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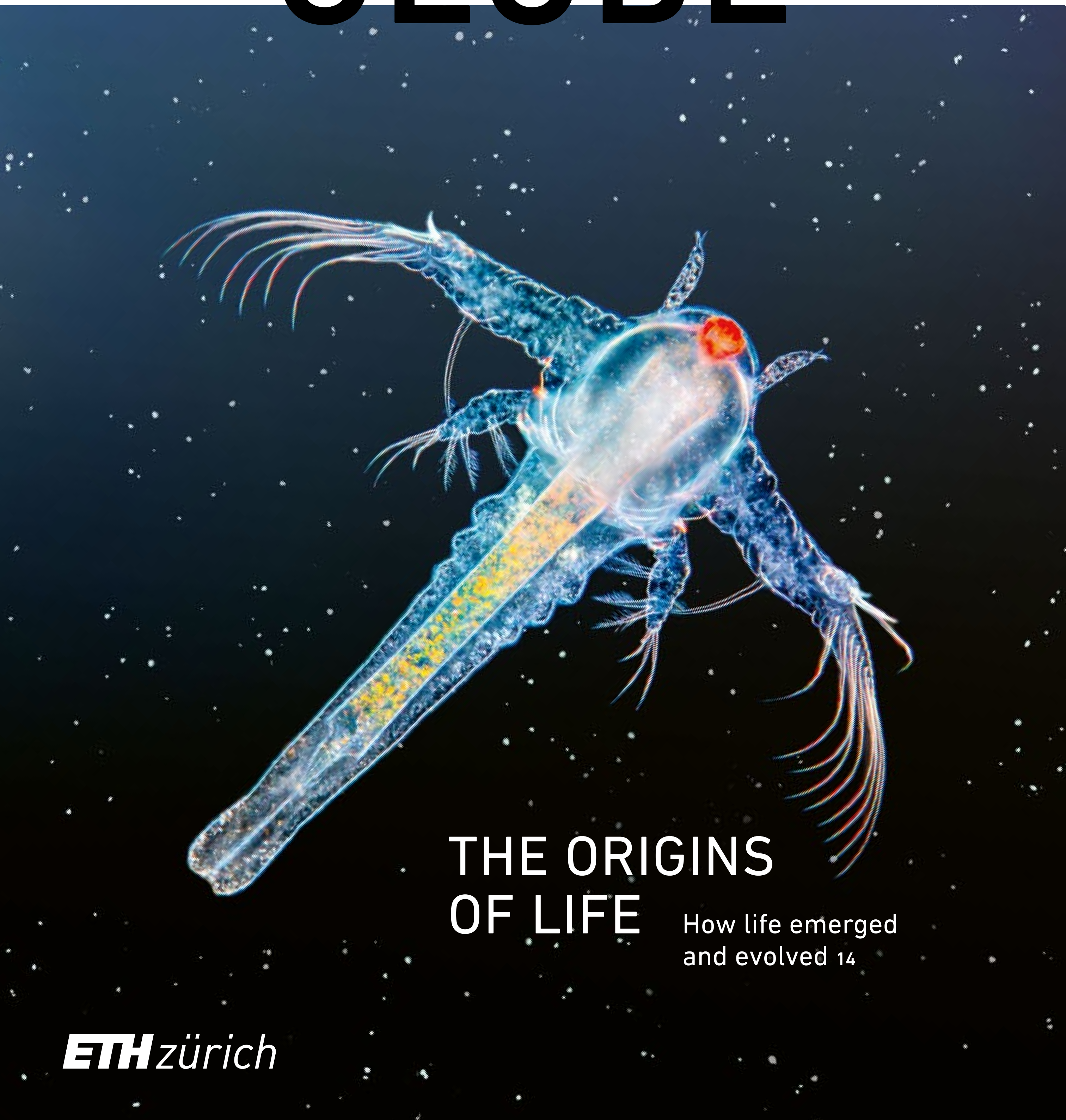
GLOBE

NO. 4/2022



THE ORIGINS OF LIFE

How life emerged and evolved 14

ETH zürich

EDITORIAL

THE BIG QUESTIONS

Since time immemorial, people have marvelled and wondered at the vastness of the universe. Today, fundamental questions on the origin of life are taking on a new urgency, albeit more from a scientific angle than a philosophical one. How did life on Earth evolve? Where else might the universe harbour life? Buoyed by cutting-edge technologies and major advances in various disciplines, this is arguably the perfect moment to find interdisciplinary answers to these questions.

ETH Zurich has therefore established a new research and teaching institute to explore the emergence and evolution of life on Earth and beyond. The Centre for Origin and Prevalence of Life – which also includes a fellowship programme designed to attract young talent – consists of over 40 research groups from five academic departments and is led by astrophysicist and Nobel Laureate Didier Queloz. Interviewed in this issue, Queloz highlights the importance of humility when dealing with questions of such magnitude. We also investigate a bold plan by ETH researchers to construct a large telescope consisting of multiple satellites. This may eventually enable us to directly image and chemically characterise exoplanets as part of our search for alien life.

This issue also asks scientists from an array of disciplines to reflect on the question “What is life?”; their answers reveal the blurring of the boundaries between life and non-life. I hope you find this issue of *Globe* both enjoyable and thought-provoking!

Joël Mesot,
President of ETH Zurich

Globe, the magazine for ETH Zurich and ETH Alumni

Images: (Cover) Brine shrimp *(Artemia salina)* can survive in hypersaline environments such as salt lakes – even when the water is almost saturated with salt. (Editorial) Oriana Fenwick

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Images: Daniel Winkler; Christian Knörr

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NEW + NOTED

Image: Keystone / DPA / Patrick Pleul

After weeks without rain, a tractor towing a drill drives across a bone-dry field in Brandenburg, Germany (18 August 2022).

Scientists identify cause of severe droughts

The summer of 2022 in the Northern Hemisphere was one of the hottest ever recorded in Europe. Now, an international team of climate scientists led by Sonia Seneviratne's research group at ETH Zurich has demonstrated the link between anthropogenic climate change and the severe droughts that accompanied the Northern Hemisphere's high summer temperatures. According to their study, climate change has made such dry soil conditions 20 times more likely to occur; in a world without climate change, this type of drought would only happen around once every 400 years. The researchers note that the main driver of drought risk is the increase in temperatures, not changes in rainfall.

The research team's findings are based on an analysis of soil moisture levels carried out in June, July and August 2022 across the whole of the Northern Hemisphere, excluding the tropics. The study focused on a specific region, Western and Central Europe, which experienced a particularly severe drought with substantially reduced crop yields. The term agricultural and ecological drought signifies a lack of moisture in the top metre of soil, or root zone, which is where plants extract water.

According to the researchers, the risk of drought is particularly high in agricultural and densely populated regions. If temperatures continue to increase, summer droughts are likely to become more frequent and more intense. This could have serious consequences for food production and water supplies and also increase the frequency of forest fires. ○

Risk factors for obesity

Researchers at ETH Zurich have shown that susceptibility to obesity is not only influenced by the region of DNA commonly referred to as genes, but also by other parts of our DNA. The study, which was led by Markus Stoffel, revealed that the microRNA-7 molecule also plays a role in a predisposition to put on excess weight. MicroRNA molecules are carriers of epigenetic information, which means that, unlike conventional genes, they are not translated into protein form. Instead, they act in our cells in the form of RNA.

By conducting experiments on mice in the lab, the research team discovered that organisms with genetic variations on their chromosomes near the blueprint for microRNA-7 are predisposed to put on weight. The researchers bred mice in which microRNA-7 was missing in certain nerve cells of the hypothalamus, the control centre between the endocrine system and nervous system. These mice demonstrated a pathologically increased appetite and became obese. Subsequent analysis revealed the same link in humans, with health data showing that obese individuals also exhibit genetic variations near the blueprint for microRNA-7.

These new findings could – at least theoretically – also be used in medicine. Scientists have already developed RNA-based drugs that use the mechanisms of action of microRNA molecules in the body. It may eventually be possible to develop treatments for people who are obese as a result of their hypothalamus producing insufficient amounts of microRNA-7. Conversely, it might also be possible to pharmacologically inhibit microRNA-7 to treat people with a predisposition to pathologically low body weight or weight loss. ○

Stable in any shape

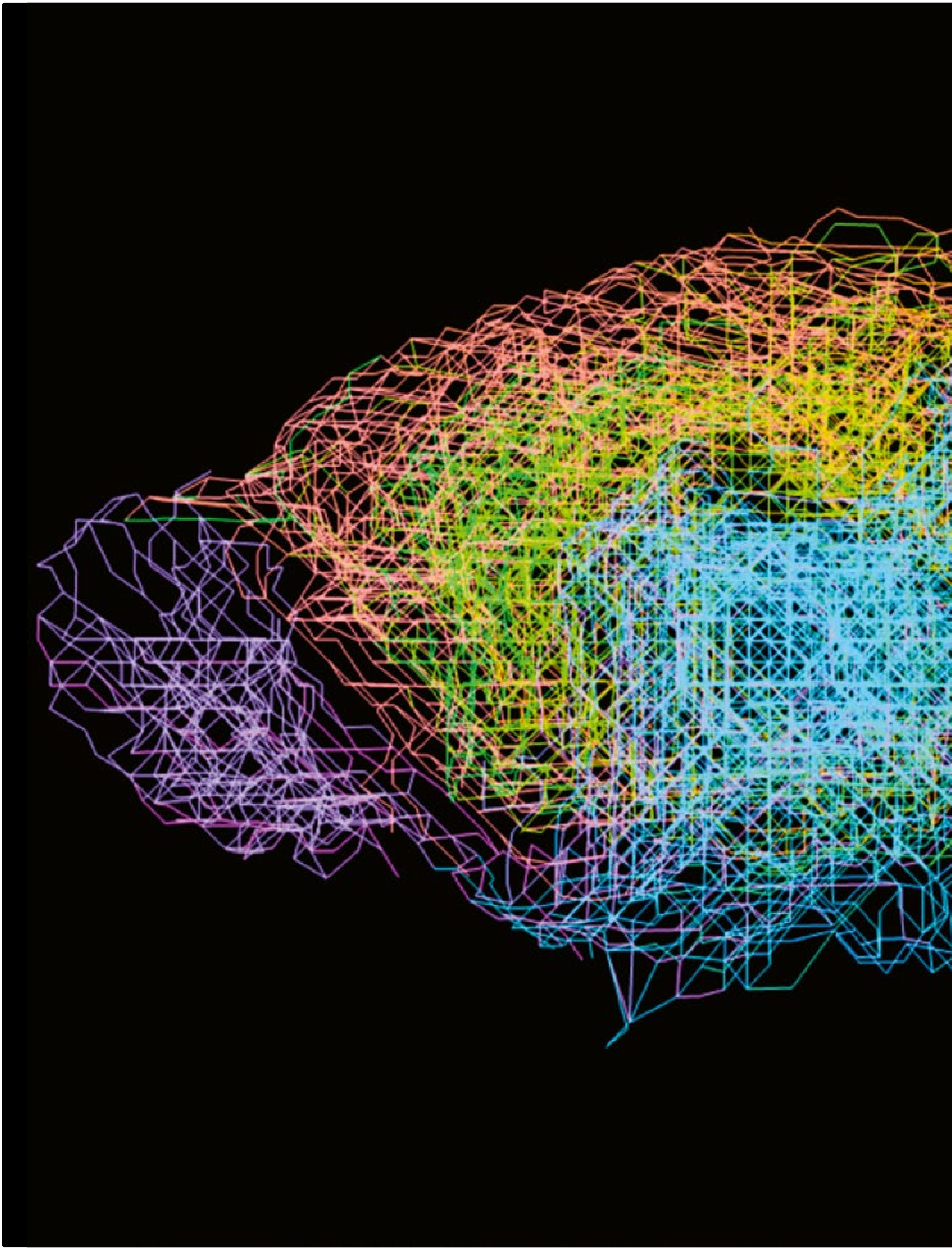
Researchers have long been trying to create materials that can assume and retain different shapes to meet different needs. Such multistable structures would allow us to build objects that can be continuously changed from one stable three-dimensional shape to another as required. Giada Risso, a doctoral student in the group led by Paolo Ermanni, has now developed a structure that can move between any number of shapes and remain stable in all of them. Potential applications include robotics, construction and the space industry.

Risso's solution is cheaper and more flexible than similar materials developed in the past. It can be bent into new shapes again and again, but can always be restored to its original shape. The basic element is a square of polyurethane film with a carbon-fibre frame; this can be augmented with other square elements as required. ○

Image: ETH Zurich / G. Risso

Lightweight and easy to produce, the multistable structure can be flexibly expanded and reshaped as required.

Video: youtu.be/gLhdczokvQY



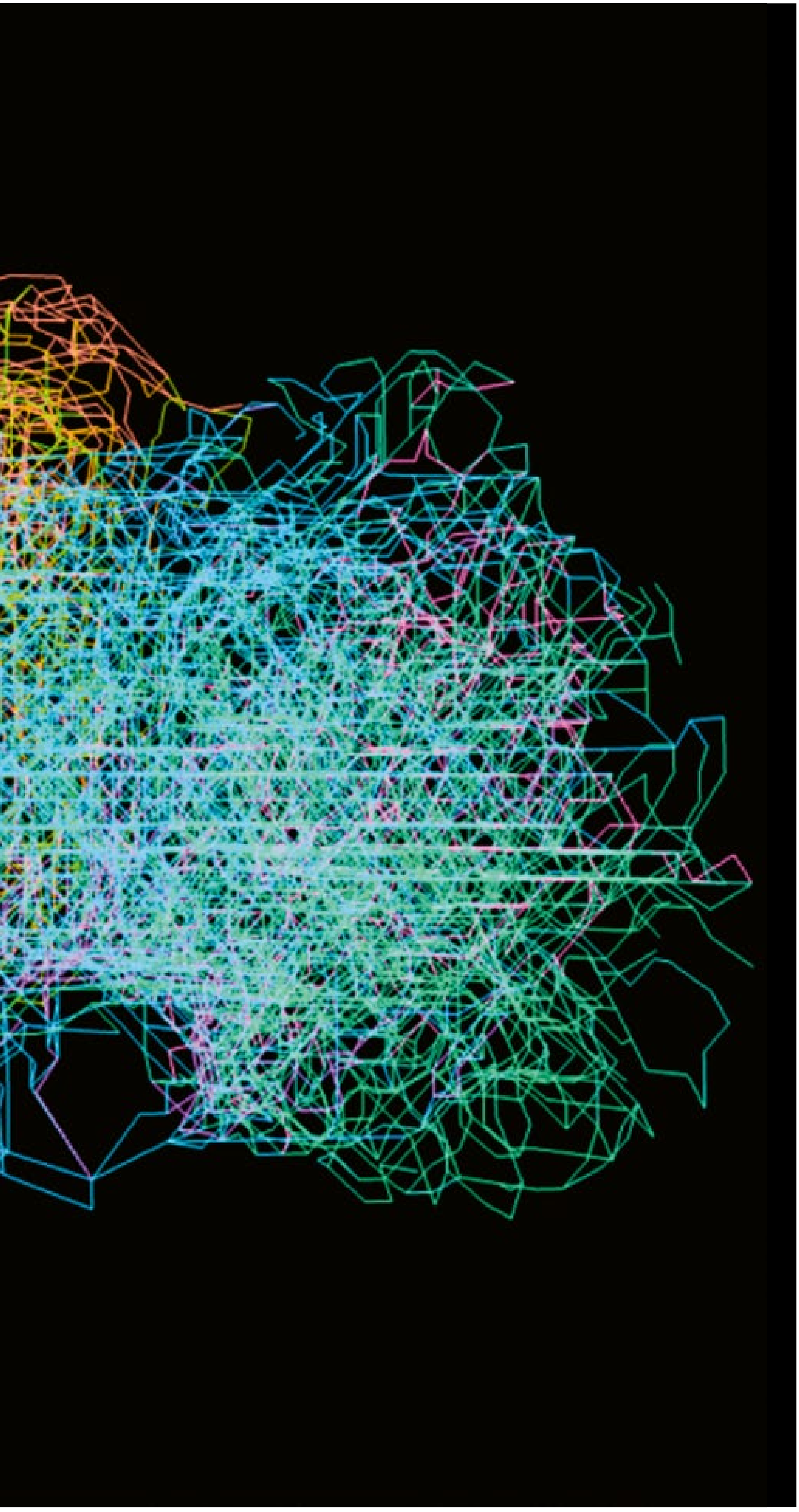


Image: ETH Zurich / Stan Kerstjens

Cell division holds the key

CONNECTED ○ The human brain is the most complicated organ nature has ever produced: 100 billion neurons, each connected to thousands of other cells through synapses, enable us to perform all the essential activities of everyday life. But what makes a small cluster of embryonic cells develop into a huge neural network that is capable of learning? Working together with his collaborators, Stan Kerstjens, a doctoral student at the Institute of Neuroinformatics of ETH Zurich and the University of Zurich, developed a model to simulate the development of a mouse's brain. They suggest that starting with a single cell, the process of cell division produces hierarchically organised regions of closely related cells with characteristic genetic profiles. Axons, the extensions of neurons, could use this lineal hierarchy as a molecular address book to navigate through the brain tissue. This would allow neurons to find their remote targets, to ultimately create the connectome, a comprehensive map of neural connections in the brain. ○

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The myth of the urban-rural divide

Environmental debates perpetuate the myth of an urban-rural divide that in reality does not exist, says Thomas Bernauer.

THOMAS BERNAUER is Professor of Political Science at the Department of Humanities, Social and Political Sciences of ETH Zurich.

The cliché of a political divide between urban and rural dwellers is often invoked to explain the results of debates and votes on environmental issues. On the one side are conservative, rural communities that embrace gas-guzzling vehicles and take a sceptical stance towards climate protection and biodiversity. On the other, liberal, city-dwelling eco-warriors who jet around the globe while preaching about climate change.

The idea of an urban-rural divide on environmental issues in Switzerland has recently attracted considerable attention, especially in regard to the CO_2 Act and popular votes on drinking water, pesticides and livestock farming. Yet how much truth is there to this theory? Personally, I find such rhetoric misleading, since there's so little empirical evidence to support it – but let's take a look at what we actually know.

ALMOST NO SIGNIFICANT DIFFERENCES As part of the Swiss Environmental Panel, my research group has been investigating whether urban and rural populations really are divided on environmental issues. Since 2018, researchers from ETH Zurich have conducted a biannual survey of several thousand randomly selected Swiss citizens in collaboration with the Federal Office for the Environment. The survey aims to gauge people's views on various environmental issues and to learn more about how they behave.

Our survey data shows hardly any significant differences between urban and rural areas when it comes to environmental attitudes and behaviours. It's true that views on environmental issues tend to be a little less forceful in highly rural areas than in big cities, that rural inhabitants tend to use cars more often and eat slightly more meat, and that city dwellers tend to fly more. But, overall, the environmental attitudes and behaviours in the two groups are very similar – and there's practically no evidence of a generalised urban-rural divide.

DIFFERING VOTING PATTERNS A review of voting patterns in nine different types of settlement over the past 20 years likewise reveals little difference between urban and rural areas. More recently, however, we have seen some individual proposals on issues relating to agriculture or fossil fuels which have attracted very different responses from urban and rural voters. These include the Hunting Act, which saw a difference of 18.9 percentage points between the two groups, as well as the CO_2 Act (17.8 percentage points), the popular vote on drinking water (15.4 percentage points) and the pesticide initiative (14.5 percentage points). However, if we take into account all the popular votes conducted over the past 20 years, plus the survey data from the Swiss Environmental Panel on environmental attitudes and behaviour since 2018, I think it would be speculative and largely inaccurate to conclude that in Switzerland there's a general polarisation between urban and rural attitudes towards environmental issues.

FIT FOR THE FUTURE The findings of the Swiss Environmental Panel actually make me feel quite optimistic. As a general rule, where we live has little bearing on our environmental attitudes and behaviour. Consequently, most of the instances of environmental proposals losing the popular vote are not due to an urban-rural political divide. However, this doesn't mean that we can simply ignore the differences between city and countryside when developing solutions to environmental problems – quite the opposite! There are cases where the cost of improving environmental protection in rural regions might genuinely be higher than in urban areas – in fact, perceived cost differences were one of the reasons for the differences in urban and rural voting patterns in the popular votes I mentioned above.

That's why, in future, we need to craft proposals that distribute the costs and benefits between urban and rural areas as fairly as possible in order to ensure they attract majority support. Scientifically robust surveys of the Swiss population can play an important role in achieving this. ○

Are urban and rural communities on different wavelengths?
A campaign poster for the drinking water and pesticide initiative, which was put up for vote in June 2021.

Image: courtesy of anonymous / Keystone, Urs Flueeler

Tracking how plastic degrades

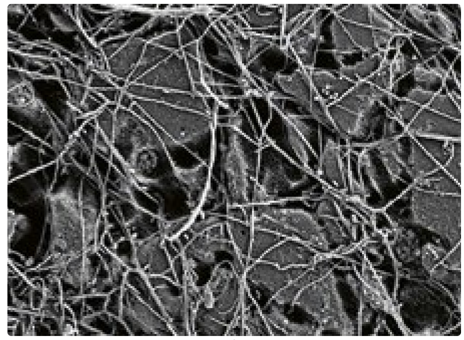


Image: Michael Zumstein

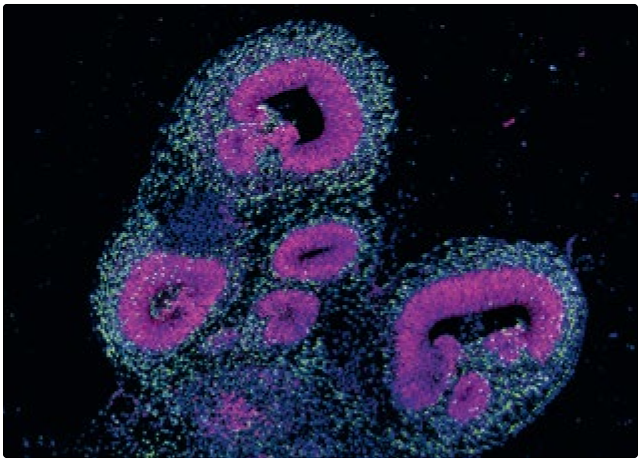
Electron microscope images show significant colonisation and degradation of the polymers by fungi and bacteria after just six weeks.

Farmers use mulch film to cover the soil in which they grow their crops. Over time, however, the polyethylene used in conventional films, which is non-biodegradable, accumulates in the soil. One alternative is to use biodegradable films, but scientists have previously been unable to fully track and measure the degree to which these degrade. Recently, however, a group led by Michael Sander developed a method that can track the polymer biodegradation process in its entirety. The new approach uses polymers labelled with a stable carbon isotope. This allows the researchers to selectively track the carbon as the polymer degrades in order to demonstrate whether and how biodegradation has occurred.

At present, a polymer is considered biodegradable if a predefined fraction of polymer carbon has been converted into CO_2 over a set period of time. As such, only CO_2 formation is measured as evidence of biodegradation, so it remains unclear how much carbon is still in the soil and whether this is being utilised by microorganisms. The stable carbon isotope provides an answer to this question. The researchers were able to selectively track the stable isotope and detect how its presence in the soil changed over time and how much of it was converted into CO_2. As a result, they could determine exactly how, and to what extent, the polymers had degraded. ○

Mapping brain development

Image: ETH Zurich / F. Sanchis Calleja, A. Jain, P. Wahle



Brain organoid from human stem cells under a fluorescence microscope.

A research group led by Professor Barbara Treutlein at the ETH Department of Biosystems Science and Engineering in Basel has succeeded in growing three-dimensional brain organoids from stem cells. Using these organoids, the researchers were then able to precisely map the development of the human brain. Conventionally, animal models or two-dimensional cell cultures are used for this purpose. By studying these organoids, the researchers were able to record the gene activity of individual cells. On the basis of this data, they then drew a map charting the molecular fingerprint of each cell within the organoid. Using genetic scissors, researchers selectively switched off individual genes in various cells. This enabled them to determine the effect those genes have on the development of different brain cells and the role they play in brain diseases. ○

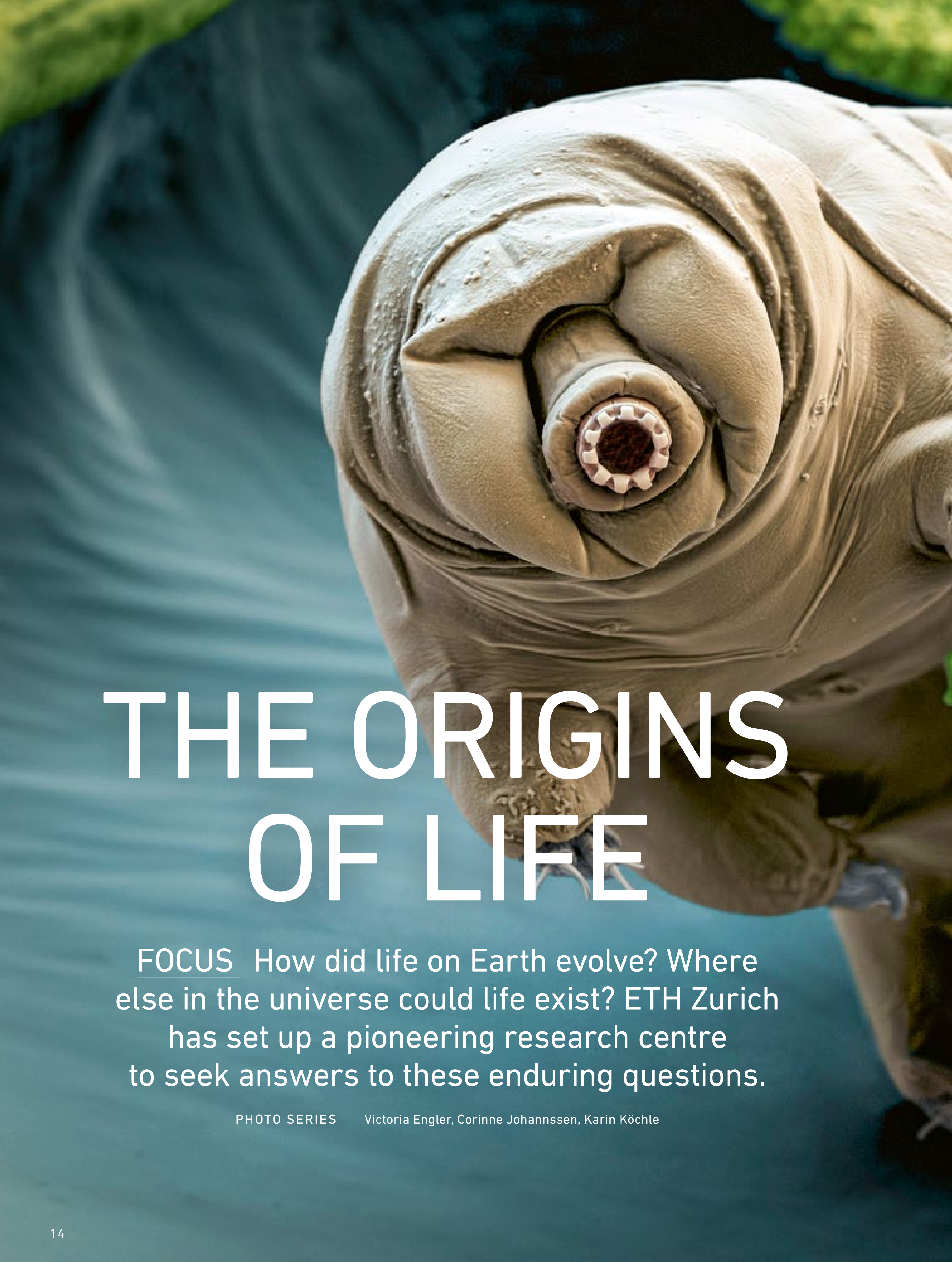
Inadequate protection

In line with zero-deforestation policies, commodity traders have voluntarily committed to stop buying soya beans grown in newly cleared areas of Brazilian forest. Yet recent research has shown that this commitment – the Amazon Soy Moratorium (ASM) – provides inadequate protection against deforestation. This was the conclusion of two studies involving Rachael Garrett, Assistant Professor for Environmental Policy at ETH Zurich, and her former colleague Florian Gollnow.

Researchers identified a number of reasons: firstly, the commitment pushes production into areas not covered by the ASM, meaning that forest clearances prevented by the moratorium are offset by deforestation in other regions; secondly, the study led by Gollnow concludes that the ASM protects a smaller area of Brazilian forest than was previously assumed. The study also investigated who has adopted the commitment and discovered that larger traders are much more likely to comply than smaller ones, who tend to procure soya beans from endangered areas. ○

Image: AdobeStock

Effective protection would require more widespread adoption of the Amazon Soy Moratorium – including by import countries, which are responsible for demand that can encourage deforestation.



THE ORIGINS OF LIFE

FOCUS How did life on Earth evolve? Where else in the universe could life exist? ETH Zurich has set up a pioneering research centre to seek answers to these enduring questions.

PHOTO SERIES Victoria Engler, Corinne Johannssen, Karin Köchle

Taking it to the extreme

Tardigrades, known colloquially as water bears or moss piglets, are only about 1 mm long – but they're tougher than they look! By entering a death-like state, they are able to survive complete dehydration, radioactivity, toxic chemicals and even the vacuum of outer space. But they're not the only ones. Our planet is inhabited by all sorts of creatures that are capable of surviving under outlandishly hostile conditions. They thrive in environments that would be lethal to other organisms.

Such extremophilic organisms are the pioneers of life on Earth. They help us better understand how life originated and spread on this planet and spur on our search for extraterrestrial life. After all, if there are organisms on Earth that can cope with hypergravity or temperatures of 400 degrees Celsius, it seems reasonable to suggest that there might be life on other planets, too. Which, of course, raises the question: Will we ever find it? ○

Image: Keystone / Eye of Science

How did life on Earth first emerge? And how was it able to prosper and evolve? ETH researchers are involved in the quest to find answers to these fundamental questions.

TEXT Peter Rüegg

FROM MOLECULES TO ORGANISMS

Since time immemorial, humanity has pondered the question of how life on Earth first began. Ancient cultures declared the creation of the world and the origin of life to be the work of gods and other divine beings. Science has always taken a different route. Drawing on the fundamental laws of physics, chemistry and biology, generations of researchers have advanced theories and hypotheses about the origin of life. In the process, they have amassed a vast fund of knowledge.

"Our fascination with such questions is deeply rooted in Western culture," says Roland Riek, Professor of Physical Chemistry at ETH Zurich. "It's a question of faith, but presented as a scientific hypothesis." Riek, who also has a background in physics and biology, is interested in the question of which chemical building blocks were involved in the emergence of life.

THE RIGHT CHEMISTRY For Riek, there is considerable evidence that the initial chemical processes that gave rise to living organisms on Earth – a few hundred million years after our planet came into being – must have involved amino acids and the peptides formed from these in the presence of volcanic gas. These are, he explains, stable and capable of withstanding very high temperatures. Furthermore, amino acids are relatively easy to produce – as other researchers have been able to demonstrate in a variety of "primordial soup" experiments. They are also found on meteorites. These, however, bear little trace, relatively speaking, of any of the building blocks of ribonucleic acids (RNA), which most scientists consider to be the molecules that first created the conditions for life on Earth.

"Peptides have the same capabilities as RNA: they can self-replicate but without the need for the high degree of precision that is involved in RNA replication," Riek explains. "And, like RNA, peptides not only store and relay information but are also catalytically active." Work at his lab includes a study of how amyloids can form from simple peptides.

Amyloids are very tough, largely undecomposable molecular complexes that are always made up of the same peptides. Such peptide complexes can store and relay information. And they grow like crystals.

Moreover, amyloids can easily dock onto RNA molecules. "It seems to me that the early picture might have looked something like this: there were amino acids, peptides and then also amyloids, which at some point bumped into RNA and combined with it," Riek says. "Over time, this combination evolved into an organism."

These chemical building blocks could have crossed paths in hydrothermal vents in the deep sea or in primeval tide pools, where they became concentrated as a result of evaporation. Such high concentrations may then have led to spontaneous synthesis of more-complex molecules. "That wouldn't happen in the ocean, because there the dilution is far too great," Riek explains.

THE FIRST CELL Scientific understanding of how the first cell formed is far sketchier. "We've got very little to go on," Riek admits.

The key seems to have been the formation of vesicles within the primordial soup and its rich brew of molecules. For this, fatty acids were required. These precursors of lipids can spontaneously accumulate to form membranes and thereby create small enclosed compartments. In effect, this created reaction vessels, isolated from the primordial soup, where these molecules could become even more concentrated. These vesicles would have greatly facilitated and accelerated any ensuing chemical reactions.

> "The molecules involved in the emergence of life were probably amino acids and peptides."
>
> Roland Riek

Image: ETH Zurich / Lukas Frey

As it grows, an amyloid serves as its own template: amino acids (coloured blocks) accumulate in the right position.

FROM PRIMITIVE TO COMPLEX "Vesicle formation was probably also key to the emergence of single-celled organisms. These provided an environment in which more complex molecules such as RNA could further replicate, eventually producing a metabolism that generated enough energy to accelerate the replication processes and enhance the transmission of genetic information," explains Martin Pilhofer, Associate Professor at the Institute of Molecular Biology and Biophysics, ETH Zurich.

"It's not clear how long this phase lasted," he adds. "The further back we go, the less we know or can postulate about the Earth's history." Nor is it possible to determine exactly when the first unicellular organisms appeared. Fossilised bacteria indicate this was around 3.5 to 4 billion years ago. What's certain, however, is that there was already life on Earth 3 billion years ago.

It seems likely that single-celled organisms first appeared in places that offered an exogenous source of energy – near hydrothermal vents in the deep sea or hot springs like those in Yellowstone National Park. It was only as they developed their own metabolism that unicellular organisms were able to become independent of this exogenous source of energy and venture into new habitats. ⟶

FROM THE DEEP SEA Dwelling in the vicinity of such hydrothermal vents, unicellular organisms could have quickly evolved along a variety of paths. "We suspect that in such extreme locations single-celled organisms developed into either bacteria or archaea soon after their emergence," Pilhofer says.

Most bacteria and archaea – once also known as archaebacteria or primordial bacteria – are unicellular organisms without a nucleus. They form two major domains in the phylogenetic tree. The third is assigned to Eukarya. Unlike bacteria and archaea, eukaryotes have a cell nucleus, which is where the hereditary material DNA is stored. A further characteristic of eukaryotes is that they feature membrane-enclosed cell compartments such as mitochondria or chloroplasts.

Researchers have long sought to determine how eukaryotes could have emerged from bacterial or archaeal microbes. A popular thesis is that a host cell "swallowed" a bacterium. This then evolved over time into a mitochondrion, which provided the eukaryote with energy. "There's no doubt that such an event occurred," Pilhofer says.

A further event may well have resulted in a photosynthetically active cyanobacterium being assimilated into a cell and thereby becoming a chloroplast, the organelle that performs photosynthesis in green plants and algae.

However, it was long unclear what this host cell – the precursor of a eukaryote – might have been. The fog began to clear a few years ago with the publication of new findings about a primordial group of archaea that had only just been discovered.

This group was found in a field of deep-sea hydrothermal vents by the name of Loki's Castle, where water spews out of rock chimneys at a temperature of 300 degrees Celsius. Located in the North Atlantic at a depth of 2,300 metres, Loki's Castle was only discovered in 2008. That same year, Swedish researchers removed sediment samples and analysed them for genetic material. This enabled them to reconstruct the genomes of unknown organisms. "Their findings have revolutionised the way we look at the tree of life," Pilhofer says.

The genomes indicated a new group of archaea that was initially labelled Lokiarchaeota after the place they were found but later, following further genomic and morphological studies, assigned as a class to Asgardarchaeota. These newly described microorganisms indicated that Eukarya was not a separate domain after all, but rather a subdomain of Asgardarchaeota. As Pilhofer explains: "The genome of Asgardarchaeota contains some genes that typically we only know from Eukarya. An important example of this is the gene carrying the genetic information for the cytoskeletal protein actin. That means that archaea have proteins that have previously been found only in eukaryotes."

The microbiologist, who specialises in cytoskeletons, has a theory about how the primordial Asgard archaeon was able to capture a bacterium. He suggests it may have had tentacles supported by actin filaments, which it used to investigate its surroundings and interact with other organisms.

In such extreme locations, archaea and bacteria frequently grow in so-called microbial mats – a densely packed environment rich in different species of microorganisms. This leads to countless interactions among individual organisms and different species. Using its tentacles, an Asgard archaeon could have embraced a bacterium and then assimilated it. "In other words, it may well have been a primordial Asgard archaeon that laid the foundations for the development of eukaryotic cells," Pilhofer explains.

Together with his research group, he is using an electron microscope to create high-resolution images of Asgard archaea. This is because the images available so far are not sharp enough to determine whether the organisms indeed possess a cytoskeleton.

ETH researchers also want to find out what the cell membrane of Asgard archaea looks like and whether the cells have a special internal membrane system. "This work will help us better understand how a host cell that once fused with a bacterium was able to evolve into a complex eukaryotic cell," Pilhofer says. ○

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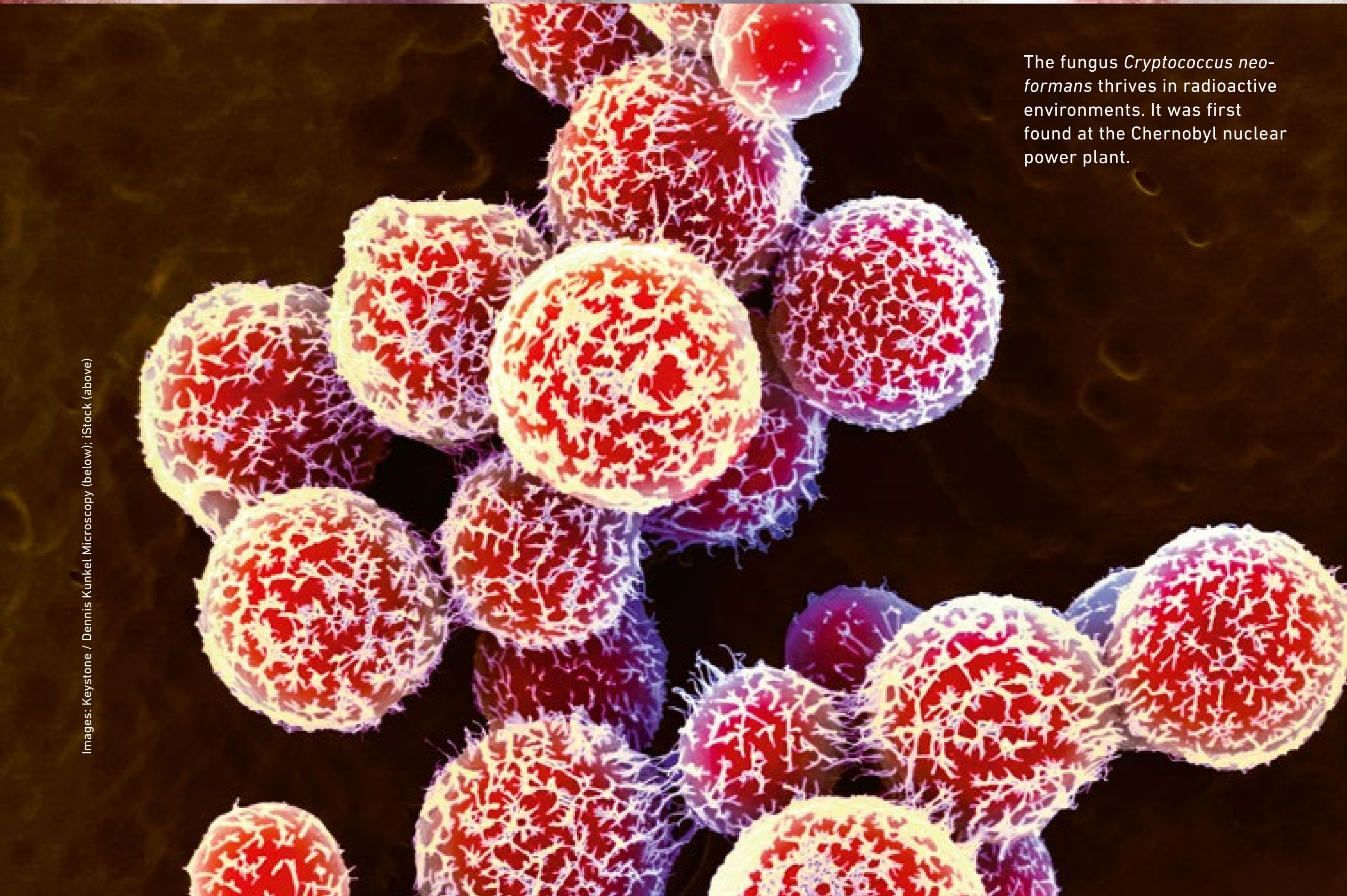
MARTIN PILHOFER is Associate Professor of Cryo-Electron Microscopy at the Institute of Molecular Biology and Biophysics, ETH Zurich.
⟶ pilhoferlab.ethz.ch

Snow algae live in the snow, surviving in an environment of intense cold, strong UV radiation and few nutrients. Scientists have so far discovered 350 species of these tiny single-celled organisms.



The fungus *Cryptococcus neoformans* thrives in radioactive environments. It was first found at the Chernobyl nuclear power plant.

Images: Keystone / Dennis Kunkel Microscopy (below); iStock (above)

PLAYGROUNDS IN THE UNIVERSE

Nobel laureate and astrophysicist Didier Queloz and earth scientist Cara Magnabosco on the origin of life on Earth, complex life beyond our planet, and the inevitable end of every life.

INTERVIEW Corinne Johannssen, Anna Maltsev

You're both tackling the big questions about the universe. Doesn't it sometimes make you feel small and insignificant?

DIDIER QUELOZ: Yes, it does indeed. But that's not a problem; I think it's one of the privileges of working in discovery science. If you really want to explore the unknown, you need to be humble because you never know what you're going to find. Being humble is a desirable quality in a researcher. Science is really amazing when the timeline you're working along extends over billions of years; you prepare for the future by building on the past. This is a key aspect of the newly founded Centre for Origin and Prevalence of Life.

CARA MAGNABOSCO: As an earth scientist and someone who studies evolution, I explore the Earth's history and the timeline of human evolution. Our lifespan is so short when you compare it with the age of our planet.

What do you focus on specifically in your research, Cara?

MAGNABOSCO: I focus on the interaction and feedback between living and non-living systems. One of our key questions is: What does a non-living world look like – and what happens when you inject life, metabolism and diversity into it?

Do you have enough time to devote to your own research? You're both in the centre's directorate, which brings together 40 research groups.

MAGNABOSCO: We have to make an effort to set aside sufficient time for events and discussions. This pays off as it enables us to make major strides in our research. The entire team at the centre is really supportive.

QUELOZ: I decided to cut my research time by half to commit myself to the centre's development. Founding the centre has actually multiplied my research and changed the way I engage in it. It's no longer all about me and my team working in the lab; now it's about me working in a larger group of people who've joined forces to address one of the universe's biggest questions ever. This way of working also has an impact on our academic culture, where egoism and selfishness are often common traits. In this sense, the centre is also a fascinating psychological experiment.

What can you learn from each other as earth scientist and astrophysicist?

MAGNABOSCO: Now that we've discovered thousands of exoplanets and gathered vast amounts of knowledge and data from observing them, the next stage is to find out more about their composition, interior, surface and atmosphere. For me as a geobiologist who studies the evolution of life throughout Earth's history, these planets represent thousands upon thousands of new playgrounds, histories and atmospheres that could potentially support life.

QUELOZ: If I want to talk about rocky planets, I go to a planetary scientist. When it comes to Earth-like planets, nobody knows more than a geophysicist. A chemist studying the origin of life who wants to find out the chemical composition of a planet's surface goes to Cara. So it's like a big jigsaw. You can't really tackle the question from just one angle: if you do, you might end up making the wrong assumptions. That's the centre's strength – it's a melting pot of expertise, talent and ages.

Didier, you've been doing research for over 30 years; Cara, you're just 33 years old. Are there differences between research generations?

QUELOZ: The young generation is way more clever than the older one. Because there's more to learn now, it's more challenging. While I think both generations adopt the same attitude to research, the younger generation is more energetic and more creative, which is crucial for progress. But researchers who combine pure energy and extreme creativity can easily fall into traps and make mistakes. That's why it's great we have a mix of young researchers and seasoned experts at the centre. I'm delighted that Cara decided to come on board.

"Our lifespan is so short when you compare it with the age of our planet."

Cara Magnabosco

Cara, what fascinates you most about your research?

MAGNABOSCO: The life you find deep underground. These are systems that have no present-day input from the surface; organisms that have no access to carbon and oxygen derived from photosynthesis. Underground, we see what reactions are possible in the absence of life – between water and rock alone. I investigate how life can harness energy if it's added to the mix. How can these organisms survive? Their populations seem to grow and turn over a lot more slowly than organisms on the surface. Exploring the community dynamics is what I find most exciting in my field.

Didier, you discovered the first exoplanet ever, and received the Nobel Prize for that achievement. What other milestones have there been in your research field?

QUELOZ: The second milestone was getting people to believe what we had discovered. Seriously! It was a big challenge; it took about four years to convince the scientific community of our findings and for them to understand the implications. This was the start of a series of fantastic advances that led to the development of a technology that would help us detect lots of other planets. ⟶

DIDIER QUELOZ is a Nobel laureate and Professor of Exoplanets at ETH Zurich. He is Director of the Centre for Origin and Prevalence of Life.
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CARA MAGNABOSCO is Assistant Professor of Geobiology at ETH Zurich and Associate Director of the Centre for Origin and Prevalence of Life.
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Images: Marco Rosasco (above); ETH Zurich / Giulia Marthaler (below)

> “We assume there’s plenty of life in the universe – but the question is whether we’ll ever find it.”
>
> Didier Queloz

Is there complex life beyond Earth?

QUELOZ: We scientists are crazy, but we’re not crazy enough to look for something we don’t think we can find! We assume there’s plenty of life in the universe – but the question is whether we’ll ever find it. Frankly, I don’t know.

MAGNABOSCO: I think there’s a high likelihood of it being out there. Especially if we accept that the very existence of cellular life indicates the potential existence of complex life. Any cell – broadly defined as something that separates and concentrates biological material – is pretty sophisticated. I’m optimistic that one day we’ll have evidence of the existence of complex life beyond Earth.

QUELOZ: There’s nothing more complicated than a cell, because it goes through many permutations before evolving into a cell. The cell is the ultimate perfection of life. So the question is, does life start in a cell? And once we have a cell, does it need special conditions before it can cluster with other cells? Hopefully, we’ll be able to answer these questions one day.

Your research is about the origin of life. How do you relate to death?

MAGNABOSCO: I relate pretty closely to it in my research. We look at deep environments where organisms slow down and die. Death is really fascinating to me.

QUELOZ: The human brain means we can make plans and think about the life we want to have in the future. That’s an amazing privilege. But one of the challenges of such a talent is that it enables us to envisage our own end. And this prompts us to ask questions such as, why do I have to die? Questions that have no answers. That’s perhaps why we all tend towards some kind of spirituality. We need this spiritual element if we’re to understand the world. But the more our society understands the world, the more dangerous it becomes. And not only dangerous to other species – of which we’ve destroyed quite a few over the last century – but to our own as well. This is why I believe we’re reaching a moment in human history when we should be thinking about the future of humankind. Looking for the origin of life and life on other planets is one way of gleaning answers about the unknown and of sustaining interest in it. ○

CENTRE FOR ORIGIN AND PREVALENCE OF LIFE The newly established Centre for Origin and Prevalence of Life (COPL) at ETH Zurich aims to overcome the boundaries between different areas of science. By harnessing knowledge from chemistry, biology, geology and astrophysics, it has created a multidisciplinary research programme linked by a common scientific vision. Thanks to the generous support of the NOMIS Foundation, COPL has also set up a fellowship programme to provide young researchers with the chance to investigate the origins of life within an interdisciplinary environment. A total of nine fellowships are to be awarded over the coming six years. To enable the Centre for Origin and Prevalence of Life to realise its full potential, continued financial support will be required from committed individuals, foundations and corporations.

→ copl.ethz.ch
→ ethz-foundation.ch/en/origin-of-life

Lamellibrachia tube worms live in extremely cold deep-sea vents that release sulphur dioxide, methane and other hydrocarbon-rich fluids.

Thermophilic bacteria thrive at temperatures above 400 degrees Celsius, such as in the hydrothermal vents in Yellowstone National Park.

Images: Keystone / Paul D. Stewart (below); Keystone / Expedition to the deep slope 2007, NOAA-OE (above)

A HABITABLE PLANET

Life has existed on Earth for billions of years. Stabilising mechanisms have helped our planet remain habitable to this day.

TEXT Barbara Vonarburg

It all began 4.5 billion years ago, when the debris from previous generations of stars formed a large molecular cloud. A part of this collapsed under its own gravity to create a new star – our Sun. The remaining gas and dust flattened into a spinning disc around this newly formed star. Over time, small particles of dust clumped together into kilometre-sized bodies called planetesimals, which eventually accreted into Earth and the other rocky planets. A final catastrophic collision between our newly formed planet and another large object ejected debris into Earth's orbit, which gradually coalesced to form the Moon.

Yet this early inner solar system still lacked key elements required for the formation of life. "The Sun was extremely hot in those early stages," says Maria Schönbächler, a cosmochemist and ETH professor at the Institute of Geochemistry and Petrology. As a result, the original building blocks in Earth's orbit were almost completely devoid of volatile elements such as hydrogen, carbon, oxygen and nitrogen that would subsequently play an essential role in the emergence of life. "But our research shows that, as the proto-Earth grew, it was also receiving material from more distant parts of the solar system, where temperatures were cooler and volatile substances were able to condense into solid bodies," she says.

ROCKS AND DUST The formation of the early Earth generated huge quantities of heat that melted its initial materials. Molten metals sank to the centre of the planet to form a mostly iron core. This was enveloped by a surface of molten rock, a magma ocean in which volatile compounds dissolved. Over the course of millions of years, the molten Earth cooled and the magma gradually solidified. "As the magma ocean crystallised, incompatible volatiles

MARIA SCHÖNBÄCHLER is Professor of Cosmochemistry in the Department of Earth Sciences at ETH Zurich.

DEREK VANCE is Professor of Geochemistry in the Department of Earth Sciences at ETH Zurich.

—› isotope.ethz.ch

such as water and carbon dioxide were released," says Schönbächler. The outgassing of these substances formed the Earth's early atmosphere.

"The early solar system was probably fairly chaotic, with all sorts of rocks and dust particles flying around," she says. "The Earth swept such material into its orbit, acquiring even more of the elements required for life – though we now know that the bulk of this material had already been accumulated in the initial phase before the Moon was formed."

REMOVING CO_2 Earth's first atmosphere was primarily composed of water vapour and carbon dioxide. "Most models indicate that the atmospheric CO_2 concentration was half a million times higher than today," says Derek Vance, who also works as an ETH professor at the Institute of Geochemistry and Petrology. This created a massive greenhouse effect that was hostile to life, with temperatures probably exceeding 100 degrees Celsius. "Earth had to rid itself of this excess of atmospheric carbon before it could become habitable," he says. Scientists have yet to offer a compelling theory as to how this might have happened.

"This was easy once the Earth got older," says Vance. "In fact, our planet has removed excess carbon from its atmosphere a number of times in its history. But this process takes millions of years, so it's definitely not a solution to our current problems with greenhouse gases!" As part of the natural carbon cycle, atmospheric carbon dioxide dissolves in raindrops to form carbonic acid. Once this reaches the Earth's surface, it dissolves rocks through a complex process of chemical weathering. The products of this weathering are flushed into the ocean via rivers and groundwater and accumulate on the seabed. "In simple terms, you take CO_2 from the air and deposit it in the ocean as calcium carbonate," says Vance. "Then you have to push that rock deeper into the mantle and bring up new rock to repeat the same cycle – and that's exactly what Earth does through tectonic processes."

The key to this cycle is negative feedback: when the Earth's surface gets warmer, rock weathering increases. "In other words," says Vance, "the more carbon you pump into the atmosphere, the faster it's removed." This negative feedback helped create the stable conditions that allowed life on Earth to evolve over the course of billions of years.

The question of when the Earth's crust formed and when it acquired an ocean of liquid water is still a matter of dispute, however; though tiny grains of the mineral zircon dating back 4.4 billion years may be evidence that the Earth cooled relatively quickly. Equally contentious is the question of the origin of life. Did it emerge in the depths of the ocean or closer to the surface? And when exactly did it begin? "Biologists suspect that the first microorganisms emerged around 4 billion years ago," says Vance. "But the oldest fossils are 3.5 billion years old, and I think they provide the clearest evidence of when life began." What we do know for certain is that there were living organisms on Earth 3 billion years ago.

At that time, the atmosphere was rich in nitrogen but lacked oxygen. What changed Earth's atmosphere and created the conditions for the evolution of new life forms was actually life itself – all thanks to photosynthesis. Algae used the Sun's energy to convert water and carbon dioxide into sugars and oxygen. As a result, molecular oxygen (O_2) began accumulating in the atmosphere around 2.5 billion years ago. At high altitudes, ozone (O_3) absorbed harmful UV radiation. "All forms of continental animal life need oxygen to breathe plus a protective ozone layer," says Vance. "But we wouldn't even have any oxygen without plants." Earth's magnetic field, which is generated by molten iron and nickel in Earth's outer core, also shields us from cosmic radiation.

"So many things could have gone catastrophically wrong for life on Earth," says Vance. Meteor impacts and giant volcanic eruptions have caused sharp rises in atmospheric greenhouse gases a number of times in Earth's history, leading to global warming. One such event, 252 million years ago, resulted in the extinction of 70 to 80 percent of all living species. Earth has also experienced cold periods that some scientists believe turned the planet into a ball of ice. Yet the Earth survived, says Vance: "Over very long periods of time, our planet is able to repair itself by means of the stabilising effects of negative feedback." ○

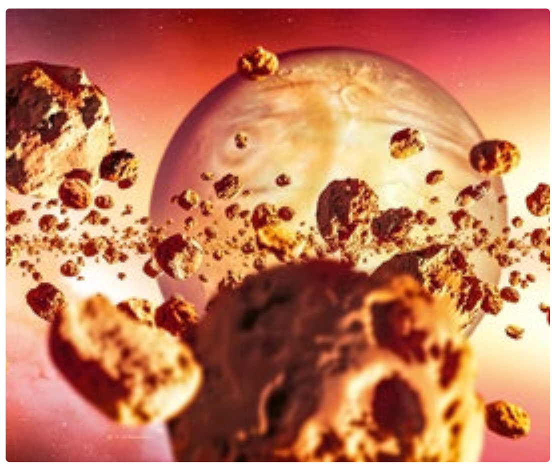

Image: Keystone / Detlev van Ravenswaay

The solar system emerged some 4.5 billion years ago. Earth and the other rocky planets formed around the nascent Sun.

WHAT IS LIFE?

We posed this question to ETH Zurich researchers. In return, we got five intriguing answers from the perspectives of biomedicine, computer science, biology, robotics and philosophy.

TEXT Karin Köchle, Michael Walther

Life and death within us

"DNA is the building block of life. It contains all the information necessary for life, from reproduction and metabolism to growth and the ability to respond to stimuli. Another characteristic of life is that we are made of cells. Within the overall framework of the human body, life plays out at various levels: organismal, cellular and molecular. There's also 'life within life', such as the many bacteria in our body that live in symbiosis with us.

The goal of our research is to improve and even extend people's lives. We do that by harnessing one of the key principles of life: replication. For example, we use nanomaterials to turn bacteria into living, remote-controlled micro-robots that can deliver drugs inside the human body and destroy cancer cells.

The fact that our cells are constantly dying and being replaced by new ones is a reminder that we carry not only life within us, but also death. Finality is also a part of life."

SIMONE SCHÜRLE is Assistant Professor of Responsive Biomedical Systems.
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OTMAR HILLIGES is Professor of Computer Science.
⟶ ait.ethz.ch

The importance of human interaction

"Today's artificial intelligence is still a long way from biological life. We sometimes forget the sheer complexity of what we're capable of! Take interaction, for example: a robot designed to assist humans should be able to constantly predict what a person might decide and do next. Otherwise, that person will be constantly waiting for the robot to choose its next course of action. Modelling decision-making processes is tough becauseit involves things like experience, personality and changing contexts.

Anticipation is another tricky area: as humans, we're very good at spotting when it's our turn to speak because we intuitively read the body language, facial expressions and verbal communication of others in the conversation. Machines haven't reached that stage yet, which is one of the reasons why chatting to an artificial life form would still feel unnatural to us. We're currently attempting to replicate this kind of intuition using data and mathematical models."

DAGMAR IBER is Professor
of Computational Biology.
⟶ bsse.ethz.ch/cobi

From linear code to three-dimensional life

"One of the key characteristics of life is reproduction, which works on the basis of linear information encoded in our DNA. Our research explores mechanisms of self-organisation: how is linear information translated into the three-dimensional form and all the functions that make up humans and other higher organisms? And how do these developmental mechanisms persist and evolve despite differences in developmental pace and embryo size? The inheritance of complex structures is an important factor in the emergence of life.

The fact that we work with embryos also raises the question of what constitutes life from an ethical perspective: at what stage of development does human life become worthy of protection? The answer to that question varies wildly from one country to the next, which can make it harder for researchers to collaborate."

Lifelike interactions

"If we're going to make robots more lifelike, our primary goal in doing that should be to support living beings. My group develops systems that do a better job of blending into human environments and navigating our natural habitat. We humans prefer to interact with beings that are similar to us and that feel alive. So, one way to improve that interaction is by making the robot feel as familiar to us as possible. That's why we're developing robotic systems with muscles or soft grippers. But these kinds of robots are tricky to control! Traditional robots have a clearly defined range of movement that is based on axes. It's easier to model that kind of system because the number of parameters is limited. But that's not how life works. Living beings can't be defined with mathematical precision – but they're good at coping with uncertainty and spontaneity. We're hoping our systems can develop some of that flexibility."

ROBERT KATZSCHMANN is
Assistant Professor of Robotics.
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NADIA MAZOUZ is Professor
of Practical Philosophy.
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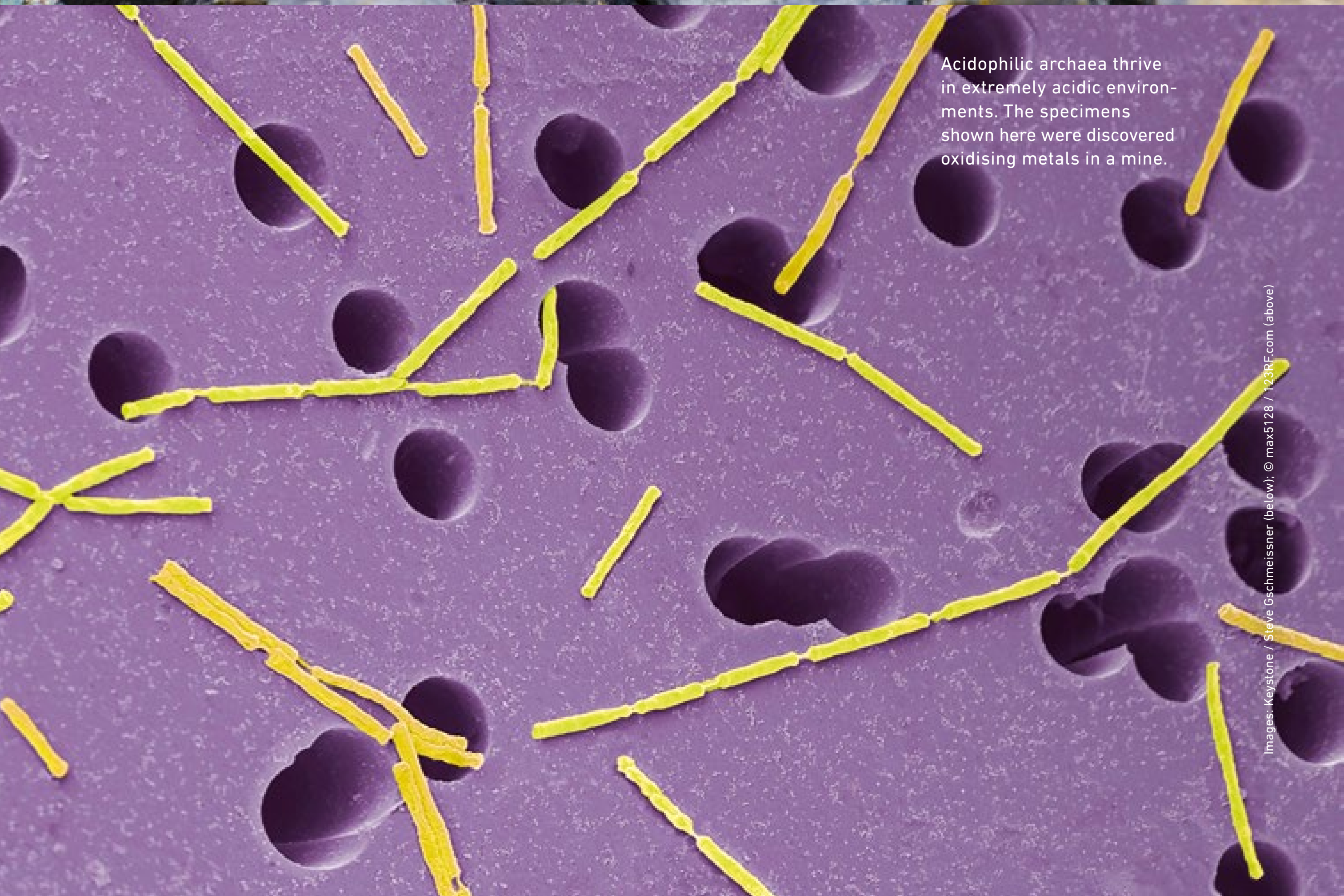
Fluid boundaries

"Ethics seeks to define not only what life is, but also which forms of life should be regarded as ethically valuable. For a long time, people tried to argue that human life is fundamentally different to that of animals and plants. But this argument is flawed – it does not stand up to scientific scrutiny, and it is philosophically unsound. The boundaries are fluid: non-human animals and plants exhibit capabilities and states of being beyond those that humans once attributed to them. For example, the ability to act on the basis of reason was long seen as the pinnacle of what it means to be human, yet this is now also attributed to other animals such as dolphins.

It's not necessary for humans to feel superior to non-human animals. One of the biggest issues in contemporary ethics is deciding whether non-human animals and plants deserve ethical consideration and, if so, what form this consideration should take. There's also a debate as to whether entire ecosystems – or even the Earth itself – should be regarded as living organisms."

With their ability to cope with high CO_2 concentrations, low air pressure and temperatures as low as 50 degrees Celsius below zero, polar lichens would be able to survive on Mars.



Acidophilic archaea thrive in extremely acidic environments. The specimens shown here were discovered oxidising metals in a mine.

LIFE ON ALIEN WORLDS

Does life exist elsewhere in the universe? There's a good chance it does – though it might look very different to life on Earth. Scientists may soon be able to offer a definitive answer.

TEXT Felix Würsten

Twenty-seven years ago, at the University of Geneva, Michel Mayor and Didier Queloz – now a professor at ETH – discovered the first extrasolar planet orbiting a Sun-like star. Much has happened since that initial discovery: astronomers have now identified more than 5,000 exoplanets, many of a similar size to Earth, in over 3,700 different planetary systems. With only a tiny portion of the universe analysed so far, it certainly seems plausible to suggest that life might exist on other planets outside our solar system.

Yet, as any scientist will tell you, a plausible hypothesis is not the same as proof. This has led many researchers to wonder how we might be able to demonstrate the existence of life beyond our solar system. One promising approach is to analyse the atmosphere of exoplanets. By studying the absorption lines in a host star's optical spectrum, scientists can determine which molecules are present in an exoplanet's atmosphere, at least in the case of larger planets.

As well as hunting for signs of methane, carbon dioxide, oxygen or water vapour, they are also interested in identifying the combinations in which these substances occur. "Both methane and oxygen are present in the Earth's atmosphere," says Sascha Quanz, Professor of Exoplanets and Habitability at ETH Zurich. "This is a chemical disequilibrium that wouldn't exist without living organisms." In other words, life must have caused this imbalance. The discovery of such a disequilibrium in the atmosphere of an Earth-like exoplanet would be a strong indicator of the presence of life.

Ideally, of course, it would be better if we could capture direct images of exoplanets rather than observing them indirectly as they pass in front of their host star. This is easier said than done, however, because exoplanets are almost completely hidden by the glare of their parent stars. To tackle this problem, Quanz has teamed up with other researchers to develop an instrument for the Extremely Large Telescope (ELT). Construction of the ELT ⟶

in Chile's Atacama Desert is currently underway and once operational, the telescope's 39-metre mirror will massively enhance the ability of astronomers to peer deeper into space. "With the ELT, we'll then be able for the first time to capture direct images of an Earth-like planet orbiting a nearby star, because this new instrument will block out the light of that star," says Quanz.

ONE SURPRISE AFTER ANOTHER But where should researchers direct the search for life? And what signals should they be looking for? Some clues can be found in physical models, such as those developed by Judit Szulágyi, Assistant Professor of Computational Astrophysics, and her group. These models can be used to reconstruct how planets form over time from the initial, protoplanetary disc of dust and gas that swirls around a newly formed star, and they also help determine which objects are worthy of closer inspection via telescope. Szulágyi builds models that take into account a whole range of factors, including gravitational forces, magnetism, the motion of gas, and the way starlight interacts with the disc material. By calculating countless different combinations of these parameters, we can get some idea of the diversity of planetary worlds that might exist in the universe.

Yet experience shows time and again that nature often has more up its sleeve than the models predict. For example, the first exoplanets took the scientific community by surprise because astronomers had never suspected that giant planets the size of Jupiter could orbit so close to their host star. Researchers were equally intrigued by the existence of so-called super-Earths, which are rocky like Earth but about one-and-a-half times larger. Szulágyi acknowledges that her models regularly turn out to be inaccurate and require recalculation, yet she remains upbeat: "It constantly pushes us to rethink our ideas about how planets form."

One of the key questions Szulágyi hopes to answer with her models concerns the origin of water. "Life on Earth requires water," she says. "Hence our interest in places that show evidence of water." Such bodies can even be found within our own solar system, and astronomers are keen to find out more about them in the years ahead. They include Jupiter's moon Europa, which likely hosts an ocean beneath its thick icy crust, and Saturn's moon Enceladus, where scientists have observed fountains of ice particles erupting from the surface.

ENTIRELY DIFFERENT WORLDS Geology can also provide useful clues to the composition of alien worlds in other planetary systems. Paolo Sossi, Assistant Professor of Experimental Planetology, investigates the exotic minerals, liquids and gases that make up the interior and atmosphere of other planets. "We simulate a wide range of conditions in our experiments," he says. "They help us build up a picture of what's happening on a planet's surface and what's going on inside it."

Our knowledge of the chemical composition of other planets is still sketchy, which makes Sossi's task more challenging. "Examining the host star's optical spectrum gives us an initial idea of a planet's chemical make-up," says Sossi. "That provides the basis for understanding which elements are present and in what quantity." By combining information on the various planets' mass and diameter with the results of modelling, scientists can then deduce how different elements are actually distributed throughout the planetary system around the star. Our own solar system is a useful reference, because 60 to 70 percent of all the star systems studied so far have a similar chemical composition. Sossi is therefore using numerical models to try and gain a better understanding of how Earth and its neighbouring planets were formed. This gives him the information he needs to reconstruct the masses, number and distribution of the planets around other stars.

Artist's impression of the Extremely Large Telescope (ELT), which is currently under construction in Chile's Atacama Desert.

Yet there are also stars that have an entirely different chemical composition to that of our Sun. For example, a star may contain more carbon and less oxygen, which might mean that the planets orbiting it are composed of different minerals than our Earth. "The predominant minerals on such carbon-rich planets could be silicon carbide and titanium carbide, or even diamonds," says Sossi. This, in turn, would have an impact on the planet's atmosphere – for example, rain on such a planet might consist of drops of graphite instead of water.

A LONG-TERM VISION Ultimately, the success of our search for alien life depends on a combination of different factors. Telescope observations, lab experiments and numerical models are undoubtedly key elements in any research programme. But we will also need intelligent algorithms that can glean as much scientific information as possible from vast quantities of data, as well as instruments that provide the precise data researchers need. "Instrument development is a top priority for planet researchers like me," says Quanz. "As researchers, we need to understand how instruments work in order to know what kind of information we can get from them."

A long-term perspective is also essential, which is why Quanz is already thinking a step ahead. He is in charge of an international initiative that aims to make major headway in the search for alien life. This forms part of one of the large-class science missions that the European Space Agency ESA is launching between 2035 and 2050. "We're reaching the limit of what we can achieve with ground-based telescopes, because all the molecules we're looking for also appear in the Earth's atmosphere, and the temperature of the Earth is similar to that of the exoplanets that interest us," he says. "If we want to escape the tremendous background noise created by the Earth, we have to head into space. It may well be the only way to detect traces of life in the exoplanet atmospheres."

Unfortunately, however, there is no way of installing telescopes in space that are as large as those in the Atacama Desert. Quanz and his colleagues have therefore proposed a bold project, known as the Large Interferometer for Exoplanets (LIFE). The idea is to position four additional small telescopes at the second Lagrange Point, which is where the James Webb Space Telescope took the spectacular images that recently wowed the world. "By combining measurement signals from multiple small telescopes, we can achieve a resolution similar to that of a single, larger telescope!" says Quanz. "This will enable us for the first time to directly image and chemically characterise dozens of Earth-like planets."

Before this can happen, scientists will need to resolve a whole series of technical challenges: the telescopes need to fly in a very precise formation that changes each time a new planetary system is targeted; the measurement signals from the individual satellites have to be synchronised with tremendous precision; and the telescopes must be equipped with extremely sensitive sensors designed to capture the little light emanating from the planet. Equally critical is the question of how the satellites will be powered, since repositioning them requires substantial amounts of fuel.

All this is technically feasible, says Quanz, though it will require a major effort not only by scientists, but also at a research-policy level. "Ultimately, it's a matter of priorities," he says. "For the first time, we have the chance to offer an empirical answer to the question of whether alien life exists. Finding that answer would fundamentally transform our view of the world – it's not an opportunity we should miss." ○

SASCHA QUANZ is Professor of Exoplanets and Habitability in the Department of Physics and Deputy Director of the Centre for Origin and Prevalence of Life (COPL) at ETH Zurich.
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Engineering for Humanitarian Action harnesses innovative technologies and scientific expertise to help people in need.

Image: ICRC

Mobilising science for humanitarian aid

The International Committee of the Red Cross (ICRC) supports people affected by war and conflict around the world. To help the ICRC plan and implement its humanitarian activities more effectively, ETH Zurich, EPFL and the ICRC launched the initiative Engineering for Humanitarian Action in December 2020. Its goal is to deliver knowledge and technologies from both universities to the crisis-torn regions where they are urgently needed.

Over the past two years, the initiative has funded 12 projects run by EPFL and ETH Zurich researchers. Six of these projects have already led to tangible improvements at the ICRC, including a new digital infrastructure to protect against cyberattacks, a biometrics solution that makes it easier to identify refugees, and enhanced logistics for the supply of medical products.

BETTER MEDICAL CARE The ICRC frequently struggles to cope with bottlenecks and other problems in distributing essential goods – and delivering medical supplies in conflict zones is one of the biggest logistical hurdles of all. With the goal of improving its logistics and enhancing the quality of medical care in humanitarian crises, the ICRC has spent the past two years collaborating with ETH professor Stephan Wagner and Bublu Thakur-Weigold from ETH's Chair of Logistics Management.

To get to the root of the problem, Wagner and Thakur-Weigold analysed the supply chains between an ICRC medical facility in Juba, South Sudan, and the organisation's logistics headquarters in Geneva. Their findings showed that the supply problems can be traced to an overly centralised planning system. According to Wagner, some goods can be procured and distributed more efficiently on a local level, particularly consumer products that are used on a frequent basis, such as bandages and certain medicines.

In future, the ICRC will have access to a digital tool that will help its logistics department determine how much of each item should be kept on hand at each location. Developed by Thakur-Weigold, the new tool offers a more reliable and cost-effective way to supply life-saving products to hospitals and aid centres in crisis-hit regions.

SECURE DIGITAL INFRASTRUCTURE In January of this year, the ICRC fell victim to a sophisticated cyberattack. Hackers compromised the personal data and confidential information of more than 515,000 individuals, including missing persons, detainees and people separated from their families by conflict.

To bolster the ICRC's defences against cyberattacks and thereby protect vulnerable individuals, three ETH professors – Luca Benini, Srdjan Capkun and Adrian Perrig – teamed up to develop a new digital infrastructure. As well as a customised network to protect metadata, the new infrastructure also features ETH Zurich's very own Scion network technology, as well as a new type of internet and cloud infrastructure that is more resilient to cyberattacks. The new system also includes processors developed at ETH Zurich which provide additional protection against hardware-level attacks.

This new architecture will help the ICRC and other aid organisations to share data more securely – both internally and with vulnerable groups. ○

Generous donations from the Stavros Niarchos Foundation, the Foundation for the ICRC, Rolex and the Fondation Lombard Odier will enable ETH Zurich, EPFL and the ICRC to launch new projects. Support provided by these partners will total over 12 million Swiss francs by the end of this year.

PHILANTHROPY

BY
Donald Tillman

Each donation can make a difference

ETH recently held a groundbreaking ceremony to mark the start of construction of the new HPQ physics building on the Hönggerberg campus. With its highly sophisticated, world-leading facilities, this new laboratory building may well make the crucial difference as the next generation of researchers strives to reach new levels of excellence in the field of quantum technology and to foster new innovations that will benefit Switzerland and the rest of the world. The mood at the ceremony was correspondingly upbeat – yet anyone who has been following this project will know that, for a long time, it was unclear whether it would ever see the light of day. ETH spent years mustering its financial resources, but it was never enough to get the project off the ground; however crucial it was to the future of ETH quantum research, it seemed destined to remain on the shelf. But fortune intervened, and along came a donor to give the final push to get construction underway. It's a useful lesson in how a single donation can sometimes be the decisive factor in taking a university to the next level in a particular field. In other words, philanthropy can indeed make a real difference!

⟶ ethz-foundation.ch

Image: Eline Keller-Sørensen

Prizes for ETH professors

Physics professor Ursula Keller has received the Marcel Benoist Swiss Science Prize for her pioneering work with pulsed lasers. Her theoretical models and experimental discoveries have repeatedly pushed the boundaries of ultrafast laser physics. Regarded by researchers as the Swiss equivalent of the Nobel Prize, the Marcel Benoist Prize is endowed with 250,000 Swiss francs.

ETH materials scientist Nicola Spaldin was also honoured. She received the Hamburg Prize for Theoretical Physics for her pioneering achievement in multiferroics research and her diverse activities in international collaboration and teaching. The prestigious award carries prize money totalling 137,036 euros. ○

Images: Heidi Hostettler; ETH Zurich / Giulia Marthaler

Ursula Keller (left) receives the Benoist Prize, Nicola Spaldin the Hamburg Prize for Theoretical Physics.

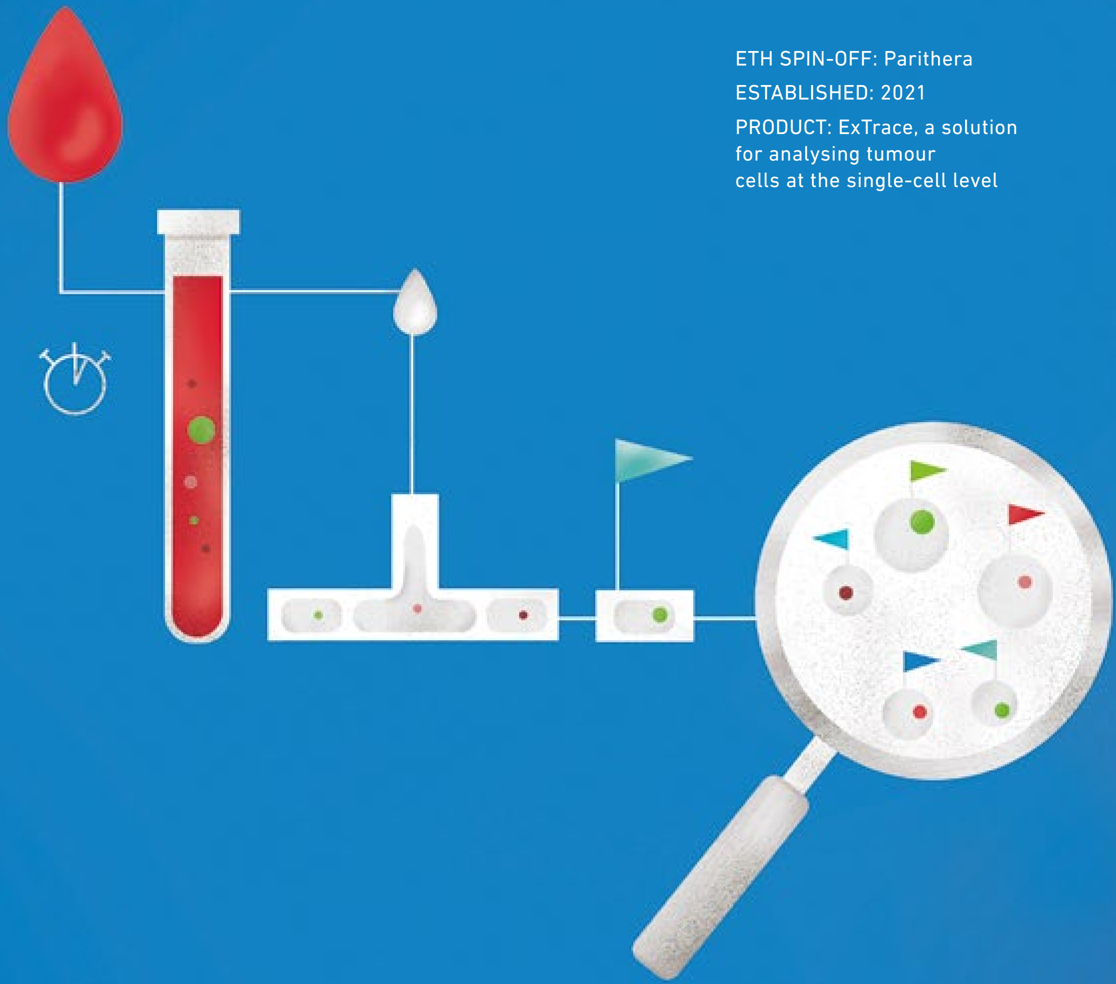
Promoting innovation and entrepreneurship

Image: ETH Zurich / Alessandro Della Bella

Sabine Keller-Busse, President UBS Switzerland, and ETH President Joël Mesot at the signing of the partnership agreement.

Only by channelling a steady flow of innovative ideas and research findings into the market can we hope to create new jobs and solutions that will lead to societal and technological progress. That's why ETH Zurich and UBS are launching a strategic partnership: over a ten-year period, UBS will invest up to 20 million Swiss francs in two joint initiatives that aim to promote entrepreneurship and innovation and to raise interest in STEM subjects. In addition, UBS will donate up to 20 million Swiss francs to help finance the construction of a new ETH building on the Hönggerberg campus. This will provide a space where students can collaborate on projects and budding entrepreneurs can connect with managers and experts. ETH is currently seeking further partners and donors to raise the remaining 15 million Swiss francs. ○

→ ethz-foundation.ch/en/spotlight/hic



ETH SPIN-OFF: Parithera
ESTABLISHED: 2021
PRODUCT: ExTrace, a solution for analysing tumour cells at the single-cell level

Monitoring tumour cells

Treatment resistance is responsible for 90 percent of cancer deaths. Chemotherapy fails because tumour cells circulating in the body become resistant to the drugs during the treatment cycle. Doctors currently have no tools at their disposal to accurately monitor this process, which makes it hard to provide an effective course of therapy. ETH spin-off Parithera has now come up with a solution: its ExTrace package offers a fast and non-invasive way to extract single tumour cells from blood samples using magnetic nanotechnology. To enable later identification, the extracted cells are encapsulated in droplets and individually tagged. This allows for subsequent analysis at the single-cell level – a method that is unavailable when cells are extracted as a cluster. ExTrace gives doctors crucial information on each patient's disease, enabling them to develop personalised cancer therapies. ○

→ www.parithera.com

Illustration: Carolin Eitel

Image: ETH Zurich / Gian Marco Castelberg

Dedicated coach with a passion for research

Detlef Günther is stepping down from his role as Vice President for Research to devote more time to his own research work. A look back over eight successful years.

TEXT Franziska Schmid

Detlef Günther is a man who isn't afraid to show his emotions. When the ETH Vice President for Research addresses topics some would consider as rather dry – such as basic research, research cooperation, platforms, spin-offs and centres of excellence – his eyes light up and his passion shines through. "The way my team implemented e-research was just incredible!" he says, caught up in his enthusiasm for the platform that ETH uses to document, link and visualise all its research activities. "A few years ago, when I told my staff how much ETH needed this kind of platform, I got a fairly muted reaction. But then the whole team threw themselves into the project – and now we have a fantastic system that is still at the pilot stage but ready for further expansion!" Günther's enthusiasm is contagious.

VIEW FROM ABOVE Günther arrived at ETH as a postdoc 28 years ago, working initially in the Department of Earth Sciences on the development of a laser-based microanalysis technique. In 1998, he took up the post of assistant professor in the Department of Chemistry and Applied Biosciences. In 2008, Günther was appointed Full Professor of Trace Element and Micro Analysis at the Laboratory of Inorganic Chemistry, two years after becoming head of the institute. Next came a two-year stint as head of department from 2010 to 2012, followed by his appointment to the Executive Board in 2015 as Vice President for Research and Corporate Relations. “My time as an ETH professor showed me how fantastic this university is; I was incredibly impressed with what I saw on a day-to-day basis,” he says. “But when I joined the Executive Board, it was like hovering over the university in a helicopter: I was able to appreciate ETH in its entirety, with all its diversity, complexity and extraordinary potential. It was wonderful!”

SHARING IS CARING Günther, who will be stepping down from his role as Vice President for Research at the end of this year, enjoys imaginative turns of phrase – sports metaphors are a particular favourite. So does this committed football fan see himself as a kind of coach for ETH research? “Well, we all know you can’t win a game with 11 strikers. That’s why a VP for Research needs to put together the right interdisciplinary mix of researchers and maybe even encourage them to try out different positions in the team!” he says with a smile.

Günther, who was born in Germany and acquired a Swiss passport a few years ago, is regarded as the father of several key technology platforms and centres of excellence that were either established or significantly expanded during his time in office. The Scientific Center for Optical and Electron Microscopy (ScopeM), for example, is testament to his belief in the importance of sharing. He argues that professors should share expensive infrastructure, thereby giving ETH as a whole greater access to cutting-edge technologies: “We have to make responsible use of taxpayers’ money. If someone only uses a certain piece of equipment a few times a year, it makes perfect sense to share it rather than keep it to themselves.”

SUSTAINABLE DEVELOPMENT Asked to describe how ETH has changed since he joined the Executive Board, Günther immediately points to the university’s massive expansion of research in health and medicine, an area of strategic action that now includes a new Bachelor’s degree programme. And there are other examples: “Sustainability, climate change and net-zero shape everything we do – from the development of our degree programmes to the vegetarian menus in the canteen. Hönggerberg has become a proper campus. Plus we’re doing more than ever to foster our students’ entrepreneurial ambitions: between 2015 and 2020, ETH students and doctoral candidates established over 160 spin-offs!”

He highlights the huge efforts that have gone into strengthening and expanding the entire value chain from basic research to teaching to technology transfer. This, he says, may well be the most significant change of all – both at the university and in people’s heads.

From 2015 to 2020, Günther was responsible for every aspect of research and corporate relations at ETH, a huge workload that would exceed the capabilities of a single individual nowadays. In 2021, the responsibilities were therefore divided between two vice presidents. “ETH has evolved much faster than I ever expected,” he says, before pausing and adding with a smile: “But one thing that hasn’t changed is the quality!”

LONE WARRIORS But, however positive the overall trajectory of the past few years, has he experienced any frustrations? Günther sees himself as a coach who does everything he can for his team and for ETH as a whole. He therefore has little sympathy for lone warriors who are only in it for themselves and who make life difficult for their colleagues. It's a drain on people’s energy, he says, which brings few benefits and often causes frustration.

But his biggest concern is Switzerland’s troubled relationship with the European research sector. Since 2015, ETH researchers have been awarded over 150 ERC grants within the Horizon 2020 programme. This impressive tally – a testament to the quality of the submitted projects – unlocked over 250 million Swiss francs of additional EU funding for these projects. And that makes the current situation all the more worrying: “When Switzerland was first excluded from Horizon in 2014, I thought we’d finally understood the damage that going it alone can do to our research sector.” He explains how the negative effects accumulate steadily and stealthily, creating a situation similar to that of climate change, where the realisation of what is at stake comes just too late. So how does Günther believe this political deadlock can be resolved? “I think Switzerland will be forced to make concessions to Europe. With so many global challenges knocking at our door, there’s no place for lone warriors any more – not in politics, and not in science,” he says.

In 2023, the job of Vice President for Research will pass to Christian Wolfrum. Günther will return to his post as Professor of Trace Element and Micro Analysis, where he already has some projects lined up for his research group of 13 scientists: “We’re hoping to use gravimetric forces to analyse thousands of cells or nanoparticles a second. I think it’s going to be an exciting time…”

Passion for the job is one key quality of a good coach – a characteristic that Detlef Günther clearly has in spades. ○

Outstanding talent

Image: ETH Foundation

ETH Rector Günther Dissertori (front row, centre) was on hand to greet the talented young students at the ESOP Welcome Day 2022.

Fifty-three Excellence Scholars embarked on Master's degree programmes at ETH Zurich this September. The Excellence Scholarship & Opportunity Programme (ESOP), which provides financial support to the top two to three percent of each year's intake, attracts talented individuals from all over the world. This year's Excellence Scholars come from 23 different countries, including – for the first time – Latvia, Thailand and Malaysia. ○

⟶ ethz-foundation.ch/en/esop

Awards on ETH Day

On 19 November 2022, ETH Zurich celebrated its 167th anniversary together with guests from the worlds of science, politics and business. ETH marked the occasion by awarding honorary doctorates to Theodor Hänsch, professor at Ludwig-Maximilians-Universität München, for his extraordinary achievements at the cutting edge of atomic and molecular physics, and to Thomas Zurbuchen, Associate Administrator of the NASA Science Mission Directorate, for his outstanding contribution to the exploration of space.

In addition, the title of Honorary Councillor was awarded to Irene Kaufmann, Vice President of the Board of Directors of the Mobiliar Group, and Giatgen Spinas, Emeritus Director of the USZ Department of Endocrinology, Diabetology and Clinical Nutrition. With their exceptional commitment, both have substantially supported teaching and research at ETH Zurich as well as the university as a whole. ○

Image: ETH Zurich / Oliver Bartenschlager

From left: ETH Rector Günther Dissertori, new honorary councillors Giatgen Spinas and Irene Kaufmann, new honorary doctors Thomas Zurbuchen and Theodor Hänsch, ETH President Joël Mesot.

IN PERSON

MARIA CONEN advocates the conservation and reuse of existing buildings – and not just for reasons of sustainability.

TEXT Karin Köchle

You were appointed to the post of Professor of Architecture and Housing this summer. What's at the top of your priority list?

People want to know how architecture can help make the world a fairer and more sustainable place as we struggle with resource scarcity and the ongoing destruction of multiple ecosystems. My priority is to answer that question by looking at specific issues in collaboration with other institutes and professorial chairs at ETH.

You've been running your own architecture firm for over a decade. What effect will this professorship have on your work?

The way we practice our profession is often influenced by factors in government and the construction industry. In this era of climate change and social upheaval, we need to be asking what kind of buildings we should be designing. In addressing this question, I think there is huge potential to explore and tackle the contradictions that arise in our day-to-day work.

You also focus on reusing buildings after they have been renovated or stripped back to the shell. Do you see much of that kind of recycling in practice?

I've long been an advocate of conserving and reusing existing buildings; not just for reasons of sustainability, but also to preserve the history and identity of a place. Unfortunately, however, the reality is that there are still many obstacles to recycling building materials and preserving existing structures.

How does one become a successful architect?

It's important to be aware of the responsibilities you have when you intervene in the living environment, because most interventions end up impacting the environment for many generations to come. A good architect needs perseverance, a sharp mind and the ability to apply connected and creative thinking on many levels; only then can you examine key issues afresh.

Which era in the history of architecture interests you most?

Every era is shaped by economic, social and technological forces, and we see those reflected in its architecture. In that sense, my interest is in the "now". We're living at a time when long-established patterns of thought and behaviour are being turned upside down. That creates a lot of uncertainty, but also lots of opportunities to shape what comes next. ○

MARIA CONEN is Professor of Architecture and Housing in the Department of Architecture.
⟶ arch.ethz.ch

Image: Christian Knörr

NEW APPROACHES TO WASTE MANAGEMENT

TEXT Stéphanie Hegelbach
IMAGES Daniel Winkler

A finished prototype: the students implemented their ideas with simple means and a lot of creativity.

REPORT | Students from ETH and the Ghanaian university KNUST came up with some creative solutions for sustainable waste management at the Rethinking Waste summer school, where knowledge sharing and intercultural exchange topped the agenda.

It's 10 a.m. at the Richterswil church community centre. The coffee samovar is already half empty, and the building is buzzing to the sound of African pop music. Students from 17 countries are making a few last tweaks to their prototypes, feverishly debating the final elements of their design amid the sketches and post-it notes covering their cubicle walls. Outside, some team members are rehearsing their presentations while others take part in an energiser activity to give them a mental and physical boost. "The students are working through he design-thinking process – a method of finding innovative solutions to complex problems," says Marriette Mertens, programme manager at ETH for Development (ETH4D) and head of the Rethinking Waste summer school.

The 16-day intensive course is a collaboration between ETH Zurich and Kwame Nkrumah University of Science and Technology (KNUST) in Ghana. KNUST has sent 21 of its students to Switzerland, where they are staying in the Richterswil Youth Hostel with 20 ETH students for the duration of the course. The shared experience has forged a close bond between the two groups and opened their minds to new perspectives. Encouraging people from different backgrounds and disciplines to work together is a good way to address global challenges such as waste management, says Mertens, who was born in Ghana.

The summer school seeks to explore how organic, plastic and electronic waste can be processed efficiently and used as a resource. In Ghana, most waste is currently sent to landfill – some is incinerated, but almost none of it is sorted. Rubbish dumps containing high levels of organic matter attract disease-spreading rodents and insects, and toxic substances seep out of landfill sites into the water and soil. The failure to separate waste into different types makes recycling impossible. Things are very different in Switzerland, where waste sorting is almost a national pastime. Yet, here too, new solutions are needed to handle the fast-growing volume of plastic and electronic waste.

STEEP LEARNING CURVE "The students began by defining the problems they wanted to address," says Mertens. Johan Nöthiger, who is studying mechanical engineering at ETH, teamed up with three ETH and three KNUST students to explore the potential of organic waste in Accra, the capital of Ghana. They developed a concept for an app called Wastech, which households can use to arrange disposal of their organic waste. Once it is marked in the app as ready to collect, it is picked up within 24 hours, though a small fee is payable if the household's organic waste turns out to be too contaminated for use as compost. "Wastech would pay for itself," says Nöthiger. ⟶

1
Sampson Renner, coach from Kwame Nkrumah University of Science and Technology (KNUST) in Ghana.

2
Johan Nöthiger, participant from ETH Zurich.

3
Carine dit Sienyta Tiaho, participant from KNUST.

4
Marriette Mertens, head of the summer school and programme manager at ETH for Development (ETH4D).

5
Robin Renggli, coach and student from ETH Zurich.

6
Wilfred Elegba, initiator of the summer school and coach trainer.

Image: Igor Frangez

As their projects progressed, the students had plenty of opportunities to reality-check their ideas. They visited waste processing facilities and attended lectures. "There was also a Knowledge Fair, where the students got expert advice on how to fine-tune their projects," says Mertens. In a final step, the students conducted street interviews to gauge people's reactions to their solutions.

Getting to grips with Swiss waste management was an interesting experience for the African students. "It was a very steep learning curve for me," says Carine dit Sienyta Tiaho with a smile. A KNUST doctoral student, she was also part of the team that came up with the Wastech app. She adds, "I feel so happy seeing all these projects. I'm confident we can put lots of them into practice in the future." She pulls up a picture of her home country, Burkina Faso, on her phone. It shows an elderly woman and a wooden cart loaded with waste. "Because of the security problems in my country, the system is still relatively undeveloped compared to that of Ghana, where private companies collect waste in trucks," she says. Her detailed study of waste disposal systems helped her find a topic for her doctoral thesis. "I've also learned how important it is to communicate ideas not just in writing but also with drawings and prototypes," she adds.

NO CONSTRAINTS ON THE END PRODUCT The students spent lots of time figuring out how to encourage changes in behaviour. "I now realise people have all sorts of reasons for sorting waste," says Nöthiger. "That's something we should bear in mind." Robin Renggli's group even composed a song called "Separate your Biowaste", which they hope will inspire people to participate in their "Green Gold Challenge", a scheme that would give users points in return for supplying pure organic waste for compost.

Renggli, a Master's degree student majoring in Environmental Systems and Policy at ETH, coached the group through the project. "I led discussions, cleared up misunderstandings and made sure the team didn't get bogged down in the details," she says. For Sampson Renner, a doctoral student at KNUST, this year was his second opportunity to take on the role of coach. "The biggest challenge for me was finding the right way and the right moment to intervene, without upsetting the team's rhythm," he says. His exhortation to "trust the process" became something of a mantra for participants by the end of the summer school. "In engineering, we're used to having some idea right from the outset of what the solution will ultimately look like. But design thinking leaves the end product completely open, and that can sometimes test people's patience," he says.

INTERCULTURAL EXCHANGE In addition to sharing knowledge and methods, the participants also benefited from a programme of social and sports activities. "Spending time together allows the students to recognise their cultural differences and figure out how these influence their teamwork and the solutions they come up with," says Mertens. "It taught me a lot about myself and my outlook on life," Renggli acknowledges. Wilfred Elegba, a senior researcher in Ghana and a lecturer and coach ⟶

Sampson Renner (right, in yellow shirt) coaching a group of students.

trainer at the summer school, has seen first-hand just how far the participants have come. “This was the first time some of the ETH students had worked so closely with members of an African university," he says. "It took a little time for some of them to warm up, but they ended up fully embracing the experience.”

Elegba, who came to ETH to do his doctorate, is the enthusiastic yet very modest initiator of the summer school. He never tired of pointing out the huge potential for collaboration between the two universities, both during his initial period at ETH and after the visit of former ETH Rector Sarah Springman to KNUST, and the eventual creation of the summer school owes much to his persistence.

GRAND FINALE As evening falls, the students head to the ETH Zurich Student Project House to give their final presentations. Waiting behind the curtain with their cardboard prototypes, some are already lost in concentration, while others crack the odd nervous joke.

“We want the students to learn how to make the most of limited resources,” says Mertens. With so few options at their disposal, the students are forced to rely on their creativity and acting skills: in a series of five-minute pitches, they present their meticulously prepared strategies in an entertaining style that gets the audience smiling. “I wish all my meetings were like this!” says ETH Rector Günther Dissertori, who is clearly enjoying the show.

The six final projects highlight the diverse strategies that can be applied to waste management. One team has developed an intelligent organic waste bin that can detect and remove contaminants using infrared sensors and metal detectors; another presents an open-data platform that lets citizens report accumulations of PET plastic waste in their neighbourhood, thereby generating valuable data that can help improve the waste disposal system. One team has even come up with a way of creating a safe working environment for informal e-waste recyclers.

LASTING BOND But the most striking sign of the students’ enthusiasm for the project comes at the awards ceremony, where the teams gleefully exit the stage, hugging each other and whooping with joy. “Their team spirit and positive energy is truly inspiring. It’s clear that the summer school will leave a lasting impression on them,” says Dissertori.

The prize-winners include not only Wastech and Green Gold Challenge but also WeCycle, an awareness-raising programme that encourages kids and teenagers to set up their own compost system at school. Each award is emblazoned with Ananse Ntentan, a flower-like representation of a spider’s web taken from the traditional Ghanaian system of Adinkra symbols. “It stands for one of the key tenets of the summer school: finding creative solutions to complex challenges,” says Renner.

This particular symbol is designed to be broken into seven pieces and divided among the team members as a sign of solidarity. Tiaho is confident she’ll be seeing her friends again soon: “I’ve invited them over to my country.” Other ETH students will also get the chance to travel to Ghana next year: plans are already in place to hold the next summer school at KNUST. ○

Image: Laurin Grether

The talented young students proudly present the fruits of their labour in the Student Project House at ETH Zurich.

INTO THE LION'S DEN

TEXT Vinzenz Greiner
IMAGES Daniel Winkler

Karin Iten knows there are limits to human knowledge – and limits to what we can accomplish. But that hasn't stopped this ETH environmental scientist and agnostic from taking on the seemingly impossible task of bringing about a culture change in the Catholic Church.

From studying poisoned rivers and polluted soil to taking samples from litter-strewn meadows, environmental scientists are used to working in contaminated areas – and Karin Iten is no exception. This ETH alumna is in no doubt that she works in a "toxic" environment, yet her respirator mask is nowhere to be seen. And instead of rubber boots and a hazmat suit, she is kitted out in red leather shoes and a jet-black leather jacket.

Employed by the Catholic Church's office in the Canton of Zurich, Iten works as a prevention officer in the diocese of Chur. She battles a toxic combination of spiritual manipulation, sexual exploitation and the abuse of power, which together form a very different kind of trinity. Much of this has deep roots – in the Holy Scriptures, in a pyramidal hierarchy topped by men in long robes, and in the Church's claim of authority over people's lives and what comes after. Does this mean a tendency to abuse power is built into the system?

This has certainly been a fundamental problem for some religions, according to Iten. "Especially if they claim to profess the one and only eternal truth. That link between authority and spirituality indicates there's something wrong with the system," she adds.

System is a term that Iten uses a lot. She adopted it as a key concept decades ago when she first came to the institution that now lies just outside her office window. Students are clearly visible on the Polyterrasse, enjoying a little autumn sunshine. Is it simply an ironic twist of urban planning that ETH Zurich lies just a few metres above the Catholic Church's office for the Canton of Zurich? Or concrete proof that knowledge tops faith? Iten, who loves this view of her alma mater, laughs: "I woul d say: doubt and humility rank higher than faith."

Hence her description of herself as an agnostic rather than an atheist – because what conclusive proof do we really have? "Knowledge has its limits, too," muses the 51-year-old, reflecting the scientific approach and mindset she learnt at ETH Zurich. In 1997, she was one of the second cohort of students to study environmental sciences at the university, learning "to question things and to take a connected, interdisciplinary approach to problem-solving". This was also where she grasped the concept of how systems learn: through networking, internal diversity and external stimuli, she says.

During our interview, it quickly becomes clear that the person providing the stimulus here in the diocese of Chur is Iten herself: "Every system should include people who are willing to take an out-of-the-box approach." As a secular, agnostic scientist, Iten is about as far out-of-the-box as it gets in this environment. "I'm a woman who says what she thinks and challenges the status quo," she says. So how did she end up working somewhere that runs so counter to her nature?

Iten grew up in the city of Wil in the Swiss Canton of St. Gallen. Her parents were both Catholics from central Switzerland, but she rarely went to church, and faith played no role in her daily life. Instead, young Karin was absorbed by the environmental debates of the 1980s. Keen to help save dying forests, she briefly got involved in a local environmental campaign before starting her degree at ETH. "But it wasn't the technical solutions that caught my attention at university," says Iten.

Her interest lay in how we connect with nature – and how we treat it. It was in the lecture halls and seminar rooms of ETH that Iten, now in her mid-twenties, discovered something that would

KARIN ITEN studied environmental sciences at ETH from 1990 to 1996. Having begun her career in development aid, she subsequently spent seven years working in addiction prevention before moving to Limita, an organisation dedicated to preventing sexual exploitation. A keen nature lover, Iten lives with her two sons in Weesen on Lake Walen. As well as working part-time for the Catholic Church, she also works for Infosekta, a consumer group that provides information about sects.

stay with her through every stage of her career: "the quest for a mindful use of power, for moderation. Humans are incredibly powerful – the key is to exercise that power within reasonable bounds."

To begin with – during her internship in development aid in Madagascar, and while writing her thesis in Mali – this quest for moderation and prudent intervention was embedded within a larger context. But, as the years passed, the focus of Iten's search gradually narrowed from environmental education to substance abuse prevention and, finally, to the prevention of sexual exploitation and the abuse of power.

Her most recent position was at the specialised advice centre Limita, where she spent 11 years as co-lead before becoming its managing director. She was in charge of developing measures and strategies to prevent sexual exploitation in organisations. Her decision to apply for the post at the diocese of Chur came after much hesitation – and incredulity on the part of her family. What ultimately swayed her was her conviction that it would allow her to take her work to the next level while exerting the greatest possible impact. "I ended up in the church because my work on sexual exploitation and power was bound to lead me into the lion's den," says Iten. "And that's exactly the kind of environment where you need to be able to prevent the abuse of power."

Iten was confronted by systemic failings and a stagnant brew of power and spirituality that engendered abuse. For decades, reformers had struggled in vain to make headway in the Catholic Church; many had become jaded and thrown in the towel. By the time Iten entered the fray in 2020, it felt like tilting at windmills. So, was she ready to be a Doña Quijote? Iten prefers to describe her role as one of action rather than conflict. "Acquiescence and aversion to change go hand-in-hand; culture change is never easy," says Iten diplomatically. "But real transformation requires a subversion of the existing order. You need to shake things up!" she adds on a more rebellious note.

This is a classic example of the two Karin Itens. On the one hand, there is the networker who talks about resonance points in the system and achieving goals in collaboration with others. This is the woman who took just two years to persuade all seven cantonal churches in the diocese, including Bishop Joseph Bonnemain, to sign a code of conduct on a use of power that would prevent spiritual abuse and sexual exploitation. The woman who describes herself as naturally reserved, a believer in cooperation, dialogue and negotiated solutions.

Then there is the second Karin Iten, whose red-and-black outfit is anything other than heavenly, and whose glittering nose piercing gives her the air of a cool aunt that teenagers might like to sweep them off to a rock concert. This is a woman who clenches her fists when she argues for plain speaking in the Church. You can see the defiance glinting in her eyes when she makes these kinds of statements, and the thick eyeliner under her eyes seems to underline her determination to challenge the Church system.

It is this Karin Iten who says that she has "left her comfort zone to help a toxic, rigid organisation chart a new course", and that "the abuse crisis offers opportunities for change, which is a prerequisite for prevention". She has publicly criticised the bishop for standing idle as dedicated individuals are worn down by Church structures. And she has defiantly countered his insistence that actively practised homosexuality is inconsistent with the tenets of the Catholic faith: "In the context of sexuality, you can't separate what you are from what you do."

For Iten, what matters is maintaining a balance between the two sides. It's another stage in her quest for moderation and the appropriate use of power – her own, in this case. So, what does the future hold? "Right now, I'm staying put," she says. But might she be tempted back to the field of sustainability? To return to her roots in the battle against climate change? That ship has pretty much run into a brick wall, says Iten with a wistful smile. But the glint in her eyes tells a different story: "Back into the fray? You bet!" ○

DISCOVER

○ Monday to Friday, 8 a.m. – 6 p.m.

Reach for the stars

The Semper Observatory of ETH Zurich, which is currently home to the Collegium Helveticum, is the perfect place to learn more about astronomical instruments. A small permanent exhibition in the foyer offers visitors a fascinating insight into various instruments collected by the observatory's founder, Rudolf Wolf (1816 – 1893).

ETH Zurich, Semper Observatory, Schmelzbergstrasse 25

Find out more about the observatory:
⟶ collegium.ethz.ch/en

Image: Collection of scientific instruments and teaching aids, ETH Library, ETH Zurich

Gregorian reflecting telescope

○ 13 – 18 March 2023

BrainFair 2023

Brain Awareness Week is an annual event organised by the ETH Neuroscience Center Zurich and the University of Zurich in collaboration with Life Science Zurich. Featuring a series of panel discussions and short presentations open to the public, it also runs a schools programme and various other activities exploring how humans and machines learn.

More information is available at:
⟶ www.brainfair.uzh.ch/de

Image: rhz Reisen

View from the Golden Horn of the old city of Istanbul and the Süleymaniye Mosque.

○ 20 – 30 May 2023

ETH alumni trip to Turkey

Led by Zurich historian Adrian Vonwiller, this 10-day trip to Turkey will include a raft of memorable highlights. Situated at the crossroads between Europe and Asia, Istanbul is one of the world's most intriguing cities, a place where outstanding historical monuments jostle for space with modern marvels of engineering and architecture. Still more wonders await in the ancient Hittite city of Hattusa, where archaeologists recently stunned the world with their discovery of hundreds of hieroglyphs painted on the stone walls 3,500 years ago. The trip will also include a visit to the spectacular and surreal landscape of Cappadocia with its numerous fairy chimneys, cave dwellings and underground, fresco-filled churches, which served as a refuge for early Christians.

Find out more and book your place:
⟶ alumni.ethz.ch/events

○ 24 January 2023, 6.15 – 7.15 p.m.

Powering up

The transition to renewables poses challenges to the power grid. Operators will have to feed more wind and solar power into the network as well as transmit greater quantities of electrical energy over long distances while minimising transmission losses. Scientists at the ETH Zurich High Voltage Laboratory are investigating which technologies are best suited to meeting this challenge.

Sign up for the free tour:
⟶ tours.ethz.ch/en

Image: High Voltage Laboratory

AUDIO

○ ETH podcast

From cubicle to limelight

Benno Zogg and Névine Schepers are researchers at the ETH Zurich Center for Security Studies. In this podcast, they talk about balancing media appearances with their work on Eastern European history and nuclear power.

○ NADEL Podcast

"1.90 a day"

The latest episode of the NADEL podcast explores how it feels to live on the brink of a civil war, asks whether people can get used to poverty, and discusses whether the world still needs "white experts".

Find out more about this
and other ETH podcasts at:
⟶ ethz.ch/podcast

BOOKS

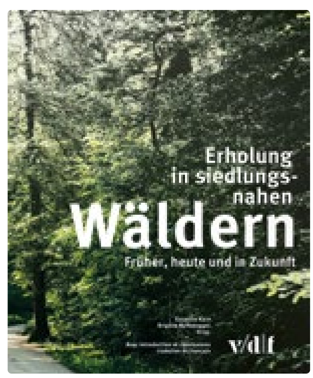
Recreation in urban forests:

Past, present and future

Forests located close to urban areas are among the most frequented recreational destinations for nearby residents and a popular spot for leisure activities. Yet there is still plenty of potential to improve forest infrastructure so as to serve people's needs even more effectively. It often takes just a few targeted changes to make a tangible difference to the mental and physical health of all forest users.

This book offers concrete examples of measures that can be taken to improve the recreational quality of forests. It includes a toolbox to assist with recreation planning as well as recommendations on how to approach the planning process. Drawing on examples of recreational forests, the authors show how forest areas can become highly valued by local people if proper attention is paid to certain factors.

The book provides a rich tapestry of stimulating ideas that can encourage a new awareness of what it means to work in and for the forest. It also offers advice on how to improve statutory and planning policies, streamline planning processes and foster expertise.



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OUT OF FOCUS

The origins of life, as seen through the eyes of Michael Meister

Illustration: Michael Meister

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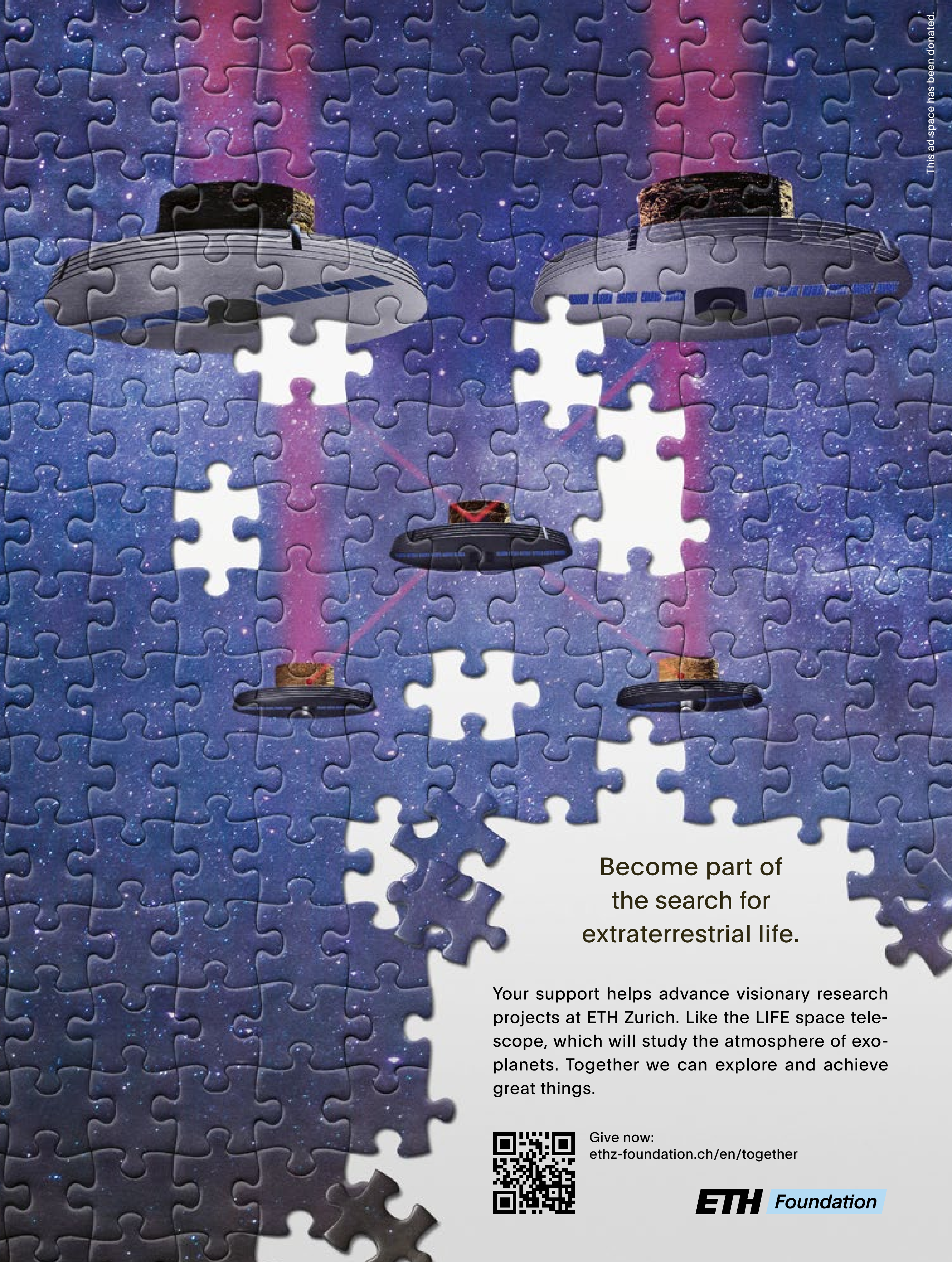
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