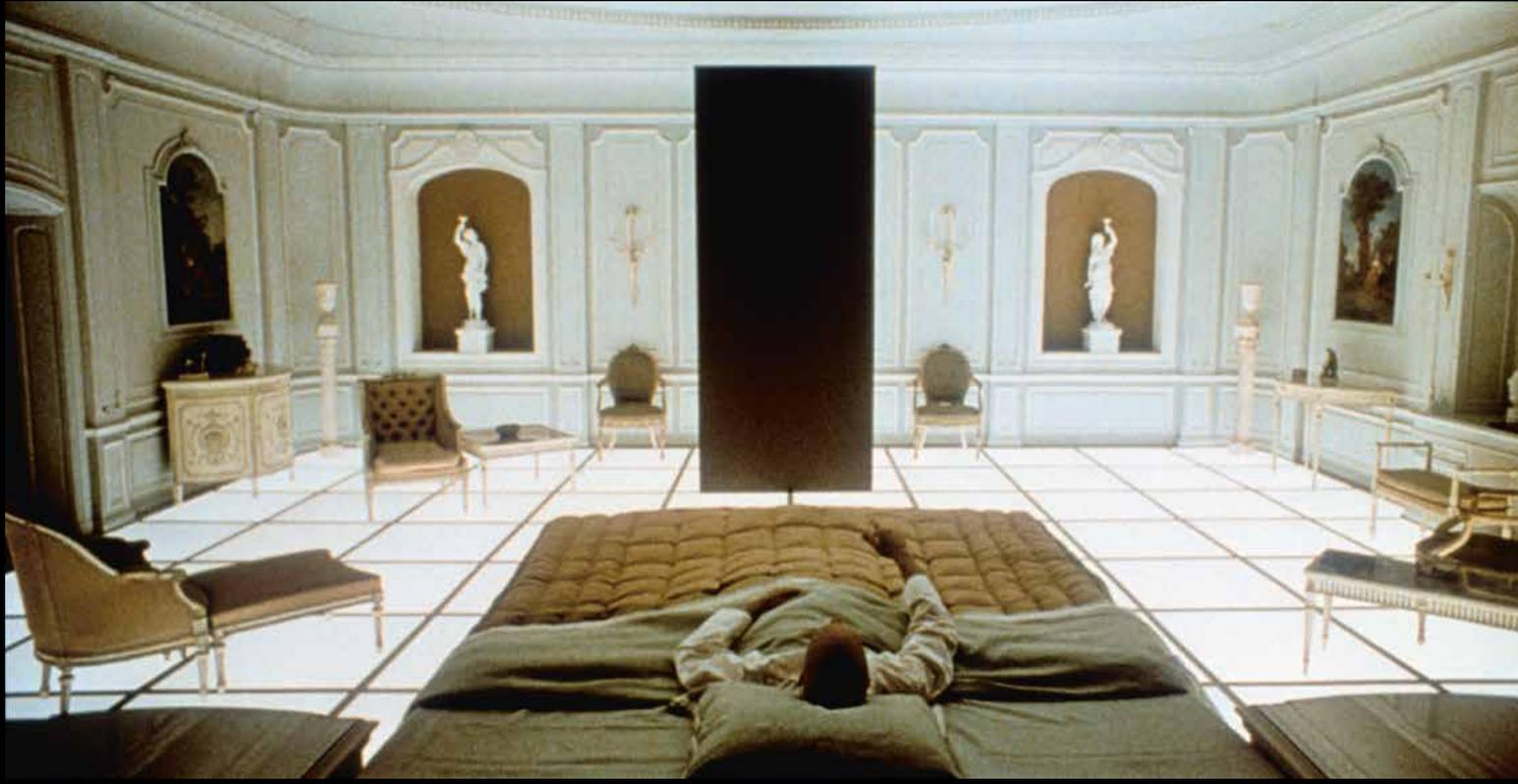
Mirjam Christ-Crain runs the Department of Clinical Research at the University of Basel and is Deputy Chief Consultant in Endocrinology at the Basel University Hospital.



“What was it? A meteorite? A visit of inhabitants of the cosmic abyss? One way or another, our small country has seen the birth of a miracle – the Zone. We immediately sent troops there. They haven’t come back. Then we surrounded the Zone with police cordons ... Perhaps that was the right thing to do. Though I don’t know ...” From an interview with Nobel Prize winner Professor Wallace.

Introduction to STALKER, 1979

Photo: Keystone/United Archives-



From the ape to the human to the astronaut to the star child: the monolith stands as a symbol of crossing boundaries. To quote Arthur C. Clarke: "If you understand 2001 completely, we failed. We wanted to raise far more questions than we answered".

2001: A SPACE ODYSSEY, 1968

Photo: Keystone/Everett Collection



At the Institute for Cybernetics and Future Research, the supercomputer Simulacron-1 is developed to simulate a small town with human 'identity units', each possessing a consciousness.

WELT AM DRAHT, 1973

Photo: Keystone/Everett Collection

The ethical and legal boundaries of science

The first legal guidelines for clinical research came about because of the improper use of human experiments. Today, science itself sometimes sets boundaries even before legislators see a need for them. *By Ori Schipper*

Our prosperity is based to a large degree on our curiosity. It is thanks to this urge to find out new things that life expectancy has doubled in the last hundred years. So does this mean that humanity would be well advised to give free rein to its thirst for knowledge and to set no limits to science?

Numerous abuses make it impossible to answer with a naïve 'yes'. These abuses have played a role in the gradual development of a complex set of regulations that today erects boundaries first and foremost for clinical research. The earliest ethical guidelines were drawn up in 1900. A few years earlier, the dermatologist Albert Neisser had carried out an experiment in which he had infected prostitutes with the pathogen that causes syphilis - but without their knowledge. The debate that this experiment ignited led to the 'Prussian Directive on Human Experimentation'. This Directive stipulated for the first time ever that subjects must give their consent when participating in research projects. With this emphasis on the right to self-determination on the part of the participant, the Directive was way ahead of its time. In fact, the paternalist doctor-patient relationship was only breached much later, says Sabrina Engel-Glatzer from the Institute for Biomedical Ethics at the University of Basel.

This was probably also why the Directive was unable to prevent inhuman experiments from continuing, both before and during the Second World War. In a letter to

Heinrich Himmler, for example, Sigmund Rascher, a member of the SS and a doctor at the Dachau concentration camp, complained that "regrettably, no experiments with human material have been carried out here yet, because the experiments are very dangerous and no one is prepared to volunteer for them". He asked whether Himmler might not be able to place a few professional criminals or camp inmates at his disposal. He wanted them for experiments intended to investigate the chances of survival for pilots after parachute jumps or after landing in the cold waters of the English Channel. Later, Rascher asked to be transferred to Auschwitz because the premises were bigger and his experiments would be easier to carry out. The human guinea pigs "who scream when they freeze" would draw less attention to themselves there. His hypothermia experiments killed at least 80 people.

After the War, the USA filed lawsuits against the doctors responsible for the Nazi experiments, and this led in turn to the Nuremberg Code. This ten-point document from 1947 stipulates that a subject's consent must be given without compulsion or deceit and that it can thereafter be withdrawn at any time. It also demands that experiments must intend to deliver "fruitful results for the good of society". The principles defined in this Code were refined by the World Medical Association and included in the 'Declaration of Helsinki of 1964', which states that vulnerable groups such as children, prisoners or the poor, for example, are entitled to more specific protection.

Abuse of research interests

However, these deliberations were only enshrined in law after a further scandal: the infamous Tuskegee syphilis experiment that was carried out on several hundred black agricultural labourers with the aim of determining the long-term effects of the disease. The US Health Department began the study in 1932 and only ended it 40 years later, after a whistle-blower went to the media. Public pressure ultimately led to a hurried end to the experiment. In the belief that the quality of the data would increase with the duration of the experiment, those responsible for it gave their test subjects no effective treatment until the very end, even though one had been available since the late 1940s in the form of penicillin.

In reaction to this publicly funded abuse of research interests, the US Congress set up a National Commission for the Protection of Human Subjects. Its task was to define the basic ethical principles with which

researchers had to comply when testing on people. In 1979, the Commission decided upon four principles that were then listed in their 'Belmont Report': respect for persons, beneficence, justice and non-maleficence. That same year saw the publication of the 'Principles of Biomedical Ethics', based on those same principles. They constituted the first-ever scholarly investigation of the topic and therefore marked the beginning of modern bioethics.

Since then, laws to strengthen patient rights have been introduced all over the world; later, ethics commissions were also instituted. These commissions monitor a research project before it has even begun, to see if subjects are adequately protected and whether the test is thus ethically defensible. "In Switzerland there are various ethics commissions today. They can impose conditions and even reject a project", says Engel-Glatte.

Proactive laws

So it seems that clinical research has had to go through a long, painful history to be able to determine what is ethically and legally permissible. But in basic research, the interaction between science and legislation also follows two further patterns. There are proactive laws, such as those that forbid the creation of hybrids between animals and humans or the breeding of human clones. These laws are enacted even before researchers are in a position to carry out such experiments. Then there are cases where scientists set their own boundaries before the legislators even see a need for it. The most famous example is the 'Conference on Recombinant DNA Molecules', organised by the US Academy of Sciences, that took place in Asilomar in California in 1975. When researchers had first begun to alter the genetic make-up of bacteria and viruses in the early 1970s, several of them, such as the later Nobel Prize laureate Paul Berg, had realised that they were moving into a sensitive area. They were afraid that genetically altered intestinal bacteria might escape the lab if there were an accident; they might infect people and could cause cancer as a result. For this reason, the scientists declared a moratorium in 1974.

Berg organised the Asilomar conference along with several colleagues. Its main goal, he wrote a few years ago in the journal *Nature*, was to establish whether the moratorium might be ended - and if so, under what conditions. Although researchers across the world had kept to the moratorium, there were widely differing opinions at the conference when it came to the anticipated risks. Berg noticed that many

scientists regarded their own experiments as less dangerous than those of their colleagues.

The breakthrough only came after days and nights of discussion, when the idea of grading risks arose. In other words, an experiment with a pathogen was to be regarded as fundamentally more dangerous than an experiment with a specific strain of bacteria that could only survive in the lab. With this idea, the professionals assembled in Asilomar laid the foundations for legal norms that would later be adopted all over the world.

Thanks to this cautious approach, science succeeded in gaining public trust; of that Berg is convinced. And when the precautionary principle was first applied, the research community - and the booming biotech industry - cleaved a way forward for itself. 'Asilomar 1975: DNA modification secured' is the title of Berg's reminiscences of the conference. Others, such as the science historian Susan Wright, criticise the fact that the conference gathered together almost exclusively molecular biologists so that they could impose a reductionist approach on the final report - one fixated on technological solutions.

Genetic experiments at school

Berg admits that the conference was indeed restricted to safety in the field of genetic engineering, primarily for reasons of time. Today, however, experiments in genetic engineering don't just take place in high-security labs, but also even in primary schools. It's ironic then that, in retrospect, the initial fears about safety that were the focus of discussion in Asilomar have since then largely dissolved away. Instead, it's the religious and legal viewpoints that were excluded at the time that have been gaining in importance. The current controversies surrounding biotechnology are often about the degree to which living creatures or individual genes may be placed under patent protection, or indeed whether we can justify interfering in creation at all.

Research moratoriums are still being declared today. In a case study, Engel-Glatte looks at experiments that have cultivated bird flu viruses. Two research groups, one from the Netherlands, the other from Japan and the USA, looked into whether bird flu might mutate so that it is not just transmitted by contact with birds, but directly between humans. The researchers created viruses that could be transmitted through the air from one mammal to another - and so, to quote the Dutch head of the research team, "belong among the most dangerous viruses that one could create". When the

researchers wanted to publish their results two years ago, they prompted intense discussions as to whether their findings should be kept at least partially secret. The idea was to prevent knowledge about pathogens that could potentially trigger a pandemic from falling into the wrong hands.

The scientists declared a voluntary hiatus in their research. As they wrote in the journals *Nature* and *Science*, they wanted to explain the usefulness of their work to the rest of the world - and to give organisations and governments the time to revisit their guidelines. Their research results were eventually published during this year-long interval, complete and unexpurgated. But the debate about the benefits and risks of this kind of research won't stop for a long time, says Engel-Glatte. "In Europe, it's only just beginning".

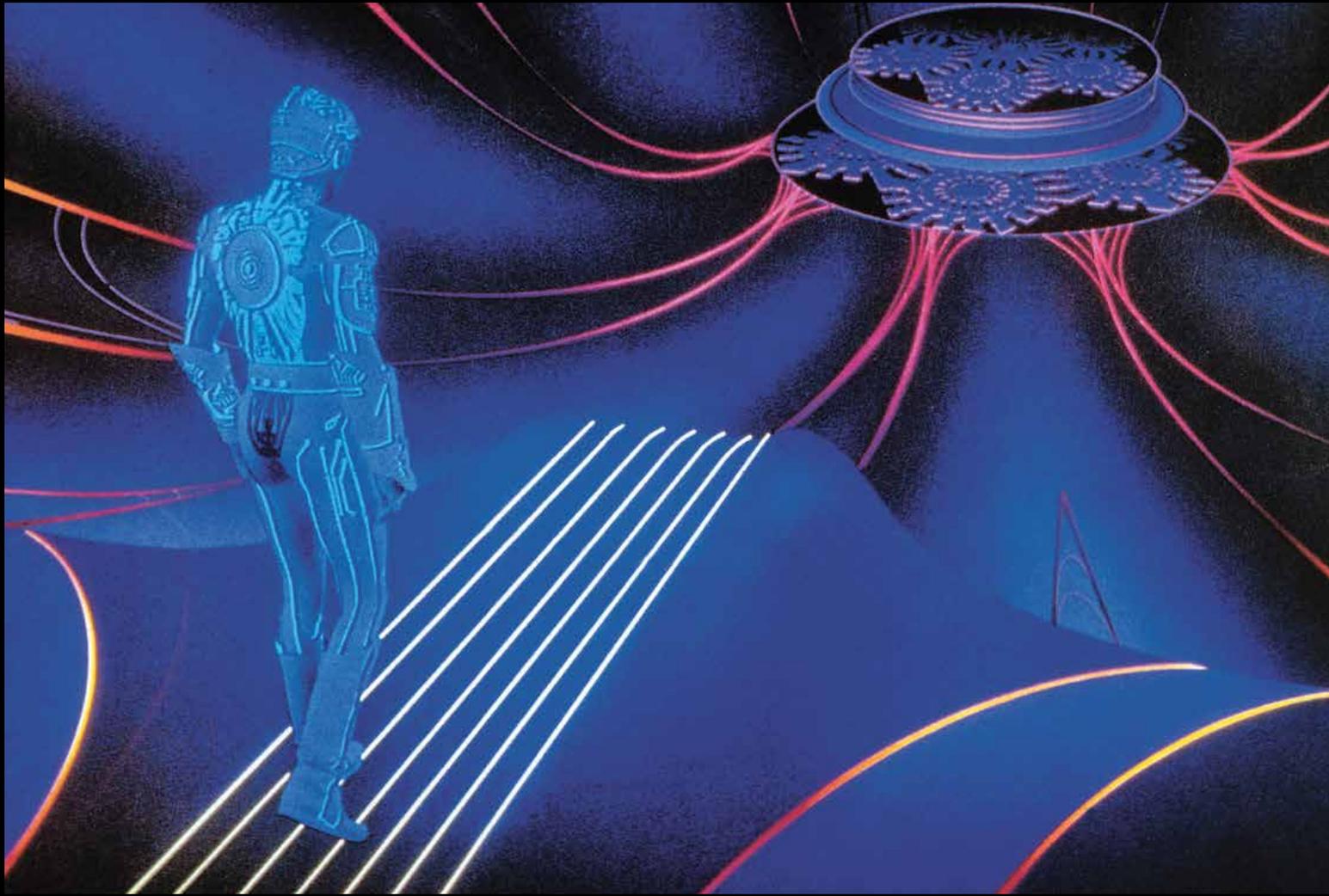
Just a few months ago, the European Society for Virology and the German Ethics Council expressed their support for setting up a biosafety commission. Engel-Glatte believes that research funding organisations must also consider these issues. If the conclusion is reached that the potential benefit of a research project does not justify the risks involved, then it is simpler just to refuse it funding right at the start, rather than trying to keep its findings secret *a posteriori*.

Ori Schipper was science editor of the SNSF and is now leaving to work for the Swiss Cancer League.

Literature:

P. Berg (2008): Meetings that changed the world: Asilomar 1975: DNA modification secured. *Nature* 455: 290-291.

S. Engel-Glatte (2013): Dual-use research and the H5N1 bird flu: Is restricting publication the solution to biosecurity issues? *Science and Public Policy*, online.

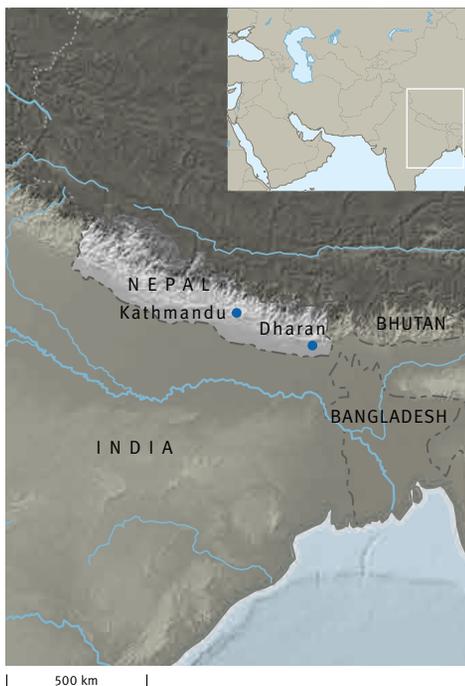


In a virtual reality run by a Master Control Program, software lives as humanoid beings similar to its users.
TRON, 1982

Photo: Keystone/Rue des Archives/RDA

Winning a race against time

What is the best way to treat neurotoxic snake bites? François Chappuis, the head of the Division of Tropical and Humanitarian Medicine of the University Hospitals of Geneva, has been supervising the first clinical randomised tests in Nepal.



“ Since 1998 we have maintained a cooperation agreement with a university hospital in South-East Nepal, the B.P. Koirala Institute of Health Science.

This collaboration has included clinical and epidemiological research on neglected tropical diseases, such as snake bites. In the south of Nepal there are two separate snake species with neurotoxic poisons, the cobra and the banded krait. A bite from either leads to progressive paralysis, resulting in respiratory failure and eventually death. The banded krait is a nocturnal biter, attacking those asleep on the ground. As its bite is often almost painless, the victims sometimes don't even wake up but die in their sleep. The cobra, on the other hand, bites by day, and often chooses its victims amongst farmworkers. In both cases, treatment is a race against time: it takes just one hour from the time of the bite for the first symptoms to appear. It is therefore critical to ensure that the patient is taken into charge within that time period.

“Our first study looked at the implementation of a network of volunteers staffing a 24/7 stand-by service for transporting bite victims by motorcycle to a treatment centre. This programme has led to a spectacular drop in mortality.

“Our most recent study looked at improving the diagnosis and management of bite victims once at the treatment centre. We also compared two different doses of anti-venoms. The first is the anti-venom dose recommended in Nepal. This procedure involves administering a small

initial dose, then a drip dose over the following hours and days. The second method, which is recommended by WHO on the basis of expert opinions, prescribes an anti-venom dose five times greater than that used in Nepal. This study was the first controlled, randomised study that has looked at the two different dosages.

“Our sample included just over 150 patients treated at three centres. It was a huge challenge to ensure a double-blind study. At each centre, a nurse had to prepare the doses in such a way that neither the patients nor the prescribing doctor could identify which treatment was being given. All of the patients were therefore drip-fed a solute. In the case of the Nepalese procedure, this contained the anti-venom, but in the other, it didn't.

“One other difficulty that we had to overcome was that the medical research assistants were all waiting for places on postgraduate training courses in Nepal. Some of them were offered places and left the study to take them. At that point we therefore had to take on other doctors and train them too.

“We were also concerned about offering the best possible care throughout the study and about making sure that what we learnt would be of use in the future. In the case of the banded krait, mortality had been at more than 30% prior to the study. During the test period, we reduced this to 6%, because we trained researchers to use respiratory resuscitation (intubation and ventilation).



There is a high risk of being bitten by a cobra when working out in the rice fields. The Indian krait (*Bungarus caeruleus*) is responsible for numerous deaths every year.

Bottom: Transporting a bite victim to a treatment centre; intubation training; examining a bite wound.

Photos: François Chappuis, Sanjib Sharma, David Warrell

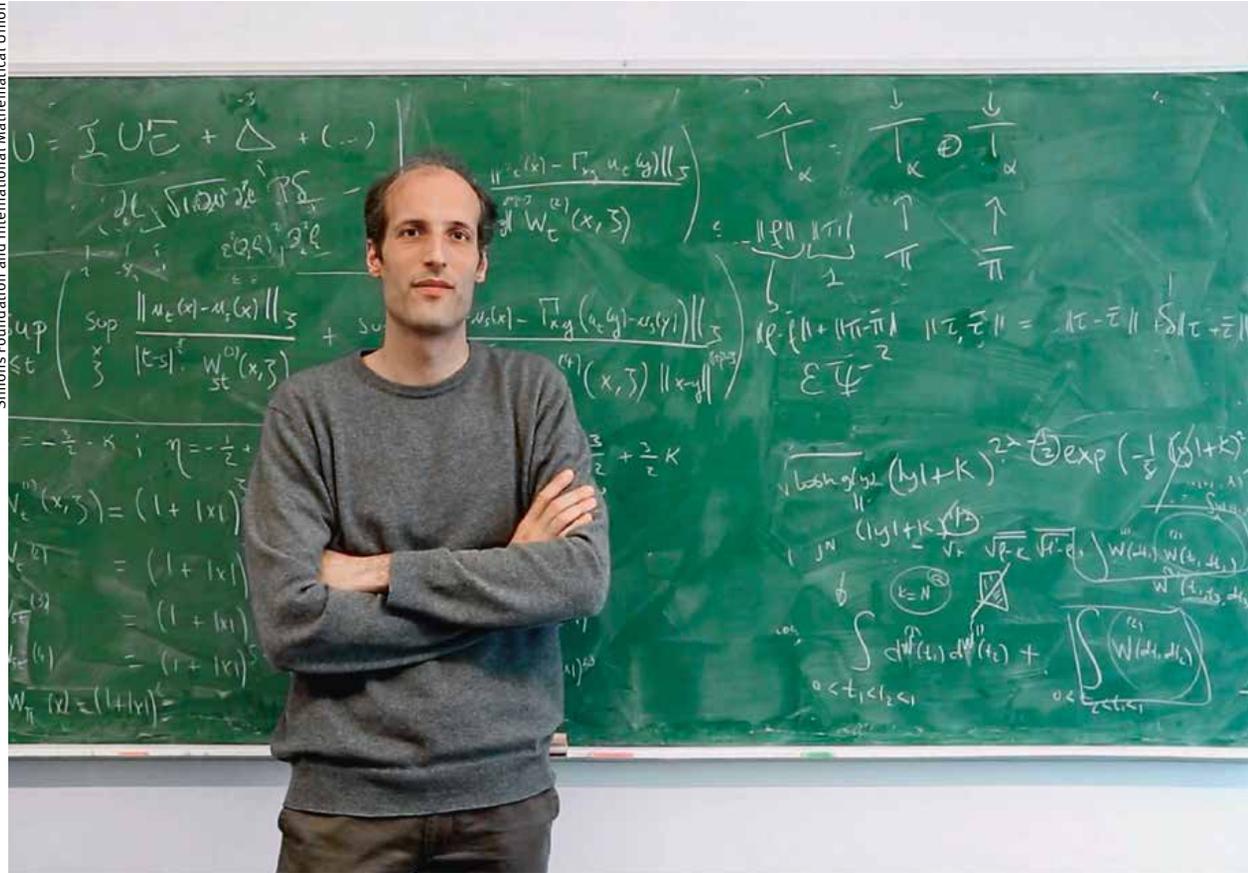
“The results did not show any differences between the two dosages. Nevertheless, we recommend the stronger dose. It is more practical, particularly when practitioners are not doctors and are working in rural areas. With the cobra bite, neurotoxicity symptoms clear up much more quickly. This is not the case with the banded krait. We even reached the point where we, like others, even asked ourselves if the anti-venom had the slightest effect.

“Luckily, with these bites, the stronger dose of anti-venom is not more toxic, but the lack of effectiveness does underline the importance of having staff trained in resuscitation and ventilation.

“In the first three months of 2015, we will hold a workshop with representatives of the Health Ministry of Nepal as well as with other stakeholders to review the procedures for managing snake bite victims in the country in the light of the results of our study”

Interview by Catherine Riva, freelance journalist and translator





The equation tamer

Martin Hairer gives meaning to impossible equations. In 2014, the Regius Professor of Mathematics at the University of Warwick received the highest award in his subject: the Fields Medal. *By Daniel Saraga*

A sheet of burning paper and a cloth soaking up water appear somewhat mundane events. But for mathematicians, describing these everyday phenomena is an unsolvable riddle.

Or at least it was until last year, when Martin Hairer published a 180-page, key work on a theory of regularity structures. Hairer is a 39-year-old Austrian who grew up and studied in Geneva and who has created a set of new tools that can resolve a large category of recognised problems described by stochastic partial differential equations. These equations describe the changes undergone over time by a multi-dimensional system subject to several non-linear factors, including one that is random. One year since its publication, Hairer's work has landed him the Fields Medal, often called the Nobel Prize for Maths.

"I read his article the way people read *The Lord of the Rings*", says a smiling Lorenzo Zambotti of the Pierre and Marie Curie University, Paris. "The community immediately recognised the implications of his work, even if its members sometimes have difficulty in following all of the technical details", adds Hendrik Weber of the University of Warwick in the United Kingdom, where Hairer has taught for the last 10 years.

A nearly normal childhood

“I was not a gifted child”, admits Hairer. He became interested in both mathematics and computing at the age of 12. By the time he was 15, he had already won a European competition for young scientists with a computer program for designing electronic circuits. The following year he created a tool for analysing and manipulating music. This program would become Amadeus, a program for Apple computers still used today by sound engineers and DJs.

“Before looking for a solution, it’s best to ensure that the problem is well defined”.

He went on to study physics at the University of Geneva, where he wrote his thesis under Jean-Pierre Eckmann. Thanks to two SNSF awards, he worked between 2002 and 2004 as a post-doc at the University of Warwick’s renowned mathematics department. He has been there ever since.

The forbidden equation

“In very simple terms, you could say that my work is about finding meaning in poorly defined equations”, explains Hairer. The equations of which he speaks are those written by physicists who wanted to describe problems such as paper burning or magnets losing their magnetism. But in their attempts to resolve them, they had no qualms about breaking them up and approximating them until a solution popped out, the same way an electrician goes about repairing an appliance in a hands-on fashion.

But such an approach is not acceptable for a mathematician. “I want to put things straight and understand what works in the method physicists use. It must be possible to give precise meaning to these equations”, he says. Before looking for a solution, it’s best to ensure that the problem is well defined.

The difficulty lies in the random part of the equation, which describes the unpredictable route taken by the flame as it consumes a sheet of paper. “The edge of the paper is smooth over short distances, but it can become infinitely bumpy on the large-scale. Because of this, we can’t use certain operations needed to write the equation, such as derivatives” (i.e. checking the gradient of the curve, Ed.).

To deal with these impossible problems, Hairer first took the work of Terry Lyons of Oxford University and generalised it to several dimensions, despite it only being applicable to one-dimensional problems.

He solved the KPZ equation, a quarter of a century after it was formulated by Mehran Kardar, Giorgio Parisi and Yi-Cheng Zhang (a physicist at the University of Fribourg). He then moved on to tackling a general theory to understand the structures that hide behind stochastic equations.

His idea is to create a solution in a step-by-step, iterative manner, starting with the solution for a simplified equation. But he must first prove that his method produces good solutions. “I figured I could use wavelets - mathematical transformations used in image compression - but I only had a limited understanding of them. At home, I spoke to my wife, who is also a mathematician. She put a book in my hands and said: ‘Read this!’ I read half of it that very evening”.

Maths is eternal

His theory of differential stochastic equations may have numerous applications in a range of different areas, but that is not his motivation. “It’s the quest for beauty. Mathematics is the only science that allows for absolute and complete understanding. From the very moment that a specific framework is put in place, something is either true or false”. Another advantage is posterity. “Our understanding of the physical world changes continuously. But a mathematical theorem is true forever”.

According to Zambotti, “he’s not a lone wolf at all. He is very down to earth and always available”. Hairer says he has no fear of ambiguity in his daily life, and spends his spare time cooking and going on walks with his wife. “I can very easily do nothing. I don’t have any problems not thinking about maths for a couple of weeks. After all, even on the quest for beauty and eternity, there has to be time to rest”.

Daniel Saraga is the Chief Editor of the science magazine *Technologist*.

The highest award for maths

Awarded by the International Mathematical Union, the Fields Medal is considered the highest award in its area. It is often compared to the Nobel Prize, but differs in that it is only handed out every four years and then to two, three or four researchers under 40 years of age. In 2010, it was awarded to the Russian mathematician Stanislav Smirnov of the University of Geneva.

Martin Hairer

Having studied and written his thesis at the University of Geneva, Hairer joined Warwick University, United Kingdom, in 2002. He progressed from postdoc to teacher to professor, and since April 2014 he has held the post of Regius Professor for Mathematics, being the second person to fill this chair. He was appointed Associate Professor at the Courant Institute of the University of New York in 2009. In 2013 he received the Fermat Prize, in 2014 the Fröhlich Prize and in 2014 the Fields Medal. He has also been elected as a Fellow of the Royal Society. He’s an Austrian national, born in 1975 in Geneva. His father was also a mathematician and his mother a teacher. He lives in Kenilworth, a small village near Warwick, with his wife Xue-Mei Li, who is also a mathematician.

When vibrations become quantum

The winner of the 2014 Latsis Prize, Tobias Kippenberg, studies quantum oscillation phenomena in microresonators capable of storing light in very small volumes. This work allows the development of very high precision measurement apparatus. *By Anton Vos*

Back in 1994, Tobias Kippenberg was riding his bicycle one winter morning in Bremen in the north of Germany. The air was cold, but as there was no frost, he had taken confidently to the road. All of a sudden, he hit a sheet of black ice that had gone unnoticed and ended up sprawled across the tarmac. He pulled himself off the ground and cursed his bad luck.

At the time this simple accident meant nothing to him. Little did he know that the final outcome would be so much happier for him, as it guided him to the world of science, to the California Institute of Technology (Caltech), the Max Planck Institute (Germany), and then the École Polytechnique Fédérale de Lausanne (EPFL).

“Just after the accident, I began asking if it was possible to dream up a machine capable of measuring the condition of the road, and, above all, to distinguish between wet and frozen ground, something which is often impossible for the naked eye”, says Kippenberg. Today he is a professor at the Laboratory of Photonics and Quantum Measurements at the EPFL, and the recent winner of the national Latsis Prize for 2014 for his work in optomechanics.

Back then, he was already fascinated by science, and as a young researcher it wasn't enough for him just to think about how such a device might improve the world (and his own situation). So he went headlong into actually designing it too. In the

library, he found a book on the interaction between light and matter, and another, written by an American researcher from Caltech, that described a radar technique applied to studying polar ice. Taking inspiration from these books and applying a lot of ingenuity he created an experimental model using a source of microwaves and an infrared laser. He gave his device the following name: *Infrared-microwave radiation ice condition sensor for cars*, and it has become an excellent black ice detector.

Thanks to this invention, Kippenberg took part in the *Jugend forscht* competition (awarded by the German foundation supporting young researchers), and promptly won it. Around the same time, in 1996, he also won the eighth edition of the European Union Contest for Young Researchers.

Back then he was still a young man, the son of a professor specialised in the comparative study of religions, and his future seemed laid out for him. He went to Aachen University to study physics and electrical engineering, obtaining his bachelor degree in 1998. His journey later took him to the United States where he was offered a place at Caltech, Pasadena.

A 12-micron bicycle wheel

It was there that he developed his first microscopic structures (microresonators) capable of storing photons for several microseconds - a considerable period for these elements of light, which in the same





“Infrared-microwave radiation ice condition sensor for cars”

timespan would have otherwise travelled almost a kilometre. He still feels passionate about this field today.

In 2005 he returned to Germany and took over as head of an independent research group at the Max Planck Institute in Garching. There he rubbed shoulders with Theodor Hänsch, winner of the Nobel Prize for Physics, and took his habilitation at the Ludwig Maximilian University of Munich. In 2008 he was awarded a post at the EPFL, first as an assistant professor, then in 2013 as a full professor.

Today he is studying a minute oscillator made of glass, shaped like a bicycle wheel but with a diameter of just 12 micrometres. It was this that won him the Latsis Prize for 2014. This resonator is both mechanical and optical. It allows light to circulate in the toric part of its structure (the tyre of the bicycle wheel, as it were). The walls reflect the light, thereby producing “radiation pressure”.

In an experiment reported in *Nature* in 2012, the regulator was cooled to half a degree above absolute zero. Kippenberg and his team showed for the first time that it is possible to reduce its temperature even further, by injecting photons into the resonator and creating well-controlled radiation pressure. During this process, a particularly strong coupling is produced between the light and the mechanical movement, so strong in fact that the optical and mechanical properties of the structure become inseparable.

Let's put it to work!

At this point, the oscillator becomes so cold that it starts to become almost entirely submerged in what is known as its fundamental state. This state of minimal vibration is something that can only be described by quantum mechanics. The theory predicts, amongst other things, that an object can never be perfectly still, even at absolute zero, and that there is always a slight movement.

“We managed to cool an object composed of billions of atoms to temperatures so low that we could observe quantum phenomena”, says Kippenberg. “This really is

fundamental science, and we aim to continue our work in this direction. But that doesn't mean that we are not interested in possible applications for our research. Quite to the contrary, my passion for science has always included both”.

Indeed, this was the goal that he was pursuing whilst at the Max Planck Institute when he managed to discover another remarkable property of microresonators. Light in a laser beam connected to a microresonator using a small fibre-optic cable can produce so-called “frequency combs”. These are essential, for example, in calibrating high-precision spectrometers used in astronomy and atomic clocks. Generators of frequency combs have always been cumbersome; they are the size of tables, very expensive and very complex. Kippenberg's, however, is tiny and is built using the same methods as for electronic chips. A first patent was filed in 2007, followed by a second in 2013 at the EPFL. This invention won Kippenberg the Helmholtz Prize for Metrology in 2009 and is very close to being put on the market, a step that Kippenberg hopes to take by launching a start-up.

Anton Vos is a science journalist, working chiefly at the University of Geneva.

Tobias Kippenberg

Tobias Kippenberg was born in 1976 in Berlin. He spent his childhood in Groningen in Holland and then went to Bremen in Germany. He graduated in physics at Aachen before going on to take his Master (2000), his Ph.D. (2004) and a postdoc at Caltech in Pasadena, California. After a few years as an independent researcher at the Max Planck Institute in Germany, he landed a job at the EPFL, where he became a full professor in 2013.

Lake Geneva's tsunamis

Over the last 4,000 years, the Lake Geneva region has experienced a number of tsunamis. This has been shown in studies of floods of Lake Geneva and Lake Biel.

By Pierre-Yves Frei

A study can fall flat even at the earliest stage. This can happen for a number of reasons: the lack of a research goal or the impossibility of proving it. It was this latter case that applied to the research being carried out by Stéphanie Girardclos of the Department of Earth Sciences and the Institute of Environmental Sciences of the University of Geneva.

“We wanted to solve the mystery surrounding the floods of the last few millennia in the Lakes of Geneva and Biel and to explore the possible link between changes in flooding and the canalisation of the Rhône and the correction of the Aare”. Their research fell into the framework of ascertaining natural risks on the basis of prior sedimentary events.

In the end, however, the researchers quickly discovered something completely different. The sedimentary traces of floods had not been sufficiently well conserved to be used as reliable evidence - in many cases they had not withstood the test of time at all. This negative point, however, was quickly swept aside by a major discovery.

And the lake dwellers' settlements?

Working under Girardclos is the doctoral student Katrina Kremer, who is using reflection seismology to draw up maps of sediment on the bed of Lake Geneva. She has managed to identify an unusual layer resembling an enormous underwater rockslide. “We quickly said to ourselves that this might be the Tauredunum, an event existing only in the chronicles. It was a giant wave said to have crossed the lake in

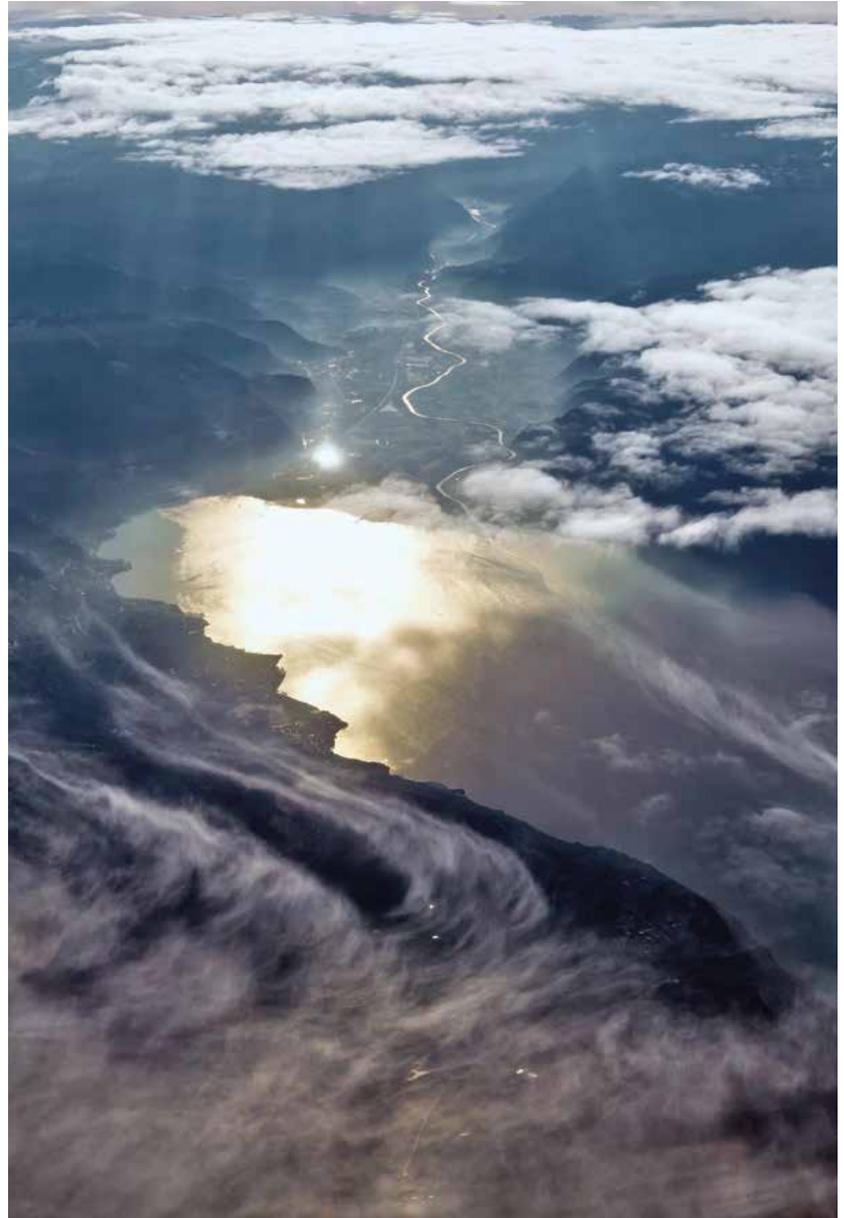
563 AD, following the collapse of a mountain side onto the Rhône delta which itself then triggered a large part of the delta front to form a giant underwater landslide.”

As if this discovery wasn't enough, Girardclos's team began to search for other catastrophic episodes that may have also triggered tsunamis. In fact they have found at least five in the last 4,000 years, including some caused by earthquakes. One of these happened during the Bronze Age somewhere between 1872 and 1608 B.C. According to archaeologists' files, however, it was in 1758 B.C. that traces of settlements along the shores of Lake Geneva were lost. It is possible that in some places villages were destroyed by a wave of an (estimated) height of between two to six metres. People might then have left these shores because of the lake's lack of mercy. But it is difficult to say.

Et quid Lake Biel? “We looked for [tsunami], but with no success”, says Girardclos. “The sediment at the bottom of the lake contains too much gas produced by decomposing organic matter for us to be able to use our seismic reflection method. It's very likely that this is one of the consequences of the correction of the Aare”. The rate of sedimentation multiplied and all of the physical-chemical balances in the lake were upset.

Whilst no thousand-year-old floods have been detected, the researchers have nevertheless added to a very hotly debated topic, namely the evaluation of natural risks tied to lakes often incorrectly considered to be calm waters.

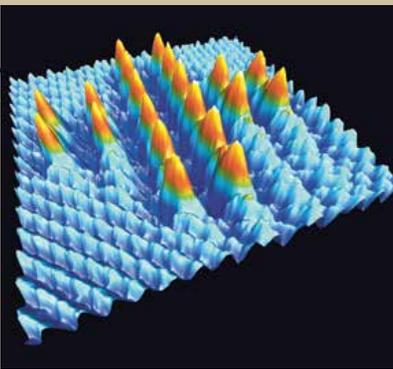
Pierre-Yves Frei is a freelance science journalist.



In 563 AD, a landslide in the Rhône delta caused a huge wave.

Photo: Keystone/Alessandro Della Bella

Shigeaki Kawai



A new technique for manipulating atoms at room temperature.

A Swiss cross made of 20 atoms

Researchers can investigate materials and alter them with a degree of precision that makes a layperson dizzy. Along with colleagues from Finland and Japan, Ernst Meyer's team of physicists at the University of Basel has now achieved a further success in this miniature world. For the first-ever time, they have been able to move individual atoms on an electrically non-conductive surface at room temperature and determine their new position. With the help of an atomic force microscope, they replaced 20 chlorine atoms with bromine atoms and arranged these into what is surely the world's smallest-ever Swiss cross. It is just 5.6 nanometres wide - in other words, some 10,000 times thinner than a human hair.

Until now, it had only been possible to move individual atoms at temperatures far below zero and on conductive surfaces. At room temperature, such selective changes to atomic surface structures had regularly failed because the warmer their environment, the more the particles move. Furthermore, says Meyer, conductive surfaces such as metals have a disadvantage when compared to isolators, namely that they often alter the characteristics of materials placed on them. His new technique for manipulating atoms is an important step on the way to a new generation of tiny electronic particles. Detectors, circuits and storage memory - all these can perhaps one day be built on an atomic level.

Simon Koehlin

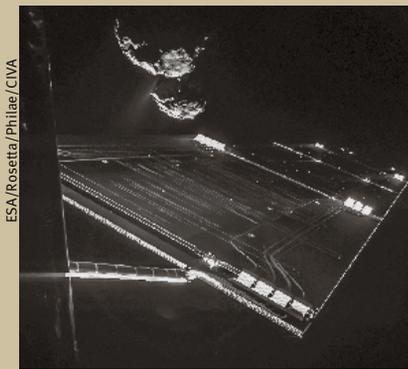
Rosetta: returning to the solar system's infancy

The space probe Rosetta set out on an impossible mission: to enter into orbit around a comet flying through the immensity of space at more than 100,000 km/h. So far, its adventure has lasted a decade. Along the journey, it made the most of gravitational catapults around Earth and Mars, and also hibernated for a period of two and a half years. Now the European Space Agency's satellite has fulfilled the first part of its mission. On 6 August, it succeeded in meeting the comet 67P/Churyumov-Gerasimenko, marking a first in the history of space exploration. For the next two years, Rosetta will orbit its new companion, studying how it is transformed by the heat of the sun and collecting gas and dust samples. On 13 August 2015 they will reach the closest point to the sun along their elliptical orbit, at a distance of 186 million kilometres.

On 12 November, the probe also launched a small landing module named Philae. Having landed on the comet's surface, it managed to collect and transmit preliminary information before running out of energy and entering hibernation mode. It should, however, wake back up next summer.

The interest that research has for comets is due to their tiny size, which means they have hardly changed since the beginning of the solar system some 4.6 billion years ago. They have therefore preserved original material from the pre-solar nebula.

Anton Vos



Rosetta's solar sail, photographed by the Philae probe, and above it the Comet 67P, eleven miles away and over two miles wide.



Lenny Winkel

The Loess Plateau in northern China: different layers from different climatic conditions.

Monsoons prevent selenium deficiency

A deficiency in the essential trace element selenium can cause serious damage to our health. Central China is particularly badly affected by this, and many people there suffer from deformed limbs and damaged heart muscles as a result. It was unclear until now just why this problem is so serious in the region, or why it doesn't affect the people who live to the south, because differences in soil composition and local geology aren't enough to explain it alone.

A group of researchers led by the SNSF Professor Lenny Winkel from Eawag in Dübendorf and ETH Zurich has now discovered that the summer monsoons clearly play a decisive role in the supply of selenium. By conducting comprehensive analyses of paleosols and climate archives, Winkel has been able to show that there is a high degree of correlation between rainfall distribution and the concentration of selenium in the soil, with the latter having a corresponding impact on the selenium values of foodstuffs. This supports the hypothesis that rain is an important factor in selenium provision, with the monsoons bringing large quantities of this important trace element from the sea onto the land. This is why the selenium provision is sufficient in the monsoon areas along the Chinese coast, while the people further inland suffer from deficiency symptoms. These findings are controversial because global warming could drastically alter precipitation in China and therefore also the supply of selenium.

Felix Würsten



The World Bank's clients are leaving the building

The time has long past when the World Bank was able to tie political demands to loans for developing and emerging countries. Many emerging economies today have better access to capital markets. This has an impact on their choice of development bank.

By Oliver Klaffke

“**M**any emerging countries don't necessarily need the World Bank any more”, says Chris Humphrey from the Department of Political Science at the University of Zurich. “They won't simply let the Bank dictate its conditions to them either, because they have become economically and financially stronger”. This new balance of power has weakened the role of the World Bank - set up in 1945 - in financing state development projects. This could be a chance for the other development banks. The backers of these other banks aren't primarily the same Western industrialised nations that make up a two-thirds majority at the World Bank. Today, some development banks are supported jointly by the emerging countries themselves. “Debtor nations have a bigger influence on how these banks are run”, says Humphrey.

In the past, economists and political scientists have been occupied mostly with the conditions under which the World Bank has been prepared to give loans. In 1944 the international financial order for the post-War world was decided upon at a



**At the World Bank in Washington, D.C.,
a window cleaner lowers himself down.**

Photo: Keystone/AP Photo/Alex Brandon

Turkey and China are less dependent on financing from the World Bank. China today is actually important in financing other countries, such as the USA. "Given the economic strength of the countries that want to borrow money, we can assume that they look very carefully at the conditions under which they can take out a loan", says Humphrey. For the countries that are looking for loans, there's more to it than just the interest rate at which they borrow money. As Michaelowa and Humphrey have ascertained, the length of time before the loan is actually paid also plays an important role, as do any bureaucratic difficulties or political aspects. This is why some development banks are rising in importance, because they take a different approach to their clients. Humphrey and Michaelowa have compared three development banks that are run in different ways. At the World Bank, the industrial nations are in charge. At the Development Bank of Latin America (CAF), however, the countries that take out the loans also call the shots. And in the Inter-American Development Bank (IADB), there is a balance of power between debtor and creditor nations.

Fewer cultural differences

The researchers found that the biggest difference between the banks lay in the hurdles they erected for countries wanting loans. At the World Bank, it takes between twelve and sixteen months for a loan to be approved. At the IADB, it takes seven to ten months, but at the CAF just three to six months. If the money is needed urgently, that process can even be reduced to one and a half months. "The differences are a result of the power relations within the development banks", says Humphrey. The CAF is borne by countries that also belong to the debtor nations. They know that countries can need money quickly, and so they speed up the process. The World Bank and the IADB have a whole series of conditions to be met - from matters of environmental protection to social sustainability - whereas the CAF raises no such issues. It relies on countries keeping to their own laws.

At the World Bank, loan requests have to go through four different 'country missions' and four different committees, and

the countries that have the say there are always making things harder. "One vice-president, who is responsible for Latin America, does not even speak Spanish", said one of the people interviewed for the study. Cultural differences don't make cooperation easier when the Latin American style - which relies on personal contacts - comes up against the North American and European style, which insists on a strict interpretation of the rules. At the IADB, on the other hand, almost 70% of the employees are from debtor nations. "The people there are culturally much closer to us", said one interviewee from Chile.

The CAF is designed specifically to meet the needs of its clients. Loans of less than 20 million dollars can be granted by a vice-president, and up to 75 million dollars by an executive vice-president. "Our investigation has shown that our hypothesis is correct", says Humphrey. "A development bank in which the borrowing countries are in the majority can offer conditions that are very favourable to them". The results of this research project let us see how a development bank could be run so that it would be accepted by the debtor nations. This year, there are plans to open a development bank that will be run by the BRIC countries (Brazil, Russia, India and China). The importance of the emerging countries in financing development is obviously increasing.

Oliver Klaffke is a science and economics journalist.

conference in Bretton Woods, a mountain resort in New Hampshire in the USA. The World Bank was given a fundamental role as the main development bank. However, it often linked loans to political demands. In a project headed by Katharina Michaelowa, Humphrey has been investigating which development banks are used by emerging countries to help fund their projects. Their research approach takes account of the economic and financial performance of many emerging countries - and this has improved greatly in the past decade. The public debt of emerging and developing countries was on average 40% of their GNP in 2010, but in ten years' time it should only be 30%. Some 25 years ago, the share of the world's foreign exchange reserves of non-OECD countries was only 30%; by 2010 it was already at 65%. It's primarily countries in Latin America that have transformed themselves. In just over a decade, poor countries have turned into well-off, middle-income economies. It is hardly surprising that the World Bank and the International Monetary Fund are becoming less and less important as lenders. Countries such as Mexico, Indonesia,

When helping isn't enough

A study in Lausanne has been looking at the role of patient organisations in the debate about organ donation. Its preliminary findings show that without strong partnerships, it is difficult to have any political impact.

By Irène Dietschi

They're called 'AGIR', 'A Coeur Ouvert' or 'PromOrgane' - and they're all patient organisations in western Switzerland campaigning for more organ donations. Today, patients are playing an increasingly active role in medicine. They promote clinical research, link up with partners from industry and engage in political lobbying. Are the organ donor organisations also profiting from this trend?

This question is being investigated by an interdisciplinary study led by the sociologist Raphaël Hammer from the Haute Ecole de Santé Vaud in Lausanne. Also involved are the historian Vincent Barras from the Institute for the History of Medicine and Public Health and Manuel Pascual from the Transplant Centre at Lausanne University Hospital (CHUV). They are analysing historical documents to see how organ donation has developed into a socio-political issue in Switzerland. These documents are taken from hospital archives, the archives of 'Swisstransplant' (the Swiss National Foundation for organ donation and transplantation), medical journals and the general press. The researchers are also investigating the role of patient organisations and are concentrating on western Switzerland.

Their initial results are rather sobering: "Patient organisations don't seem to succeed in getting the topic of organ donation into the public sphere as effectively and as visibly as the 'Positive Council' managed to achieve with HIV, for example", says Hammer. To be sure, the fifteen associations that were interviewed for the study are all very committed. They help those who're affected, they organise holiday camps, concerts and events, and they send out internal newsletters and set up stands in public to get their message across. All the same, they have hardly any impact on the public



A liver donated for organ transplant at the Charité Hospital in Berlin.

Photo: Keystone/Laif/Dominik Butzmann

debate. Most of them have very meagre financial resources and very few personnel, and their actions depend on the initiative of a few members. What's more, their actions are locally based, with coalitions between them cropping up only rarely. Plans for a national umbrella association were abandoned years ago. Often, it's very personal motives and stories that lie behind these solo efforts. The founder and president of 'A Coeur Ouvert', for example, said in an interview with the researchers that he was involved because he wanted to give back something for the 'gift' of an organ he had received. "I was given help, so it's logical for me to help others now".

Dreadful donor statistics

It's an honourable stance. But in the public sphere, skilful lobbying is what's needed. Hammer suspects that the Positive Council has been so successful because those behind it - HIV sufferers, supported by a well-organised gay community - have conducted a united campaign. The situation is different with the organ donor organisations. They lack almost everything they would need to be able to close ranks. They are also divided in their strategic approach. Some of the interviewees support

the 'consent solution' as provided for by the Swiss Transplant Law - in other words, organs may only be taken from a deceased person when express consent has been given. Others, however, are in favour of the 'opt-out solution', which means organs can be extracted automatically unless someone has expressly forbidden it.

Nevertheless, they all have one thing in common: most patient organisations have difficulty with the neutral, cautious policy towards organ donation shown by the federal government. In their eyes, the current campaign motto of Swisstransplant - "Have you ever thought about the topic of organ donation?" - doesn't go far enough. "Neutrality is useless when it comes to organ donation", said one interviewee to the researchers. The dreadful statistics for organ donation in Switzerland would seem to confirm his opinion.

Irène Dietschi is a freelance science journalist with her own agency in Olten.

Science as a career

Building a successful career but also having time for your partner and family - that's what many young scientists would like. This is the finding of a study conducted by the sociologist Ulle Jäger from the University of Basel in which she evaluated 40 interviews from Switzerland and Germany. But in reality this goal is difficult to achieve, because a scientific career demands mobility and unlimited availability. "For me, I can imagine two scenarios", says Jäger.

Put bluntly, her first vision of the future is this: the scientific establishment carries on as before. Those men and the smaller number of women who are given the necessary freedom in their private lives can get professorships more easily than their colleagues who live in more equitable domestic partnerships.

The second scenario is this: the time delays caused by starting a family, by looking after older family members or similar domestic commitments have no negative impact on career planning. However, in order for this second scenario to have any chance of becoming a reality, the demands made on young scientists today would have to be reconsidered and questioned more rigorously.

Do all positions in the science world really demand that one should first spend time abroad? How important is the number of publications for a teaching career? Jäger draws the following conclusion: "Instead of judging solely on 'excellence criteria', it should be a matter of organising career requirements so that someone can be 'good enough' and not have to go beyond their own boundaries when they want to achieve harmony between their career and their private life". *Nora Heinicke*



Professional and private harmony?

The *National-Zeitung* of Basel: "The last bastion of free speech in the German language".

Back in the days when Basel's newspaper was liberal

"No newspaper is more avidly requested in the cafés of Prague than your *National-Zeitung*. It's also sold in large quantities on the streets. It has a special status as the last bastion of free speech in the German language". Max Brod wrote these words to the arts editor Otto Kleiber in Basel in the winter of 1939. For more than three decades - from 1919 to 1953 - Kleiber ran the arts pages of the *National-Zeitung* in Basel, and he offered a safe haven to German literature in exile during the Nazi period. Well-known figures such as Bertolt Brecht and Erika Mann published their texts in Kleiber's column 'Unter dem Strich' ('The bottom line') when they could not publish in Hitler's Germany - and in this they were also joined by other, lesser-known writers.

Three years ago, the literary scholar Bettina Braun of the University of Zurich began researching into the *National-Zeitung's* hitherto largely unsuspected significance to literature in exile between 1933 and 1940. By sifting through 5,000 editions she found 3,500 articles by exiles (back then, the newspaper was published in two different editions every day - early and late). Braun has entered these texts into a database that will be made accessible to other researchers. This collection of texts forms the basis for her doctoral thesis, which is on the history of arts pages in Swiss newspapers during the time in question. The *National-Zeitung* - which in 1977 was merged with the *Basler Nachrichten* to form the *Basler Zeitung* - stands out as an important address for exile literature. Back then, the *Neue Zürcher Zeitung* did not want to publish critical articles by exiles. That was a time when Basel's newspaper was the liberal one. *Stefan Stöcklin*

B. Braun (2012): Das literarische Feuilleton des Exils in der Schweiz - Die Basler "National-Zeitung". *Zeitschrift für Germanistik*, 3/2012: 667-669.

Africa is ageing quickly

Demographic developments are not just a matter of concern in industrial nations, but also in developing and emerging economies. A research team from the Institute of Social Anthropology at the University of Basel, led by Brigit Obrist, has been investigating ageing in Africa, using Tanzania as a model. Their most important finding, says Obrist, is that "ageing in Africa is bound up with many uncertainties". There are hardly any formal support systems such as state pension provisions or public nursing homes, even though elderly people in Africa are also suffering increasingly from chronic diseases and ever greater numbers of them are in need of care. The most important support comes from family, relatives and the community. These traditional networks have, however, become fragile and unstable, says project leader Piet van Eeuwijk. Additional safeguards are gradually being established in the form of new relationship patterns, such as social contacts via mobile phone, money transfers from children living abroad, or joining clubs for seniors.

Despite many uncertainties, Africans strive to age with dignity. Most of them - especially the men - work for as long as they are able. And if people aren't in gainful employment any more, then they often still have tasks and a function in their family and their social environment. "Even though younger generations strive for different forms of knowledge today, old people are still regarded as influential in private and public life", says Obrist. This means that the elderly are still an important social and political pillar in African society. *Irène Dietschi*



A study participant from Zanzibar, together with the wife of her grandson and her great-granddaughter.

The university – an institution for the upper and middle classes

How can we best achieve equality of opportunity in education so that more than just the well-off can afford a degree? The issue is a sensitive one, but it's hardly ever been researched properly.
By Roland Fischer



The Association of Swiss Student Bodies (VSS) hands over the Scholarship Initiative on 20 January 2012.

Photo:Keystone/Marcel Bieri

Something is rotten in the state of Switzerland – at least when it comes to financial support for students from financially weaker families. In a nutshell: the current scholarship system is a real federal mess. There are 26 different sets of regulations, which means an application for help can sometimes be a geographical lottery. “Today’s rules are unfair because a student from Nidwalden has a far worse chance of getting a scholarship, and gets far less support, than a student from the canton of Vaud. This is the case, even if they both attend the same university of applied arts in Bern and their families are equally poor”, wrote the Association of Swiss Student Bodies (VSS) recently. They were reacting to a decision by the Council of States, which had refused for the umpteenth time to take any steps towards harmonising the scholarship regulations (see box). For example, in the canton of Grisons, one in every 74 citizens gets a scholarship, but in the canton of Glarus it’s just one in every 285. And the value of the scholarships also varies greatly. In the canton of Neuchâtel, students in tertiary education get an average of 4,000 Swiss francs per year. But in the canton of Vaud next door, students get three times as much. Essentially, it’s only very few cantons that have enough money to realise the ideal of equality of opportunity, regardless of a student’s background or family situation.

This dire situation with scholarships is the result of a development that was actually positive in itself. In the 1960s, student numbers began to grow – and this trend has continued to the present day. Until then, studying at a university was quite naturally something only for the well-off. In total, some 14,000 students were enrolled at the eight cantonal universities and the ETH in 1960, which meant a university attendance of roughly 3%. Scholarships were simply not a topic of discussion. But then came the expansion of education, and with it the Scholarship Law of 1965, the aim of which was “to allow children also from less-well-off families to choose a career suited to their abilities and aptitudes”, as Federal Councillor Tschudi wrote at the time. In the early years of the Swiss scholarship system, that noble goal was achieved.

Falling scholarship quotas

Between 1960 and the mid-1970s, student numbers tripled in Switzerland and have continued to grow to this day. However, the amount allocated for scholarships has hardly grown since the 1980s, which means that the number of students receiving them has decreased. Whereas in 1980, 16% of those in tertiary education were given a scholarship, in 2013 it was just over 7%. The federal government is hardly involved any more at all. Of the CHF 300 million spent on scholarships, only 25 million come from the federal government. So we’re clearly back in a situation where anyone wanting a higher education has to be able to

afford it. “Universities remain an institution for the upper and middle classes” says Charles Stirnimann, who runs the Office for Financial Contributions to Education in Basel and is President of the Inter-Cantonal Scholarship Organisation (IKSK).

From a societal perspective, the situation at the universities of applied sciences is more interesting. These have a much greater potential for getting students from more deprived circumstances into higher education, and they display far greater social mobility, says Stirnimann. Accordingly, the universities of applied sciences ought to have a far higher quota of scholarship holders than the universities – but in fact their figures are roughly the same, as is confirmed by the statistics recently released by the Swiss Federal Statistical Office. For Stirnimann, who is a historian and an expert in the Swiss scholarship system, this is a good example of how scholarships “are not just a social benefit, but also a socio-educational service” – or at least, they should be. If channelled properly, it is possible “to make optimum use of the existing potential in society” and have an impact on societal change. This is an argument that is gaining currency again because Swiss employers are complaining about a shortage of skilled workers.

Loans in Scandinavia

What would the ideal scholarship system look like? Wouldn’t all applicants have to be supported if possible? If this were to be the case, then between 20 – 25% of all Swiss students would get a scholarship – though the actual figures would differ greatly from one canton to the next, because travel and living costs vary with the distance students live from their university. Or should more specific criteria be applied to funding allocations? Educational research doesn’t really have an answer here, as there is poor understanding of the effective impact of scholarships and other such support mechanisms. In 2002, the German researchers Stefanie Schwarz and Meike Rehbarg subjected Europe’s very different scholarship systems to an initial descriptive comparison. In Scandinavia, for example, 70 – 80% of people born in any single year go into tertiary education, and many of them are supported by loans. However, this study did not focus on determining which system is best at making university attendance possible to those who want it.

In Switzerland, the educational researcher Nils Heuberger has been the most active in this field, and this year the Swiss Conference of Cantonal Ministers of Education (EDK) appointed him to a new post with the task of investigating it further. His research has shown that the earning capacity of a family still has a clear influence on whether or not its children go into the higher streams of secondary education. This then has a knock-on effect on their further educational development. Heuberger stresses that the question of scholarships

is ultimately a cultural issue in education. He has carried out a study for the Swiss Graduate School of Public Administration (IDHEAP). It showed that there were big differences between the German-speaking and French-speaking regions of Switzerland. Any “ideal” scholarship system would thus have to be determined independently of the broader educational and socio-political context.

For Lea Oberholzer, who is responsible for dealing with scholarship issues at the Association of Swiss Student Bodies, it is clear that the scholarship system should ideally be run on a federal level. And what does Oberholzer think about the increasing political pressure to give loans rather than scholarships? “Experience has shown that the prospect of years of debt means some people would rather abandon all ideas of studying than take out a loan”. And this would result once more in a disadvantageous situation for those who in any case belong to the underprivileged. In this regard, Heuberger points to surveys carried out by the Federal Statistical Office that prove that not all loans offered are in fact accepted. And so the situation remains a political stalemate between the federal authorities and the cantons – with a lot of unanswered questions. Action needs to be taken on all levels; in fact, it would be an ideal topic for a large-scale research project.

Roland Fischer is a freelance science journalist.

The Scholarship Initiative

The Scholarship Initiative of the Association of Swiss Student Bodies wants to get rid of all cantonal differences in the Swiss scholarship system. To achieve this, responsibility in many areas should be given to the federal authorities. The Federal Council has indirectly made a counterproposal in the form of the revised Law on Support for Education. This would provide a better financial base for those cantons that support a process of national alignment through the Scholarship Concordat. So far, 14 cantons have signed up to the Concordat.

“Showcasing damages science”

“Most science communication is propaganda. It isn’t allowed to speak of failure, only of success. But where criticism and distance are absent, trust crumbles first”. These are the words of Pius Knüsel, former Director of the Swiss Arts Council Pro Helvetia, the cantonal adult education college, in a hotly debated speech at ScienceComm, the science communication congress. Knüsel’s speech covered a range of topics, stretching from federal funding for culture to the sponsoring of professorial chairs and to research magazines that describe only extraordinarily useful science projects. But Knüsel believes that both the dominance of ‘usefulness’ and the flowering of science public relations, or PR, are ultimately damaging to the average citizen’s sense of identification with the science world. Knüsel has now revised and shortened his speech for publication in Horizons.



Pius Knüsel is the Director of the Volkshochschule of the canton of Zurich and former Director of the Swiss Arts Council Pro Helvetia.

Photo: Caroline Minjolle/Pixsil

Since the Renaissance, art and science have developed into two very different forms of knowledge. Science presents provable knowledge, while art presents unfocussed, subjective experience. And yet there are similarities between the two. One of the most striking is how they are communicated in the public and political spheres. Both art and science operate with promises of usefulness and uniqueness and employ methods derived from the entertainment industry. This means we have a distorted view of what is in fact fundamental.

Let us take a current example from the world of culture. The federal funding proposal for the years 2016 to 2019 proposes a 15% increase in funding for the Federal Office of Culture and the Swiss Arts Council Pro Helvetia, from 759 to 895 million francs. The problem with this proposal is that the 160 pages of the document in question make no substantive arguments. Culture, it tells us – in particular, modern building culture – creates social cohesion. But this can no more be proven than the opposite. And then we’re told that culture overcomes

modern individualism. Does it? Isn’t it in fact the source of it? It goes on to say that culture reduces social polarities; perhaps a standardised global culture does that, but it certainly isn’t the case with the cultural diversity that is proclaimed in the document, which inevitably creates polarities and tensions rather than reducing them.

The funding proposal does not reflect on this. It also ignores the statistics proving that our policies of high culture have for 40 years only been reaching the same sections of the population, namely the educated and the well-off. The proposal is instead founded on ideological dogmas. It demands expansion in order to make up for the deficits that it claims exist. One suspects that these messages are constantly repeated because the goals are unattainable. The reason for this unattainability is not sought, however, in the fact that the goals are wrong, but in a lack of financial means.

Conversely, politicians and the cultural system we fund see the dissemination of non-subsidised (i.e. commercial) culture as a catastrophe that must be combatted with yet more subsidised art. Because if we were able to accept that the cultural development of society can take place in an uncontrolled, ‘untamed’, self-financing manner, then we would have to ask uncomfortable questions about the extent of state intervention in the cultural sector and the costs it brings with it. This, however, remains taboo because of the procedural logic involved – the growth and expansion of one’s own area of responsibility have become self-legitimizing.

Two years ago, I was prompted to give up my post as the Director of the Swiss Arts Council Pro Helvetia by a rejection of self-criticism, a resistance to facts and the prevalence of dishonest reasoning. I then became the Director of the Volkshochschule (VHS) in Zurich. These adult education colleges can be regarded as the first great cultural/political project of the early 20th century, easing social cohesion through democratising education. These colleges were highly successful in popularising academic education. Knowledge was communicated here directly, one on one. In Switzerland there are today still 70 such colleges. But in terms of education policy, they are now off the radar. I see two reasons for this: the dominance of utilitarian thinking and the mania for self-promotion on the part of the universities.

Career accelerator

Between 2009 and 2011, the Zurich Education Department cut the subsidy for the VHS from 1.5 million francs to zero. Its

most important argument in favour of this measure was that only career-oriented further education was politically relevant. In future, the canton of Zurich will only support further education if it serves as a career accelerator and promises higher income - and thus a bigger tax base. To this end, it has for more than 20 years been building up a weighty, fully state-subsidised institution: 'Zurich Adult Education' (Erwachsenenbildung Zürich). An education policy such as this, focussed on working capacity, is to my mind a form of state utilitarianism that sees education as an accumulation of technical competencies, not as the critical investigation of a universe.

The dominance of the utilitarian has long since also reached our universities - in the form of an urge to self-portrayal. In the winter of 2013/14 the VHS Zurich offered a lecture series entitled 'Utopias for Zurich'. On six evenings, development perspectives were discussed for the metropolitan area of Zurich. The Mayor was also there and spoke about her 'social Zurich'. While we were still busy with the details of the series, there was an announcement by the city of a lecture series in collaboration with the University of Zurich: 'Growth pains' - on the same topic, and also with the participation of the Mayor. Both series ran well. The difference was: the evenings at the VHS cost each listener 30 francs, while the

co-production between city and university was free of charge. At the VHS, the lectures included discussion of an alternative, critical position - but this was lacking in the series held at the university.

Shortly afterwards, the Mayor visited the Rector of the University. The headlines ran: "We'll carry on! And we'll do it ourselves". That's the new trend. Universities, like city councils, want to control their public image. Science, research, politics and planning go hand in hand. Science is useful, and politics pretends to be a science. No one notices that science communication turns into science PR: the critical added value that can be brought by an independent institution in civil society - such as the VHS - counts for nothing.

Surfeit of communication

This anecdote illustrates the PR culture that has been directed towards us for some 20 years now. With regard to the non-economised areas of life such as politics, culture, education and health, people speak of 'communication' because it sounds nobler. Since I began working in adult education, university magazines have been piling up on my desk. They describe only extraordinarily useful research projects. Then there are the invitations to science days, open days, science slams, research nights, children's afternoons and learning festivals.

There has been a wholesale accumulation of science communication offerings. Their intention is clear: the science business wants to prove to the public how useful it is. It wants to generate attention, convey its significance and present science as a seductive experience, a kind of entertainment that also brings forth knowledge as a by-product.

This blossoming PR culture distorts the image of what it presents, as does all PR. It puffs up the importance of the universities. It reduces science to pleasantries and aestheticises research into a child-friendly show. But more than this: it turns the universities into competing brands. It turns them into companies that compete against each other on the funding market. This kind of science communication therefore calls into question the generally positive preconception that education and science are useful and necessary. It does it by preempting doubts in the current development of science.

But no one doubts the value of science. Otherwise we wouldn't have our current university system. Christoph Pappa, Secretary General of the University of Bern, wrote in *Horizons* in March 2014 that "in our age of competition among educational institutions, of increasing rivalries and ever scarcer resources, you have to be able to explain to people the benefits of a university.

"This blossoming PR culture reduces science to pleasantries and aestheticises research into a childfriendly show".

“I would ban the superlatives and stop the PR. What is important will work its way into society regardless”.

Otherwise, sooner or later you'll have problems". But either he was saying something quite banal here - because everyone knows what the benefit is of a university - or he is afraid of a critical discourse taking place on the academic scene.

And there is indeed reason for criticism. Universities (just like cultural institutions) have to define and distinguish themselves regionally, nationally and internationally. They develop into an image factor, a driver of the regional economy. Politics demands they create partnerships with business, offer professorial chairs funded by third parties, a self-supporting economic approach, facts for politicians to use, and host scientifically supported utopias. The universities join in merrily - especially the universities of applied sciences. They accept the consequences of an increasing institutional egotism and the stealthy privatisation of what is really a societal resource: the university. Whether it's discussions about sponsoring the UBS International Center of Economics at the University of Zurich or the Swisscom Chair at ETH Zurich, or the debate about the pros and cons of the gigantic Human Brain Project - founded on political promises - they all offer proof of the political orientation of academic life.

On a smaller scale, science likes to be seen as a local partner of politicians. 'Research for the good of everything' is the dogma here. Science communication - however unobtrusive it pretends to be - is a part of this internal cultural shift on the part of the universities. It trivialises academia, turning it into a utilitarian concept. It subverts the idea that science and research

are a universe of their own and have a right to incomprehension, to aberration and even to lunacy; it subverts the fact that science is a system that can only succeed as a global, productive resource that cannot be splintered off into different, competitive brands. A local lighthouse will shine at best only as far as the local council offices.

I fear that the less our citizens identify with the scientific and academic scene, the more it descends into mere showcasing. The offer is of a vicarious proximity to science that in fact only prompts scepticism; the communication bombardment produces only stress. Mature people are well aware of the societal significance of institutions of science and culture. Presenting them with pre-digested signifiers of their importance will instead offend. Doing it by dumbing down to the level of a Sunday supplement only provokes people.

Public doubt

The fact is that nothing makes people more sceptical than propaganda. But that is precisely what most science communication is. It isn't allowed to speak of failure, only of success. But where criticism and distance are absent, trust crumbles first. The problems it wants to solve are made only worse because it obscures an important source of knowledge: public doubt.

In the alumni magazine *Oec.* in June 2014, Josef Falkinger, Professor of Public Finance and Macroeconomics at the University of Zurich, named three factors on which trust in science and academia is based: professional expertise, intellectual honesty and the conviction that it makes sense to "make

use of reason" and to make "public use of it" (Immanuel Kant). Falkinger wrote that "it's not about who's the best and who wins, but what ultimately results in terms of knowledge or technology. Trust decreases as the quantity of superlatives increases".

This is why I would ban the superlatives and stop the PR. What is important will work its way into society regardless: through those who apply their knowledge, through teaching, through the critical interest of the media in the universities, and through commerce. Communication between universities is guaranteed by regular exchange within the scientific and academic community. Science does not need to wield a narcissistic mirror as if it were in showbiz. The discourse on education policy will still take place even in the absence of PR departments - that's why we have independent media. Allowing people to express doubts in this way is a matter of sheer honesty. And ultimately, criticism is a hallmark of scholarly endeavour. This is the only way for science and academia to progress, both on an individual level and as a system.

The complete lecture (in German) can be found at www.sciencecomm.ch.

Technology: still a man's job

Engineers, chemists, physicists and computer scientists are still urgently needed, despite the many funding initiatives that target them. Better data and more in-depth analyses should help to reverse the trend in future.

By Marcel Falk

It's a topic parents all talk about. Young people, children, even babies can hardly be torn away from their smartphones and tablets. They're mad about their gadgets, and technology seems to fascinate them. Yet all the Western industrial nations have had the same problem for decades: too few children - and too few girls in particular - want to become engineers and natural scientists. Despite many initiatives in schools and outside them, the economy still lacks the necessary experts.

The problem is clearly more complicated than was thought. Educational researchers now want to obtain solid data to be able to investigate this lack in the natural sciences and the technology sector. So Peter Labudde and his team from the University of Applied Sciences and Arts Northwestern Switzerland (FHNW) polled over 3,500 pupils and compared their answers with those of people who have taken up studies or a career in the natural sciences or technology. Some of the results are surprising.

The popularity of natural sciences and maths varies greatly. For example, biology is the most popular subject among high school students, with physics the least popular. Overall, no one likes maths much. The researchers have noticed that the proportion of unsatisfactory marks - and their degree of variance - is greater in maths than in other subjects. Do these bad marks dissuade young people from studying subjects such as computer science, engineering or physics?

But generating enthusiasm in certain topics can be done outside school, too. There is more encouragement for pupils to take an interest in technology at home than there is at school. The difference



According to a survey of 3,500 school students, careers in the natural sciences are regarded as useful, but uncreative. Photo: Shutterstock/Hurst Photo

between girls and boys is vast - only 40% of girls feel supported in their family when it comes to their interest in technology; with boys, it's 64%. It is interesting that this divergence between the sexes isn't found in the natural sciences.

“New products no one needs”

When asked about their self-confidence in technological matters, the results were sobering: as expected, boys see themselves as competent, while the girls have little confidence in their technological abilities. This lack of self-confidence was even noticeable in girls who were given just as much encouragement as boys and showed the same degree of interest in technology. The researchers felt that this was a result of stubborn stereotyping: both genders still regard technology as a man's work.

What is decisive in later career choices is the image that children and young people have of a profession. Careers in the natural sciences and in technology are in part regarded positively, as something modern and useful; but they are also seen as monotonous and lacking in creativity. Careers in engineering are also regarded as risky, and are seen as producing “new products no one needs”.

Rudolf Künzli, a former director of the School of Education at FHNW, believes that one-sided initiatives to promote only

technology and the natural sciences are in fact damaging to the image of these professions. In a recent edition of the *Schweiz am Sonntag*, he said, “in puberty, social aspects are naturally the main focus of attention. If you belittle social topics, you can only lose out. There would be a far better chance of success if we stressed the common ground shared by the natural sciences and the humanities”.

And in fact, the field is wide open. Education researchers also think so. They have proposed a national research programme on education and promoting young talent in the natural sciences and technology; it is currently being evaluated.

Marcel Falk is head of communication at the Swiss Academy of Natural Sciences.

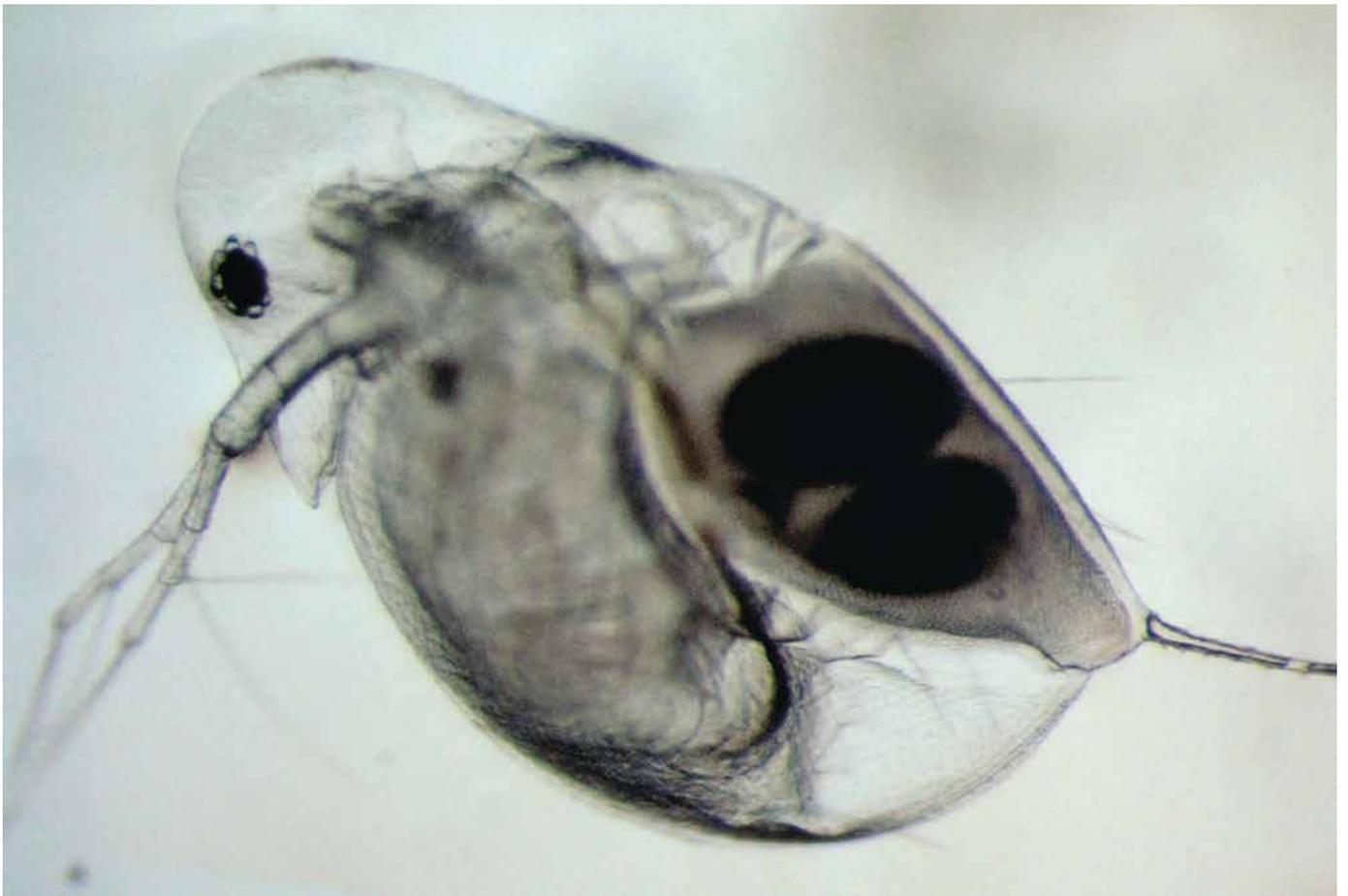
Literature:

Akademien der Wissenschaften Schweiz (2014): MINT-Nachwuchsbarometer Schweiz – Das Interesse von Kindern und Jugendlichen an naturwissenschaftlich-technischer Bildung. *Swiss Academies Reports* 9 (6).

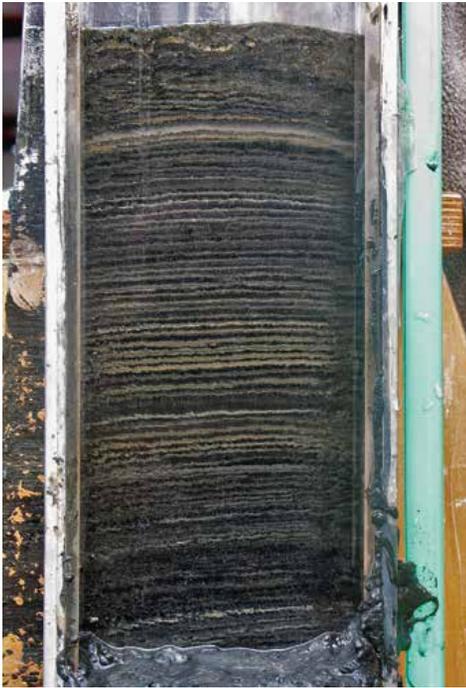
Diversity lost for ever

Until the 1970s, the combination of agricultural methods and phosphate-based detergents caused the eutrophication of many Swiss lakes. Since then, the water quality has improved noticeably, but water fleas have not succeeded in attaining their former diversity.

By Atlant Bieri



Water fleas (here, *Daphnia longispina*) usually reproduce asexually: females that are genetically identical to their mothers are born from all the eggs. But if environmental conditions worsen, males are also born that fertilise the eggs of the females. Here we see a female with two fertilised eggs; they are protected by a shell and can survive for decades at the bottom of the lake. Photo: Christian Rellstab, Eawag



Drilling cores from the bottom of the Greifensee. Every year, one light and one dark sediment layer are deposited. Photo: Piet Spaak, Eawag

Water fleas are just one to two millimetres in length and are thus among the smaller inhabitants of our lakes. And yet they are also among the most important. Billions of them swim through our lakes and constitute the main source of nutrition for young fish. Now researchers have discovered something disturbing about these water fleas. Their genetic diversity has altered fundamentally in the last hundred years. And it's humans that are to blame.

Piet Spaak is the Head of the Department of Aquatic Ecology at the aquatic research institute Eawag and has been investigating the fate of water fleas for the past 25 years. In order to carry out his studies, he has had recourse to a unique biological archive: the bottoms of the lakes. A new layer of sediment is formed there every year. By drilling and removing cores from the sediment, he can read the layers to find out what happened in earlier times - rather like looking at the rings of a tree.

These layers include the dormant eggs of water fleas, which can survive undamaged for a long time in dry or cold conditions. Young animals can even emerge from them after several decades. "At the bottom of a lake, the water is always at four degrees and there is little oxygen", says Spaak. "In such conditions, the eggs do not develop". After some fifty years, most of them eventually die. But even after a hundred years, researchers can carry out genetic analyses of dead eggs and thereby determine the characteristics of the species alive at that time.

In order to access the past, the scientists have to drill up to a metre into the silt. Spaak and his doctoral students Nora Brede, Cristian Rellstab and Markus Möst have taken so many samples from numerous lakes in Switzerland and Italy that they are able today to document completely the development of the water flea over the past hundred years.

It transpires that the water flea most common in prealpine lakes in the first half of the 20th century was the species *Daphnia longispina*. It specialised in surviving in waters low in nutrients. The lakes back then were relatively clean, and it reproduced slowly. It was distinctive in that it tried to avoid fish by only coming up at night to feed on algae on the water surface. By day it hid in the lower levels of the lake.

In the 1930s its situation worsened because more and more liquid manure from farms began to seep into the streams and rivers. Untreated waste water also began to flow from factories and the growing number of private households. This all had a negative impact on *Daphnia longispina*. The sewage acted like a fertiliser and caused a rapid increase in the amount of algae in the lakes, resulting in so-called algal bloom. When the algae died, they sank to the bottom of the lakes where they were broken down by bacteria. These bacteria in turn used up the oxygen in the water, which suffocated most other living creatures in the lake. Biologists call this process eutrophication.

Not prudish when choosing mates

The climax of this phase came in the 1970s. Agriculture was becoming more intensive, and phosphate-based detergents were also popular. The phosphates acted like supercharged fertiliser and prompted yet more algae growth. With this increase in nutrients appeared a second species of water flea, *Daphnia galeata*. It had previously led a shadowy existence in the alpine regions and is native to nutrient-rich waters - unlike *Daphnia longispina*. This new water flea began to spread rapidly in the over-fertilised lakes.

These two species of water flea are related closely to each other. And because male water fleas are not particularly prudish when it comes to choosing their mates, a female of a different species is to them just as good as one of their own. "Male water fleas will try to copulate with anything. If you put a pipette into their container, they'll latch onto it" says Spaak.

So eventually, *Daphnia galeata* and *Daphnia longispina* brought forth hybrids that were perfectly suited to conditions in the over-fertilised Swiss lakes. "These hybrids combined the advantageous features of both species", says Spaak. He believes that this adjustment to the new conditions in the water took place over a period of just ten to twenty years. "Normally, evolution

progresses by means of chance alterations in the genetic material. That can take thousands of years. But the hybridisation accelerated the process", he says.

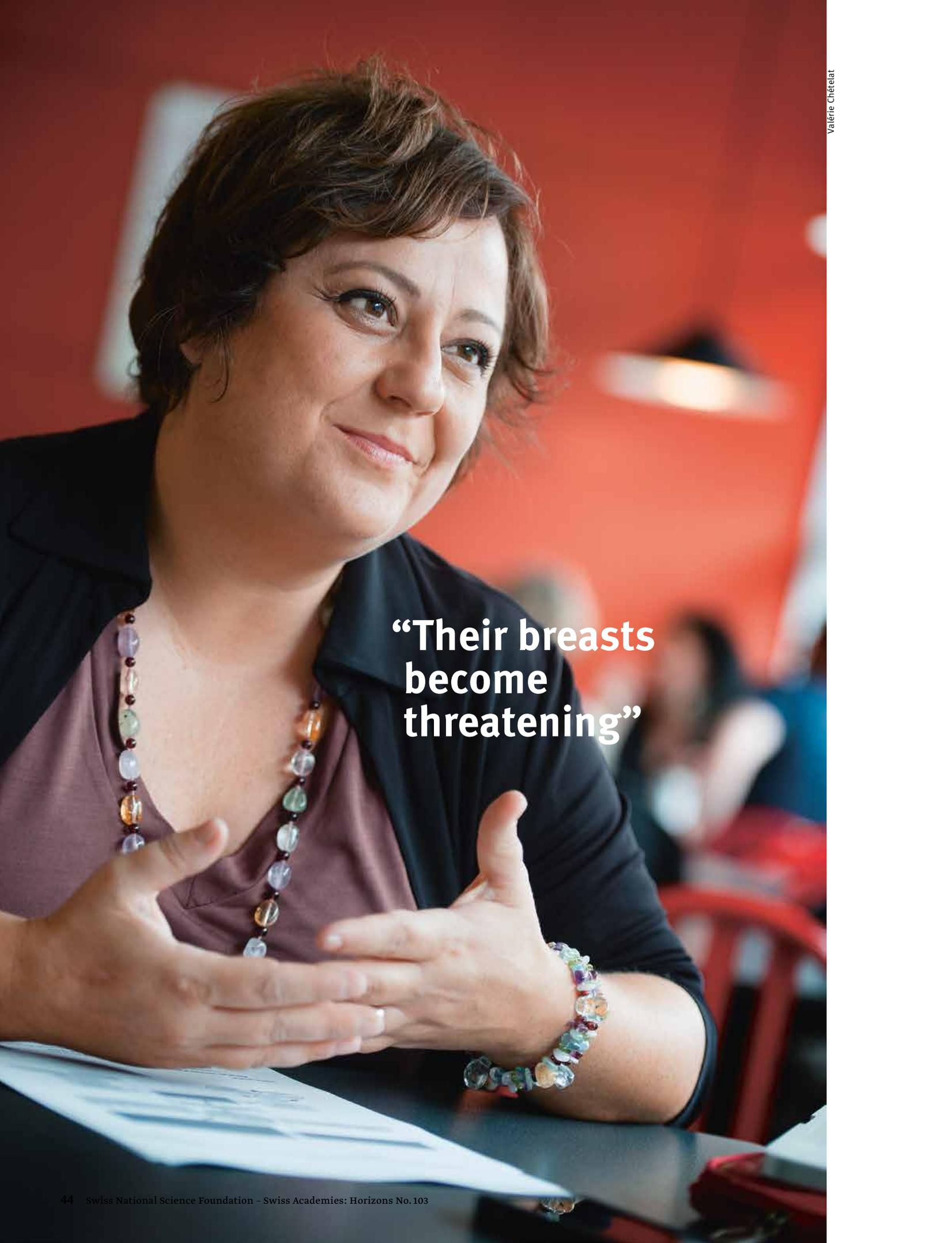
Improved water quality

These hybrids now reproduced and henceforth dominated in many of the eutrophic Swiss lakes. *Daphnia galeata* too was able to remain in high concentrations. *Daphnia longispina*, on the other hand, was marginalised. In the lakes that to this day have a large concentration of fertilisers, this distribution of the species has remained. One example is the Greifensee. While its phosphate content has decreased over the past fifty years from 500 micrograms per litre to 70, this is still roughly as much as was found in Lake Constance when it was at its most polluted. For this reason, the Greifensee remains eutrophic to this day. Fishes such as whitefish cannot reproduce on their own there because their eggs suffocate.

The ban on phosphate-based detergents introduced in the 1980s and the expansion of wastewater treatment plants improved the water quality of many lakes, however. As a result, the hybrids and *Daphnia galeata* became scarcer again. Lake Constance, Lake Lucerne and the Walensee are examples where this has happened: here, *Daphnia longispina* has once more gained the upper hand.

However, when analysing the genes of *Daphnia longispina*, the researchers discovered that this water flea is no longer the same one that was in our lakes a hundred years ago. By mating with *Daphnia galeata*, its genetic makeup has changed irreversibly. The new *Daphnia longispina* is in fact a hybrid of both species. The old water flea species are thus lost for good. Genetic diversity has been reduced, and biodiversity with it. "When man intervenes in the environment, the results are often impossible to foresee", says Spaak. "Even when we are able to reverse our disruption of the environment, this does not mean that we can return things to their original state".

Atlant Bieri is a freelance science journalist.



**“Their breasts
become
threatening”**

Women with genetic predispositions to cancer face the challenge of becoming a permanent patient without even being ill, according to the sociologist Maria Caiata Zufferey. *By Fleur Daugey*

Horizons: For the last 15 years it has been possible to test for the presence of a genetic mutation which leads to ovarian and breast cancers. What happens to women who have this gene?

Maria Caiata Zufferey: For the general population, the risk of developing breast cancer before reaching 70 years old is 10%. For women who have mutated BRCA1/BRCA2 genes, the risk rises to 45 to 85%. When women are told that they are at risk, we also give them some recommendations: undergo screenings every six months as of 25 years old, remove the ovaries ideally before 40 and, on a case-by-case basis, optionally ablate the breasts, i.e., undertake a mastectomy. Of course, the final decision lies always with the patient herself. Self-determination is a key principle in this area.

H: These women, otherwise in good health, find themselves under the sword of Damocles and stuck with the obligation of making decisions that involve major surgery.

MCZ: Yes, that is why I chose to study how women behave when faced with such uncertainty. How do they handle it when managing the risk of illness on a day-to-day basis and over the long term? I gathered the life stories of 32 women in French-speaking Switzerland and the canton of Ticino aged 26 to 60 years old, who had known about their condition for at least three years. These women had decided to take the genetic mutation test following the illness or death of a relative – a mother or a grandmother, for example.

H: How do they take this news?

MCZ: They experience an enormous sense of responsibility towards their ancestors. They feel privileged to have had access to this information. And they feel indebted to the women in their family who have had cancer and who did not have the chance to prevent it. They all want to use the information in the best way, and they also feel responsible towards their partners and their children. Those who have daughters also emphasise giving hope to their children and setting them a good example too.

H: Your results show that, despite this medical path being well trodden, patients are often disappointed in the relationships they have with their doctors.

MCZ: The Swiss medical profession still has to adapt to the specific status of people with genetic risks. Preventative medicine is a new idea that still lacks consensus. Female patients consult a number of different practitioners – doctors, gynaecologists, radiologists – who struggle to communicate with each other and who often

offer contrary opinions. Sometimes, when an operation is being considered, there are surgeons involved too. It seems that increased awareness of this new kind of patient amongst doctors is important but will only come with time. We mustn't forget that this type of test is still new.

H: What kind of things are these women told by their doctors?

MCZ: We see three different ways in which patients are assisted with their choice. One of the women that I interviewed told me that she thought her gynaecologist didn't "go deep enough". She wanted an expert opinion to be able to make the right decision, but he refused: "I give you the information, you use it", was his answer. Other doctors adopt the opposite attitude

"Women consult different practitioners who struggle to communicate with each other and often offer contrary opinions".

and completely deprive the patient of her freedom of choice. It reminds me of one 60-year-old woman who had yet to undergo the ablation of her ovaries because her gynaecologist thought that regular monitoring would be enough. This is completely against all recommendations. Finally there is the approach that I find most to the point. This is really a joint project in which the patient and her doctor work together on the decision. After consulting her, the doctor gives his or her logical opinion based on the patient's profile, which is always unique. The doctor can then say: "on the basis of the medical information in our possession and of your own personal situation, the way forward that to me seems most appropriate is as follows". This kind of help in the decision-making process is essential.

H: Does this type of relationship with doctors improve the chance of the decision being correct?

MCZ: I think so. We make the right decision so long as we correctly justify it. This makes the decision a personal one and avoids later regret. It's therefore necessary to support the choice with arguments, to make sense of it in one's own eyes and in

“Women who’ve been operated on are satisfied with their decision, despite the psychological and physical difficulties caused”.

the eyes of others. This is not something a woman can do alone. She needs the appropriate support. Expert medical advice is essential to ensure she takes into account not only the scope of the risk being taken but also the possibilities open to her. Here too the relationships with her partner and her relatives are significant. What is missing today is the opportunity for women to share their experiences with others in similar situations. Creating support groups and online communities seems key to reducing the feeling of isolation. There is a demand for this kind of help.

H: What kind of dilemmas do these women have to resolve?

MCZ: Women between 35 and 45 years old face the most difficult decisions, because often they have yet to fulfil all of their maternity goals or they are not in a stable relationship. I’m reminded of a 40-year-old woman, divorced with two children. She wanted to carry out a mastectomy, but it went against her desire to find a new man in her life. She found it impossible to enter into a new relationship after having undergone what she saw as a mutilation. This type of internal conflict can push certain women into ignoring medical recommendations. Around half of the women that I interviewed followed recommendations, but others allowed the deadlines to pass them by, whereas others did things much earlier. I saw two cases in which 33-year-old women, who both already had children, insisted on having their ovaries removed. They saw their situation as being very bad and preferred to undergo the consequences of an early menopause.

H: Do some women start to see their organs as enemies?

MCZ: Absolutely. The sample I took is not representative of the general population, but I was still surprised to note that more than half of the women had undergone a mastectomy or foresaw doing one in the short term. Those who had were satisfied, despite the psychological and physical difficulties caused by the operation. One of the women said she had “turned her body into a construction site for several months”. Often women do not consider surgery at the beginning but change their minds as time goes by. When they undergo a mammography, the radiologist may see something strange but without being able to identify it with certainty. Such a situation entails undergoing a biopsy, and the wait for results provokes anxiety. Their breasts become more and more threatening. Little by little, they experience a symbolic separation from this part of their bodies, up to the point that they request the operation and say, “take these off”!

H: What is it like to be a person at risk who is not ill?

MCZ: It’s complicated. There is the advantage of being able to receive treatment, but it can be uncomfortable. Here too, the medical profession has yet to find an appropriate response. For example, there was a case of a woman who had stopped mammography whilst she was pregnant and nursing. That meant a two-year interruption in screenings. When she wanted to start them back up, the secretary said there would be a six-month wait, arguing that the woman was still young and that she didn’t have cancer. They often have to wait in line behind those who are ill. At the same time, their doctors and their relatives ask them to do all they can not to become ill. This is what makes the situation uncomfortable.

H: Where will you take your research now?

MCZ: It would be interesting to study the experiences of doctors. They are not in a comfortable situation. Their patients throw numerous questions at them related to death, sexuality and feminine and maternal identity. These are complex topics that go beyond the body itself. I would also be interested in listening to what partners have to say. How do they help their partner face uncertainty?

Maria Caiata Zufferey

Maria Caiata Zufferey was born and raised in Lugano, Ticino. She studied social sciences at the University of Fribourg, where in 2004 she finished her thesis on rehabilitation from drug addiction. After spending time at the CNRS in Paris and at Imperial College London, she worked at the Faculty of Communication Sciences in Lugano from 2005 to 2011. For the last three years she has been continuing her research at the Sociology Department of the University of Geneva thanks to an Ambizione award from the SNSF.

The changing face of the AIDS virus

With its ability to recombine, HIV is a headache for therapeutic researchers. But exciting new data has been brought to light following studies on the virus's genome in large populations.

By Fabien Goubet

There are many faces to the HIV virus. It has its own sub-types, each with its own genetic sequence. These subtypes are often, but not systematically, associated with geographical areas (especially Asia and South America), or with risk groups (such as users of injectable drugs or sex workers). To make things more complicated, two different subtypes can create a new and unknown virus in a process similar to the way the flu virus also changes. This is known as recombination, a transformation that was first observed in HIV in 1996. Since then virologists have been coming across several new recombinants every year.

Today we do not know exactly the effect that recombination has on the global evolution of the virus. We don't know if it is causing the HIV genome to diversify, or to homogenise. And without any large-scale studies, it is difficult to say. At the University of Lausanne and the University Hospital of Lausanne (CHUV), Séverine Vuilleumier's research team has developed a mathematical tool "intended to describe better the demographic history of the subtypes of the virus with a view to clarifying the trends for the future".

There's no golden rule

The first step was to analyse the genetic sequences of the HIV subtypes detected in China. Thanks to this method, they have traced the paths of successive waves of viral infections in the country. This has brought to light that the subtypes B and later C (originating from Thailand and India respectively) took root in China as epidemics amongst drug users in the 1980s. "This is in

line with the explosion in drug trafficking in this part of the world during that time", says Vuilleumier.

As the epidemics spread, a growing number of recombinants appeared. Then in the 1990s a new epidemic started when the subtype CRF01-AE hit the male homosexual population. This group became responsible for the largest increase in the number of infections in China. Today, there are three subtypes, as well as a large number of recombinants.

"In China, it seems therefore that the dominant subtypes are linked to risk groups and their interactions", says Vuilleumier. "But this is not a golden rule. In South America, it was successive waves of migration that were responsible, as we have since been able to show".

Using this method of analysis, the research team has studied the genomes on a global level. According to Vuilleumier, the result is that "the HIV genome is tending towards homogenised recombinants". She

adds a word of caution, however. "That doesn't mean that there will be only one type of HIV. A new recombinant could emerge at any moment and upset the entire situation". The team is currently working with the virologist Amalio Telenti of the CHUV and the population geneticist Jeffrey Jensen of the EPFL.

"Recombinants are not the focus of most research. Thanks to our work, we have been able to build bridges to those scientists. It is possible that our results can help to target better the most virulent subtypes and recombinants and then to adapt therapy", says Vuilleumier.

Fabien Goubet is a science editor at the newspaper *Le Temps*.



Ma Ru from Shanghai in China, now seven years old, was born with AIDS.

Photo: Keystone/EPA/Michael Reynolds

The chemistry has to be right

All across the animal kingdom, family life is marked by conflict. How much attention and care should parents give their whining offspring? Is it better for a young animal to help its siblings, or just to grab their food for itself instead? These are the kind of questions that occupy Mathias Kölliker, an evolutionary biologist from the University of Basel. As his model organism he's chosen the earwig. Earwig mothers are almost touching in the way they care for their brood - they watch over the eggs, feed their young and protect them from enemies. This is a primordial form of brood care. Young earwigs are not as dependent on their parents as young mammals or birds. They can already look for food themselves, but they also beg for things to eat. They don't do this out loud, but using chemical substances on their outer shell.

Now Kölliker and his colleagues have found out that the mothers also use such chemical signals to show their young how well they are doing. And just as the mothers react to the begging of their young, the latter react to the signals given out by the mother. They adjust their behaviour in turn, and according to the situation they share more or less food with their siblings. If the mother is in bad shape, for example, and will soon have to let her young fend for themselves, then it's advisable for young earwigs to help their siblings, says Kölliker. Because if they act as a group, they can defend themselves better against enemies and seek food more efficiently. *Simon Koechlin*

J.W.Y. Wong, C. Lucas & M. Kölliker (2014): Cues of Maternal Condition Influence Offspring Selfishness. *PLoS ONE* 9: e87214.



A female earwig looks after its young.



A digital illustration of DNA.

The risk of illness in junk DNA

Why are some people more susceptible to diseases than others? It's obviously not always the fault of our genes - i.e., our coding stretches of DNA - at least not with complex diseases such as Type-2 diabetes. It is mostly in the so-called non-coding sections between individual genes that we find the main genetic differences between healthy and sick people. And yet just a few years ago, these sections were still often regarded as 'junk DNA'.

Meanwhile, it's become clear that these variable sections determine when, in which cells and to what degree genes are active. They play an important role in epigenetics. Their control over genetics is primarily a matter of the packaging density of the genetic material. If human DNA were to be unravelled completely it would be some two metres long, but in our cells it's wrapped in a ball around proteins and so has a radius millions of times smaller than this.

Together with colleagues at Stanford University, the Swiss bioinformatician Judith Zaugg has investigated 19 different people from Europe, Asia and Africa to see which parts of their genetic material are particularly densely packaged and are thus inactive. In the process, she has found big differences between individuals. Zaugg thinks the reason is that additional proteins could be attached to the variable sections between the genes, depending on the DNA sequence. This would alter not just the packaging density but also the activity of the gene and, ultimately, the risk of diabetes. *ori*

M. Kasowski *et al.* (2013): Extensive variation in chromatin states across humans. *Science* 342: 750-752.

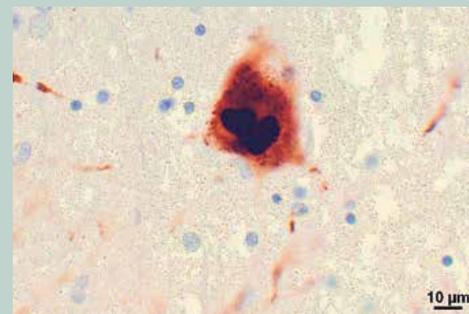
Fighting Parkinson's with genetic engineering

Parkinson's disease kills off nerve cells in the middle brain, and this in turn causes stiffness, trembling and other movement disorders that make life difficult for those affected. There are still no drugs that could reverse the process of the disease or even just slow it down. But Roger Nitsch, Professor of Molecular Psychiatry at the University of Zurich, is now putting his hopes on a genetically engineered human antibody. It has been able to lessen the symptoms of Parkinson's in mice, and is now due to be tested on humans.

The causes of nerve-cell death in Parkinson's have not yet been explained. Researchers think that misfolded proteins - diseased variants of the body's own proteins - could play a role here, because they occur in the so-called Lewy corpuscles. These are fibrous nodules that collect in the nerve cells of those affected by Parkinson's. The antibody engineered by Nitsch and his team attaches itself specifically to these misfolded proteins and neutralises them. In animal tests, the number of Lewy corpuscles decreased after the antibody was given. Nitsch's goal is to be able to slow down the progress of the disease in this manner.

Misfolded proteins are associated not just with Parkinson's, but also with Alzheimer's - and with amyotrophic lateral sclerosis (ALS), which has recently become better known thanks to the Ice Bucket Challenge fund-raiser on the Internet. Nitsch and his team are also researching into treatment methods for these two diseases. *Thomas Pfluger*

M. Hanenberg *et al.* (2014): Amyloid- β Peptide-specific DARPins as a Novel Class of Potential Therapeutics for Alzheimer Disease. *Journal of Biological Chemistry* 289: 27080-9.

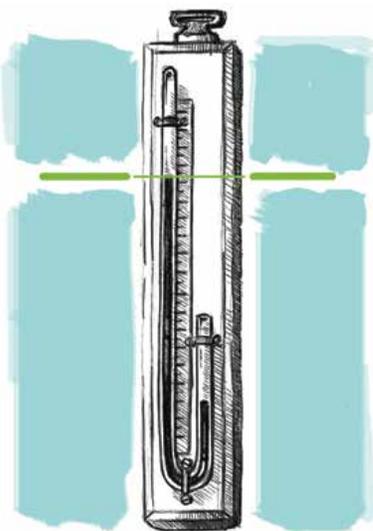


Lewy corpuscles, coloured brown, in the brain tissue of a Parkinson's patient.

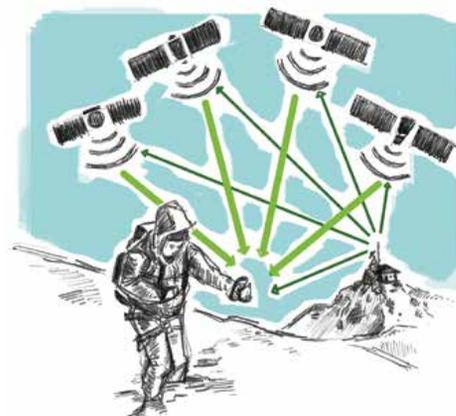
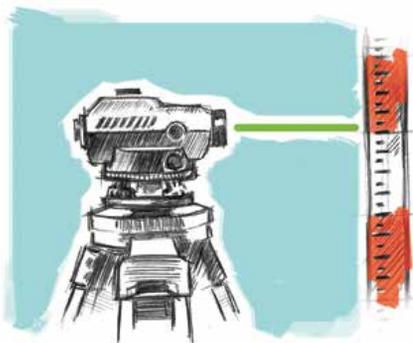
Measuring altitude

By Philippe Morel, with illustrations by Dominik Richard Kurmann

1 To longitude and latitude, we can add a third coordinate, altitude. Only with all three can you define a position accurately. But how do you go about measuring altitude? At the end of the 18th century scientists climbed the Alps with barometers strapped to their backs to try and determine the heights of the different summits. With increasing altitude, the weight of a column of air reduces, as does pressure. So, by measuring the pressure, it is possible theoretically to determine the altitude at which the barometer is located. But of course this method does not take into account the fact that atmospheric pressure in a single position can vary considerably within the space of a couple of hours. So if the weather takes a turn for the worse – i.e. if an atmospheric depression approaches – then the height of the barometer will start to go up even though it is not changing altitude. So while this means of measurement is practical, it lacks precision.



2 There is another, altogether more complicated method, known as levelling. Starting from a fixed point, such as zero altitude, a surveyor can very precisely measure the difference in height between one point and a measuring rod situated some distance away, using a spirit level. By adding the differences in the level we can determine the elevation at which the rod is situated. This can be done in a slightly different way with trigonometry. In this case, the angles are measured to calculate the difference in altitude. This method is also somewhat imprecise.



3 Today, GPS has become the central tool for measuring altitude, even though it was not designed for this specifically. A GPS device can simply capture the signals from four satellites to measure altitude. This method of direct measurement, however, is also lacking in precision. In order to improve it, the key is to set up a reference station with a known altitude, determined with precision, and to measure the difference in altitude between the station and the point of measurement. As the variations in the signals of GPS satellites are almost identical for two closely located stations, it is possible then to subtract one from the other to ascertain the real altitude.

Only international scholarship can achieve universal validity

By Thierry Courvoisier

The fact that research is very much determined by local context can be seen in the development of semi-conductor theory and plasma physics. In the 1930s and '50s, American and British physi-



SCNAT

cists dominated the field with models in which electrons were either free or bound to atoms. But it remained difficult to explain the characteristics of solid bodies or plasmas with such models (plasmas are gases in which the particles are electrically charged). In the Soviet Union, on the other hand, physicists lived in a society that was

determined by collectivism. The physicists transferred this manner of thinking to their scientific ideas, and introduced collective effects that are known today as phonons or plasmons (see A.B. Kojevnikov: *Stalin's Great Science*. Imperial College Press, 2004). There are many other examples that show how researchers are always influenced by their respective cultural and social environment.

However, the path from an idea or intuition to scientific findings is always a long one. This process depends on considerable interaction with researchers who think differently, who criticise the original idea, who enrich it and confront

Letters to the editor

Dear *Horizons*,

I am almost always pleasantly surprised by your choice of focus topics. Time and again I'm delighted by the quality of the articles, by the excellent layout and often also by the expressiveness of the professional portrait photos. And when compared to its German equivalent, the magazine *Forschung* of the Deutsche Forschungsgemeinschaft, *Horizons* also comes off considerably better, to my taste. Instead of pandering all too frequently to the vanity of academic bureaucrats, your focus is on your readership, and you offer food for thought in clear prose.

There's just one thing: on page 48 of edition No. 102 you carried a photo of a rodent that the caption claimed was a muskrat. But the photo is in fact of a nutria. I suggest that when using third-party

it with their own approaches. It is this part of the scientific development process that is profoundly international. Only a confrontation with other milieus can lead science from local to universal validity. In the above example, it was discussions with the Americans that brought the initial Soviet concepts to fruition.

In Europe, we have the immense advantage of an incredible density of cultures in a relatively small geographical area. This means that the confrontations necessary to the scientific process can take place on our doorstep.

Separating ourselves from our scientific environment in Europe would mean that our research could no longer profit from interaction with other cultures. If people believe that European contacts can be replaced by intercontinental contacts, then they are not just oblivious to the resulting impoverishment of scientific interaction, but also to the fact that it adds big barriers to the process of scientific communication – a process that is in any case laborious. Ultimately, separating Switzerland from European science would result in our own research losing its claims to universal validity.

Thierry Courvoisier is the President of the Academies of Arts and Sciences and a Professor of Astrophysics at the University of Geneva. This text is based on a lecture that he gave on 2 October 2014 in Bern at an event entitled 'It's our future – now we're talking'. The complete lecture can be found at cap.unige.ch/courvoisier.

photos of animals or plants, you don't trust the vagaries of the picture agencies, but only experienced biologists... the muskrat and the nutria, incidentally, are not closely related at all. Their external similarity is a result of the same selection factors in their habitat, namely inland waters. Their anatomy reflects their amphibian way of life. But both are still invasive species here. Günter Matzke-Hajek, Alfter, Germany

I would like to thank you for your excellent article 'The invisible achievers', in which you are perfectly right. It's high time that people are really made to take notice of the situation for mid-level university academics in Switzerland, especially with regard to their future prospects.

André Horak, University of Bern

December 2014 to March 2015

Science cafes

Science History Museum, Geneva
 ▶ www.bancspublics.ch

Until February 2015

'Crimes and Punishments'

History Museum, Lausanne
 ▶ www.lausanne.ch/mhl

Until February 2015

'LAB/LIFE'

Musée de la main, Lausanne
 ▶ www.museedelamain.ch

Until 3 May 2015

'The Mochica Kings'

Ethnography Museum, Geneva
 ▶ www.ville-ge.ch/meg

16 January 2015

Dialogue between research and conservation practice

University of Bern
 ▶ www.biodiversity.ch/e/events/swifcob/

November 2014 to February 2015

Medicine: Is less more?

University of Bern
 ▶ www.forum.unibe.ch/de/pro_Medizin.htm

27 January 2015

New plant cultivation methods

University of Bern
 ▶ www.geneticresearch.ch/d/produkte/Veranstaltungen/Tagung_2015.php

29 January 2015

Conference: 'Sustainable Use of Resources – from Evidence to Intervention'

University of Basel
 ▶ www.sagw.ch/en/sagw/veranstaltungen/vst14-sagw/vst14-ne/ressourcen/Evidenz-Intervention.html

“Being open to the world is essential for Switzerland”

At its annual meeting in the Kursaal in Bern, the National Research Council of the SNSF welcomed a prominent guest speaker in the form of Felix Gutzwiller, who explained his view of the current challenges facing Swiss science policy. Gutzwiller is a member of the Swiss Upper Chamber, a doctor of preventive medicine and a former member of the SNSF’s Research Council. Switzerland’s research scene, he says, has until today been able to benefit from positive overall conditions such as legal certainty, reliable funding, access to the world’s best minds and international collaboration. “Thanks to these factors, Switzerland today is one of the most competitive, most innovative countries in the world”. Being open to the world has always been a decisive factor in the success of Switzerland as a centre of research and innovation, but he insists that “this

Marco Finsterwald



openness has come under threat and must be defended!”. The acceptance of the referendum on mass immigration presents Switzerland’s research scene with major problems, because it can no longer be sure of recruiting the world’s best minds. “The voice of science and research has to be heard more often in Swiss society”, said Gutzwiller. The institutions involved in education, research and innovation have to show a greater commitment to this, and so do researchers themselves. In the medium- and long-term, everyone has to offer active support in the battle to keep Switzerland an open centre for knowledge and research.

Ambizione: funding for 60 young researchers

This year, as part of the “Ambizione” project, the SNSF has given funding to 60 young researchers. Through this means of career support, talented young researchers can be helped along their first steps in independent research. Just under 32% of the recipients are women. The monies cover both salaries and project funding for a maximum of three years.

Science article of the year

The Swiss Academies of Arts and Sciences have awarded the Prix Média 2014 to the following journalists for their success in conveying scientific knowledge to the general public: Julie Zaugg and Clément Bürge for their article on fracking in *L’Hebdo* magazine, Catherine Riva for her article

Keystone/Anthony Anex



on mammography screening in *SEPT. info*, Mathias Plüss for ‘Thirteen popular misconceptions on intelligence’ in *Das Magazin* and Nik Walter for his insights into animal testing research practices in the *Sonntagszeitung*.

Clean energy, clean air

Implementing the energy strategy should be linked with the goal of air pollution control, write the Swiss Academies of Arts and Sciences in a new factsheet. Burning wood in micro-cogeneration plants has a positive impact on the climate but causes



high particulate emissions. Yet air pollution control can generally be combined well with climate protection and the energy strategy, because greenhouse gases and airborne pollutants mostly have the same sources. The Academies therefore recommend supporting only those energy and climate measures that also take air pollution into account. (www.akademien-schweiz.ch/factsheets).

Horizons

The Swiss magazine for scientific research is published quarterly in German, French and English. Volume 26, No. 103, December 2014. www.snf.ch/horizonte

Publisher

Swiss National Science Foundation (SNSF)
Jürg Dinner, Communication Department
Wildhainweg 3
Postfach 8232
CH-3001 Bern
Tel. 031 308 22 22
abo@snf.ch

Swiss Academies of Arts and Sciences
Generalsekretariat
Hirschengraben 11
CH-3001 Bern
Tel. 031 313 14 40
info@akademien-schweiz.ch

Editors

Valentin Amrhein (va), Chief Editor
Marcel Falk (mf)
Philippe Morel (pm)
Ori Schipper (ori)
Marie-Jeanne Krill (mjk)
Mirko Bischofberger (mb)

Graphic design, photography

2. stock süd netthoevel & gaberthüel,
Valérie Chételat
Cover photo: Interfoto/SuperStock.
Illustration: Eliane Häfliger, HEAB

Translation and proofreading

Max Crisp, Chris Walton, Interpreters’ and Translators’ Association, Zurich

Printer and lithographer

Stämpfli AG, Bern and Zurich
Climate neutral, myclimate.org
Paper: Refutura FSC, Recycling, matt
Typography: FF Meta, Greta Text Std

Distribution

36,839 copies in German,
15,418 copies in French.

© All rights reserved.

Reproduction with the Editor’s permission is requested.
ISSN 1663 2710

Subscription is free. Distribution of the paper version is usually restricted to Switzerland and foreign organisations.

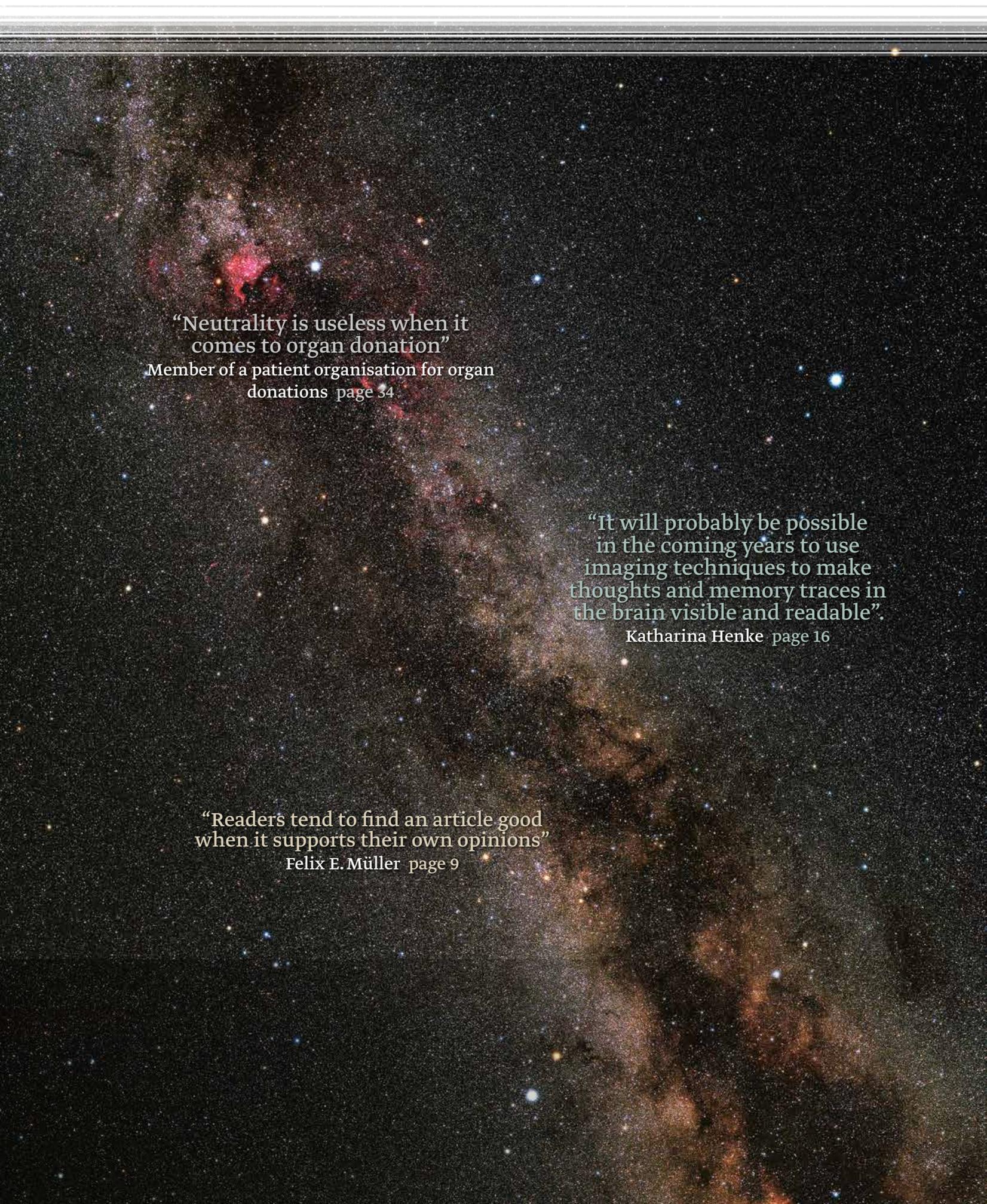
The opinions in the articles are those of their authors and do not necessarily reflect those of the SNSF and/or SA. Research presented is generally supported by the SNSF.

The SNSF

The SNSF is the principal body for the promotion of scientific research in Switzerland. It is mandated by the Confederation to promote basic research in all fields and disciplines and each year distributes some 755 million Swiss francs amongst more than 3,500 projects involving about 8,750 scholars.

The Swiss Academies

Also mandated by the Confederation, the Swiss Academies of Arts and Sciences are committed to an open dialogue between science and society. They are on the side of science, each specialising in a respective domain, yet also acting in an inter-disciplinary way. Being anchored to the scientific community rewards them with access to the expertise of around 100,000 researchers.



“Neutrality is useless when it
comes to organ donation”
Member of a patient organisation for organ
donations page 34

“It will probably be possible
in the coming years to use
imaging techniques to make
thoughts and memory traces in
the brain visible and readable”.
Katharina Henke page 16

“Readers tend to find an article good
when it supports their own opinions”
Felix E. Müller page 9