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Cover: AG Dausmann

Surprising findings on tropical hibernation: Thermoregulation strategies enable fat-tailed dwarf lemurs to adapt to the climate, habitats and sleeping sites in Madagascar.

Peter Strohschneider

Europe and the Integrative Power of Science

Stifling populism, authoritarian Caesarism, technocratic reductionism: the crisis of Europe and its union is also affecting the freedom and pluralism of science and research. If Europe were to recall the intellectual and cultural diversity of the sciences, then these very things could advance European integration.

On an occasion such as this, in the year that marks the 60th anniversary of the Treaties of Rome, as we try to relate questions about the European Union and questions about science and research, in one sense we have every reason to feel satisfaction and confidence – even a certain pride.

The founding of the European Economic Community and the European Atomic Energy Community in 1957, just twelve years after the end of the Second World War, was the first step in a process which brought decades of unparalleled peace and prosperity to our continent and brought together first six, then 28 (soon to be 27) nation states in a unified whole.

The sciences are a constitutive element of this modern Europe of present and future, and especially so the universities – closely linked as their establishment and development has been, and continues to be, to European history. The universities stand for that manifestation of "Western rationality" (Max Weber) and that specific European type of higher school which went out from here to be recognised, adopted and further developed all over the world – becoming the globally omnipresent and formative instances and forms of approaching and shaping the world that we know today.

However, this satisfactory occasion should not conceal the fact that there is also cause for concern. Our symposium is taking place at a time when Europe and European research are in a poorer state than we would wish them to be.

Europe is changing, and the dimensions and implications of this change threaten to exceed our capacity to analyse them. They are certain to affect science, research funding and science policy. And they are turbulent in such a way that we are forcibly confronted with the big questions:

What future lies ahead for Europe? For its science, for European education and research areas? Can science help to promote the integration of Europe to become an open, tolerant, peaceful continent which regards its own cultural diversity as a prerequisite for quality of life, legitimacy and civic liberties? The prerequisite for excellent and productive research? And if so, how?

All over Europe, new forms of old nationalisms are spreading in a way that would have been difficult to imagine just a few years ago. Across the continent (including countries where they did not ultimately triumph, as in the Dutch and French elections), public opinion is being shaped by radical right-wing xenophobia and an ethnicism, believed to be long gone, which is contrary to the European spirit. Not only in Turkey and Russia, but also in the heart of the European Union, in Hungary and Poland, a populistically authoritarian Caesarism is taking hold of state and societal institutions. At the same time, it is eroding constitutional democracy – not only at national but also at European level. The internal tensions are unmistakable, the centrifugal forces are becoming stronger. The European Union's lack of legitimacy is clear, as is its lack of ability to act. Moreover, the European

Slightly abridged version of a speech given by the DFG President at the German-Italian symposium "The European Union – Challenges and Opportunities for the European Scientific Community" on 13/14 July 2017 in Rome, organised by the DFG and Villa Vigoni under the patronage of the German Embassy in Rome.

Illustration: DFG/Brugnoletti

Commission and the administration in Brussels are tending towards an increasingly reductionist, a merely economistic concept of what a united Europe should be. The idea of a widely legitimised, pluralistic, integrative union is now perceived as little more than an attack from the outside.

This pallid technocracy, which Hannah Arendt identified as despotic from a political perspective, sees itself as fighting to defend itself against the representative democracies of the member states. This leaves a vacuum of culturally substantial meanings, and into this vacuum, all over the continent, are pushing the kinds of populisms which – through misguided and misleading simplifications – circumvent the complexity of modern scientific civilisation and seek to sidestep its demands. Increasingly, the defining sense in the public space is resentment – against foreign appearance, foreign knowledge and foreign belief, against elites and experts (including scientists), against the cumbersome legitimation processes of representative democracy.

But what do technocratic reductionism and the populism that takes constitutional crisis in its stride have to do with science? In my opinion, everything – because they negate it. Without curiosity about things we don't yet know or understand, without the expectation that new discoveries or surprising insights could burst our expectations, the processes of scientific knowledge production could not exist. Research is by its very nature based on questioning what we think we know about the natural and the cultural world. This is what makes science and research pluralistic endeavours.

Yet they remain tied to preconditions which are by no means a given. What is probably the decisive prerequisite is the structural pluralism of the institutionalisation and funding of science, as well as the intellectual pluralism of thinking styles, problem and theory horizons, knowledge traditions and research practices. New knowledge, in other words the rearrangement of existing knowledge, always requires cognitive disarray. Good research simply cannot happen without diversity in research culture.

And this brings us back to Europe and its current science policy. This policy is based on an entirely utilitarian concept of unification. Increasingly, research is being reduced to "real solutions" for "real problems", as Commissioner Carlos Moedas put it, and European science policy is therefore preparing the ground for economic reductionism to take root in the institutions of European science and research, too. Europe's science policy also seeks to address its legitimation problems, such as the crisis of confidence in science, with naive ideas of civic science extending even as far as populism.

This policy therefore threatens to abandon principles that it considers to be "traditional constraints", which in decades past were actually responsible for Europe's scientific performance and innovative capabilities: the pluralism of the scientific horizon, methods, topics and approaches, the tension of "truth and utility" (Wahrheit und Nützlichkeit) (David Kaldewey) of research, and independence from direct economic, political, social or ideological mandates.

Is it really wise for European research policy to play off impact-oriented research against scientific curiosity and thus dramatically underestimate the richly varied and enormous societal functions of science? In research policy, societal impact is usually nothing more than an expectation of impact which, like any expectation, remains uncertain. It is both legitimate and important


Illustration: DFG/Schneider


Illustration: DFG/Brugnoletti

What role can science and research play *in European integration in view of the current crisis? This was the key question at the two-day German-Italian symposium organised by the DFG and Villa Vigoni on the EU and the European scientific community, held in Rome in mid-July. Should science be regarded as the engine of European development? In a certain sense, it can certainly promote not only this but also the identification of citizens in Europe with Europe and the European project – with new perspectives and questions in place of views and answers which are all too well known. There was unanimity on this point in the main scientific presentations given during the symposium as well as during the final discussion with DFG President Peter Strohschneider, Tanja Börzel from FU Berlin, former Italian prime minister Giuliano Amato and Annette Schavan, the former German Federal Minister of Research and now ambassador to the Holy See (all in photo on left together with moderator Tilman Kleinjung from Bayerischer Rundfunk). Photo on right: after the conclusion of the event at the Palazzo Cardinal Cesi. Left to right, Peter Strohschneider, Gisela Cramer von Clausbruch (BMBF), former ambassador Michael H. Gerdts, former ambassador Michele Valensise and Secretary General Immacolata Amodeo (all Villa Vigoni), DFG Secretary General Dorothee Dzwonnek.*

where research seeks to generate direct solutions to clearly defined societal problems. But to make this expectation the single most important criterion for research funding would massively restrict the societal capabilities of modern science.

It would be no less wrong to reduce European science policy and research funding to technology innovation subsidies and regional structural policy. Rather, in the current situation, every effort should be made to bring to bear the cultural and intellectual wealth of European societies in science and research and in this way unfold the full social, economic and cultural functionalities of modern science.

However, this requires the European Union to remain subsidiary to national orders and not the other way round – in science and research policy as in other areas. Or to put it in concrete terms, research systems must be complementary at a national and a European level and in the relationship between the two. They should follow the idea of a shared European research area which does not approve the deterioration of options in science and research culture but increases the breadth and scope of effectiveness of modern research.

The key, then, is the idea of a Europe which believes in the integrative "power of pluralism" (Rudolf Stichweh) in research funding as in any other area, in the intellectual and scientific cultural diversity of Europe, without which the truly world-changing effectiveness of European science would be inconceivable.

Let us discuss how science policy and research funding can thus be rendered European. This would, not least, help to remedy the lack of legitimacy which has become conspicuous in the current crisis facing Europe.

Prof. Dr. Peter Strohschneider
is the President of the DFG.

New Beginnings in Kiev

DFG renews cooperation with partners in Ukraine and advises on establishment of a National Research Foundation

At the end of April, a DFG delegation led by President Prof. Dr. Peter Strohschneider travelled to Ukraine to recommence institutional cooperation with Ukrainian partner organisations in research. The visit coincided with the 25th anniversary of the commencement of diplomatic relations between Germany and Ukraine and the opening of the German Embassy in Kiev.

The joint funding of bilateral research projects had been suspended in 2014 following the state and financial crisis in Ukraine. During the visit, Strohschneider met with Ukrainian science minister Lily Hrynevych to hold consultations. The DFG would like to recommence joint calls for proposals with the Ukrainian national science fund SFFR. This was the outcome of a meeting with SFFR director Prof. Dr. Borys Grynyov.

The National Academy of Sciences of Ukraine (NASU) is also very interested in further developing its more than twenty-year-old relationship with the DFG. Together with NASU President Prof. Dr. Borys Paton, Strohschneider renewed the cooperation agreement dating from 1995 (photo), which required redrafting following the state crisis and reforms in Ukraine.

As part of the national reforms of education and research, Ukraine plans to strengthen competitive research funding and institutionalise it through a National Research Foundation of Ukraine (NRFU). When this is established, the DFG as the largest research funding organisation in Europe will lend its support in an advisory capacity.

www.dfg.de/dfg_magazin/internationales/170516_ukrainekooperationen


Illustration: DFG

Consultations in Mexico

Paving the way to even closer bilateral cooperation

At the end of May, DFG Secretary General Dorothee Dzwonnek travelled to Mexico for consultations with universities and partner organisations. There, she met first with representatives of the National Autonomous University of Mexico (UNAM), one of the oldest and largest universities in South America. As a result of this meeting, a workshop will be held in the near future for researchers in various disciplines from both countries.

The DFG delegation also visited the first German-Mexican Research Training Group, "Between Spaces – Entre Espacios", which has grown into a flagship project since its establishment in 2009.

In the eight years during which the project has been funded so far, more than 80 doctoral researchers have been trained and supported in the topic area. It is funded jointly by the DFG and the Colegio de Mexico (COLMEX). The DFG Secretary General met with its president, Prof. Dr. Silvia Giorguli, to discuss the expansion and consolidation of bilateral relations and cooperation.

At a meeting with Enrique Cabrero, the director of the National Science and Technology Council (CONACYT), both sides emphasised the great importance of cross-border cooperation between the two funding organisations and collaboration between researchers in Germany and Mexico.

www.dfg.de/en/dfg_profile/head_office/dfg_abroad/latin_america/reports/2017/170613_mexikoreise_dzwonnek

New Developments in St. Petersburg

DFG delegation visits Russian cooperation partners / Nine new projects

At the beginning of June, a DFG delegation led by Secretary General Dorothee Dzwonnek visited cooperation partners in St. Petersburg. At a press conference (see photo on right), a workshop and an evening reception at the House of Scientists, attention was focussed on bilateral exchange in the region. During a meeting between the rector of St. Petersburg State University (SPbU), Prof. Dr. Nikolai Kropachev, and the DFG Secretary General, discussion focussed on further project funding and the targeted ongoing development of German-Russian cooperation.

Illustration: DFG

In the last five years, the DFG has funded nearly 100 proposals with cooperation partners in Russia's northern capital. This includes the first German-Russian Collaborative Research Centre, TRR 160 "Coherent Manipulation of Interacting Spin Excitations in Customised Semiconductors", which is based at the Ioffe Institute and the State University. In 2017, nine collaborative projects in mathematics, physics, biology, chemistry and geography began to receive funding.

To nurture links, the DFG and the German Consulate General in St. Petersburg hosted an evening reception at the House of Scientists. This was also the venue where the CRC/Transregio was formally inaugurated.

www.dfg.de/en/dfg_profile/head_office/dfg_abroad/russia


Illustration: Barbara Helwing

Cultural heritage of humanity – how should archaeological sites and artefacts be handled? Following the destructions in Syria and Iraq, this question is attracting considerable attention. The archaeological heritage of Iran and its study – illustrated here by a view across the partially snow-covered excavation site at Tepe Sialk – was the focus of a three-day symposium held at the beginning of July in Bonn, organised by the DFG and the Bundeskunsthalle, Germany's national exhibition venue for art and cultural heritage. The framework for the symposium was provided by an exhibition at the Bundeskunsthalle, "Iran – Ancient Cultures between Water and Desert". In 13 presentations, archaeologists from Germany, Iran, France, the UK, the USA and Australia discussed their research results and points of view.

www.dfg.de/dfg_magazin/internationales/170726_iran_symposium

Series: Migration and Refugees / Part 2


Illustration: Oba / Velay Grant

Humans have always been on the move – and the history of humanity is also a history of migration. In part two of our series looking at research on migration and refugees, we take a look at the historical dimension – and being on the move as a part of the human condition. We visit a recently opened exhibition which draws on the findings of a Collaborative Research Centre based in Cologne to examine the question of how humans migrated from Africa to Europe. And we take a brief look at other selected DFG projects on this topic.

Poster: Neanderthal Museum

On Homo migrans

Mobility and migration are an integral aspect of the human experience. A look at the findings of the CRC "Our Way to Europe" and their presentation at the Neanderthal Museum

The movement of people across the earth has a long history, yet this fact is rarely recognised – at least in popular awareness. This is certainly true in the more alarmist debates heard in politics, the media and the public sphere amid Chancellor Merkel's optimistic "We can handle this" with regard to the refugee crisis in autumn 2015. But are major migrations really "unprecedented" and are the associated challenges an unknown or modern phenomenon?

Throughout the centuries, from one region to another, even one continent to another, for those engaged in historical research it is simply obvious that migration, whether voluntary or forced, has a long history, one that is as old as humanity. Ever since humans began walking on two legs, they have moved around – and in our globalised world, they will continue to do so. The exhibition "2 Million Years of Migration", which is open to visitors at the Neanderthal Museum until 5 November 2017, invites visitors to visualise the migrations of prehistoric times, their progress and context, with those of today. The "longue durée" of demographic change throughout human history is strongly linked to migration and is presented here in the form of a research-based exhibition. This is what awaits visitors in the basement of the Neanderthal Museum near Düsseldorf.

The clear and resounding message is in the very title: "2 Million Years of Migration". Seen in this way, mobility and migration are an inherent aspect of the human experience and the human condition. Here we see *Homo movens* and *Homo migrans* as the norm, migration as a normal state of affairs. The exhibition organisers, led by curator Melanie Wunsch and Professor Gerd Christian Weniger, director of the Neanderthal Museum, are conveying a statement to visitors and the general public. Dramaturgy and scenography help to convey the message in an exhibition intended to be a "visitor experience" (see box on p. 10).

The exhibition follows on from research conducted by the Cologne-based Collaborative Research Centre (CRC) "Our Way to Europe". For the past eight years, a team of 70 researchers in archaeology, geoarchaeology, palaeogenetics and anthropology has been investigating a key question: how did modern humans migrate and spread from Africa to Europe – and how can these events be reconstructed, explained and understood?

Jürgen Richter, Professor of Prehistory and Protohistory at the University of Cologne and spokesperson for the CRC, emphasises that "all non-European humans can trace their history back to an emigration from east Africa" in a time window of 70,000 to 60,000 years ago. This was the beginning of the story of anatomically modern humans. The exhibition tells this story vividly and engagingly in four "stations".

Left: The exhibition sign for "2 Million Years of Migration". Right: Exciting content in an unexciting guise – the DNA of Neanderthal humans in a plastic micro reaction vessel. Below: The multimedia presentation incorporates boxes and suitcases, among other things.

About two million years ago, the small, stocky *Homo erectus* lived in the east African savanna. A detailed artist's representation shows the world they inhabited (see photo below). These ancient people gathered roots, leaves, eggs and fruits and changed their "hunting grounds" in order to survive. Around 1.6 to 1.2 million years ago, *Homo erectus*, the hunter and gatherer, reached southeast Asia and Spain.

The second chapter in the development of the genus *Homo* began approximately 200,000 years ago, when modern humans, *Homo sapiens*, developed from certain representatives of *Homo erectus*. The replica of

Illustration: Unterstell

the skull found in Herto, Ethiopia, which is about 160,000 years old, is striking, not least because of its modern cranial anatomy: the forward-tilted forehead with less prominent brow ridge and a narrower, toothed jaw (see photo on p. 11).

These modern humans spread over the African continent and then to Europe and Asia, using

Illustration: Neanderthal Museum

different routes – one of which was certainly the land route via the Near East. This movement was probably prompted by extreme climate fluctuations. In Europe, in simplified terms, they encountered *Homo neanderthalensis* in the west and the so-called Denisovan people in the east. Both groups disappeared 40,000 years ago, for reasons that are still unknown.

Then, around 7,500 years ago, strangers came from the Near East through eastern Europe (the "Balkan route") to central Europe: early farmers who cleared the land, cultivated grain and kept sheep and cattle. When there was no longer enough cultivable land or pasture, they moved on.

At another station, in the landscapes of what is now Germany, some 4,800 years ago people came from eastern Europe bringing their corded ware, soon to be followed by people of the Bell Beaker culture. "They coexisted in a kind of parallel society," explains Wunsch. Gradually, "a multicultural society with complex social and economic structures developed". A foretaste of the modern world?

As neat and convenient as the long lines might be, there still remain major and minor questions unanswered in scholarship, with findings being considered contradictory or their significance being disputed. Even the fundamental question as to the "cradle" of humanity is a continual source of debate. Tempers and debates climbed a few degrees following the recent re-dating of Stone Age cave finds from Morocco.

How do the CRC research team obtain fresh insights? Their work has a geoarchaeological focus, which means that they employ a combination of methods from the geosciences and archaeology, particularly in order to study "culture-environment interactions". For example, they aim to better understand the beneficial and limiting environmental factors in the regions of origin, transit and destination.

Spokesperson Jürgen Richter explains their approach taking the example of a site in the Ethiopian highlands: the cave of Mochena Borago. 50,000 years ago, this cave was clearly a safe refuge for modern humans. The researchers' strategy is firstly to analyse artefacts such as bone remains and fossilised tools using archaeological expertise, and secondly to collect sediments from the site in the form of core samples and evaluate them as climate archives. The combination of the two approaches promises to be very fruitful.

Additional expertise is supplied by the selection of team members. The CRC collaborates with the Max Planck Institute for the Science of Human History in Jena, established in 2014 – the reason being that palaeogenetics and palaeoanthropology have made enormous strides in recent years. For example, the DNA of the Neanderthal genome has been sequenced as part of an international initiative. This is presented in a micro reaction vessel inside a box. It may be a small exhibit, unspectacular at first glance, but it represents an enormous and very exciting research achievement (see photo on p. 9).

This in itself is worth reflecting upon. The same goes for the message of the whole exhibition: "Regardless of skin colour, religion, language, ethnic identity and cultural background," says the final panel, "all humans have a migration background. In a world which is becoming ever more interconnected through globalisation, we should view migration as a natural part of life, both at a personal level and at the level of society and government."

Some may perceive this as a politically correct wagging finger, or even insipid do-goodism. But what is much more important is the implicit attitude which the exhibition can convey and reinforce: the attitude of a "certain dispassionateness" in relation to migration, to "people with a migration background", and the associated questions, challenges and opportunities. In the knowledge that migration is a part of human existence on earth, in prehistory, today, and in the future. Seen in this light, looking at two million years of migration and human history is both helpful and valuable.

Dr. Rembert Unterstell
is Publishing Executive Editor of german research.

After its presentation at the Neanderthal Museum (where it can be seen until 5 November 2017), the exhibition itself will go on the road and be shown at other venues throughout Germany.

www.neanderthal.de/en/Special-exhibition.html

Illustrations: Unterstell

An exhibition for the whole family, suitable for visitors young and old. Right: Replica of the 160,000-year-old cranium of a modern human, discovered in Herto, Ethiopia.

The special exhibition "2 Million Years of Migration" at the Neanderthal Museum uses a multimedia, interactive and dialogue-oriented approach. As well as presenting artefacts from human history, it invites visitors to discover and engage with exhibits and knowledge about the migration history and general history of humanity. It is more a knowledge-based visitor experience than a "science exhibition", designed for families rather than for a genuinely academic audience.

The exhibition concept, which makes visual use of cubes, includes richly detailed illustrations, expert boxes and special boxes. There is also plenty of hand luggage, for example a toolbox which ancient humans took with them on their travels. Suitcases are a striking and obvious symbol and a key metaphor in the dramaturgy of the exhibition.

For children there are boxes to rummage in on the floor and a special audio guide that takes them from station to station and tells them about the human family. There are also video installations, such as the teaser film for the exhibition (www.youtube.com/watch?v=bv_I9XwSj14), which includes personal stories, testimonies and sympathetic portrayals of migrants today.

Illustrations: Neanderthal Museum

"2 Million Years of Migration" exploits a range of channels to convey its message to the visitor. It begins with portraits from the Humanae project (see photo above), a long-term photographic project by Brazilian artist Angélica Dass, which documents the skin colour of thousands of individuals and in so doing makes a statement against racism. Here, "2 Million Years of Migration" places an exclamation mark, as it does behind the overarching message of the exhibition: "You're a migrant too." **RU**

Illustration: dpa/Matthias Schrader

Pioneers of Rebuilding

The integration of refugees and displaced persons in the West German labour market after the Second World War

For a long time, historians have interpreted the 20th century as a century of displacements. This includes the flight, forced migration and fate of at least 12 million Germans from eastern and central Europe and the former eastern territories of the German Empire. In a project funded since 2015, "The economic effects of displaced persons and their integration in West Germany, 1945–70", Dr. Sebastian Braun from the University of St Andrews has been examining this displacement of people from an economic perspective.

The key question this project addresses is: How was integration accomplished in the labour market? In September 1950, approximately one in six West Germans was a displaced person. Firstly, an electronic database is being produced using population and employment census data from 1946, 1950, 1961 and 1970. The aim is then to analyse "the medium-to long-term effects of the influx of displaced persons on the employment structure of West German regions". The overall intention is to discover "what factors accelerated or slowed the economic integration process of displaced persons".

The project in the DFG database Gepris:
gepris.dfg.de/gepris/projekt/267108021

Space and Knowledge

The Berlin-based Cluster of Excellence TOPOI seeks to better understand factors in the development of ancient civilisations

Using networked basic research to look at the ancient world: the Cluster of Excellence "TOPOI – The Formation and Transformation of Space and Knowledge in Ancient Civilisations" aims to examine connections between space and knowledge in the civilisations of the Near East, the Mediterranean, the Black Sea region and parts of the Eurasian steppe between the sixth millennium BC and approximately 500 AD. Through interdisciplinary collaboration, the research team – which has been funded by the DFG since 2007 – seeks to understand spaces, spatial systems and different forms of space-related knowledge as interrelated factors in the development of ancient civilisations.

"The research team studies large-scale spaces, such as different ideas about the cosmos or borders and the control of large empires, medium-sized spaces – the immediate living environment and its specific spatial order – and the smallest spaces, in which we map the inside of our bodies or the place of our mental capabilities."

TOPOI brings together the research capacities of disciplines relating to antiquity in Berlin and is based on the close cooperation between the Free University of Berlin and the Humboldt University of Berlin with the Berlin-Brandenburg Academy of Sciences and Humanities, the German Archaeological Institute, the Berlin State Library – Prussian Cultural Heritage, National Museums in Berlin – Prussian Cultural Heritage and the Max Planck Institute for the History of Science.

The project in the DFG database Gepris:
gepris.dfg.de/gepris/projekt/39235742

Mobility at the Dawn of the Modern Age

Humanities Centre for Advanced Studies aims for new perspective

Migration and Mobility in Late Antiquity and the Early Middle Ages" is the topic of a recently initiated Humanities Centre for Advanced Studies at the University of Tübingen. The group intends to spread its focus over the classic "Migration Period", employing a concept of mobility that incorporates "different forms of mobility (including the mobility of spiritual or agrarian workers)" and whose impacts are understood as "a spectrum with blurred transitions" which are to be "analysed in a historical-comparative approach". The aim is thus to test "the capability of a fundamentally new perspective on the centuries of change from the Roman to the post-Roman world". The project is in its initial phase and has been funded by the DFG since 2016.

The project in the DFG database Gepris:
gepris.dfg.de/gepris/projekt/289020600

Networked Refugee Research

DFG supports academic networking / interdisciplinarity as a challenge

Many fields of research face the challenge that researchers work beside rather than with one another. This is equally true in studies on migration history, refugees, displaced persons and asylum-seekers. The network "Foundations of Refugee Research", which is based at the Institute of Migration Research and Intercultural Studies at Osnabrück University and has been DFG-funded since 2015, aims to support academic networking in this field. A group of 14 researchers will come together in a series of workshops to discuss concepts as well as issues such as normativity and ethics in refugee research. Another goal of the network is to publish a reference work on the principles of refugee research and to support "the development of individual and collaborative research projects with international importance" and the establishment of long-term structures for lasting interdisciplinary collaboration in this field.

The BMBF-funded project "Refugees: Research and Transfer" includes an interactive research map which currently includes over 500 searchable projects: https://flucht-forschung-transfer.de/map/#6/51.200/9.000

The project in the DFG database Gepris:
gepris.dfg.de/gepris/projekt/270107948

Read part 3 of the series in the next issue:

Migration incentives and migration barriers? Language acquisition and migration from an economic perspective

Rüdiger Heimlich

“Just Call Me a Desert Researcher”

Whether in documentary films, exhibitions, talks or articles, for decades the Cologne-based geologist and climate scientist Stefan Kröpelin has been popularising the history, landscapes and people of the Sahara. As a field researcher and in many ways a “science ambassador”, the DFG and the Stifterverband have chosen him as the recipient of this year’s Communicator Award.

Illustration: Adam Polczyk / U Cologne

The international journal *Nature* simply calls him the "man of the desert". German radio station Deutschlandfunk has dubbed him the "German Indiana Jones", and a Saudi glossy magazine the "veteran" of Sahara research. Stefan Kröpelin prefers to be simply named a "desert researcher", a geoscientist whose interest lies in the climate history of North Africa as well as in archaeology and nature conservation. "We travel through regions which no scientist has ever visited before and won't visit again for a long time. You need to be open to anything and everything you encounter."

That might mean caves with rock paintings or the remains of freshwater shells in the desert sands. It might also mean scorpions in your sleeping bag, bandits or refugees in desperate search of water. What does a desert researcher need, apart from scientific expertise? A feel for people and landscapes, patience, determination and a large pinch of luck.

Stefan Kröpelin has had all of these over the last four decades. When he recounts – and Kröpelin is an engaging speaker – the risky situations he and his teams have often found themselves in, sometimes without any apparent way out, his tales could easily beat any adventure novel. Little wonder, then, that even Google founder Larry Page or the President of Chad, Idriss Déby Itno, both listen to him with fascination.

So is he Germany's answer to Indiana Jones? Stefan Kröpelin smiles. The media love exciting pictures, the scent of adventure and danger, secrets and treasure-hunting. In 2006, Kröpelin appeared in a ZDF documentary, Magische Welten: Aufbruch ins Ungewisse (Magical Worlds: Advance into the Unknown), introducing millions of viewers to regions of which there are scarcely any maps. Right at the start of the expedition, a differential gear breaks down. Then Kröpelin scrambles into a dried-up well where a scorpion crawls into his shirt. Kröpelin's films reveal the adventurous side of research, but "I'm no adventurer", he says. "Our work comes with risks attached, and yes, we're looking to uncover secrets: What did the Sahara look like at different points in its history? When were humans able to cross it?" Kröpelin has also found a treasure – in the depths of Lake Yoa in northern Chad.

After a gruelling journey over 1,200 kilometres of desert terrain, in November 2010 Kröpelin's expedition team from Cologne reached the Ounianga oases: 18 deep blue lakes surrounded by palm trees and yellow-green fields amid an ocean of sand. It's an ecological sensation: saltwater and freshwater lakes 1,000 kilometres away from the Nile, fed by ancient groundwater.

"We were lucky on our mission because there was relatively little wind," says Kröpelin. "There are days when the wind just blows you down and all you can do is crawl across the sand on all fours." The team takes a platform out on the gently windblown lake and slowly sinks an acrylic glass tube, metre by metre, to the 25-metre deep bottom. Then the hard work begins. In the sweltering heat, they use a weight to drive the bore cylinder into the soft lake bed. They work for days, one blow after the other, pushing it 16 metres down. Every so often they pause to carefully lift the tube out. After all they extract 16 metres of mud. A closer examination reveals over 20,000 fine sediment layers, in every colour from ochre to dark grey – a unique and complete climate archive containing seasonally layered deposits from the past 10,500 years.

Kröpelin and his colleagues can read it like a book: the greening and gradual desiccation of the Sahara, as well as shorter-lived events such as heavy rains, periods of drought, sandstorms, savannah fires, volcanic eruptions, earthquakes and nuclear tests, or the time when crops such as date palms were introduced. "These lakes are a treasure. The Sahara is as big as the USA, but no one would have expected such an undisturbed, continuous geo-document in the middle of the world's driest desert." Kröpelin considers it the high point of his research.

The desert has fascinated him ever since he was at school. His father was a senior political editor with broadcaster Bayerischer Rundfunk and his mother a lawyer in Munich. They encouraged their son's reading habit, which took him on journeys of the imagination with the likes of Heinrich Barth, Gustav Nachtigal and *Gods, Graves and Scholars* by C. W. Ceram. In conservative Bavaria, his parents were liberal and independent – traits they passed on to their son. In 1968, he was expelled from school due to "political agitation". Unsurprising, perhaps, as during this period Stefan was playing on the stage of the Action Theatre beside Rainer Werner Fassbinder.

He completed his schooling in Berlin and had a series of temporary jobs, working as a scaffolder, a detective or a Santa Claus. During film festivals he served as a "guest officer", guiding visitors such as Jack Nicholson, Robert de Niro and David Bowie through Berlin's nightlife. "Wild years," recalls Kröpelin with a grin. This enabled him to finance his trips. In 1970, he set out on his first trip in an old Volkswagen van that only cost 100 Deutschmarks, which took him to Afghanistan and the Dalai Lama in the Himalaya. At Berlin's Technical University he studied what was then the new subject of computer science. In 1977, after sitting the intermediate exams, he switched to geography and geology. "Unless you wanted to be a teacher, there was little in the way of job prospects. But that didn't put me off."

It's not just rock paintings that interest the researcher – documentation with the camera is part of fieldwork, as here on the Ennedi Plateau in Chad. The sandstone complex in the Sahara was added to the UNESCO list of World Heritage Sites in 2016.

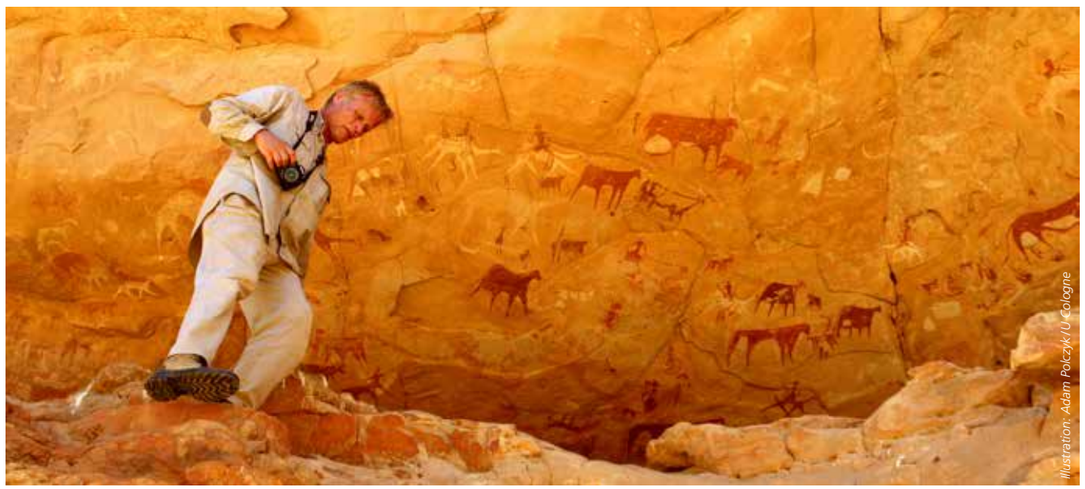


Illustration: Adam Polczyk / U. Cologne

Illustration: Uwe George

Lake Yoa at Ounianga against the imposing backdrop of the Sahara: the first samples were taken in 1999 from a platform. There are currently 19 lakes at Ounianga, covering a total area of 15 square kilometres – the largest and most famous in the Sahara.

In 1982, the interdisciplinary research project "Occupation History of the Eastern Sahara" took Kröpelin to the Gilf Kebir – a remote, as yet largely unresearched sandstone plateau in southwestern Egypt. "I was never interested in travelling to places where people had already carried out a hundred investigations, just to add publication number 101. I found the last remaining 'unexplored bits' on the map much more exciting." He spent a week studying geological deposits and prehistoric sites, all alone – and was worried about dying of thirst because his colleague failed to pick him up on time. He was on the point of considering the 200-kilometre walk to the next source of water when the vehicle finally came into view.

He had another stroke of luck with the DFG Collaborative Research Centre 389, which took him after the end of the Berlin-based geoscientific Collaborative Research Centre 69 "Arid Areas" to the University of Cologne in 1995. Here at the "Africa Research Centre", a team of archaeologists, botanists, zoologists, ethnologists, anthropologists and linguists has been studying the prehistory and protohistory of the eastern Sahara since 1986. "When we first started, there was hardly any research done in this part of the Sahara. Obviously there were the early discoveries of Rohlfs, Frobenius and Rhotert, as well as of pioneers like the 'English Patient', Ladislaus Almásy. But the interdisciplinary basic research was new."

In 2003, the multipart WDR documentary Wenn Weiden zu Wüsten werden (Meadows Become Deserts) vividly told the story of the climate history of the Sahara. "We don't research for our own benefit," says Kröpelin. "It's our job to pass on our knowledge to those who fund our work – the public." Kröpelin does this through TV programmes for schools, science magazines like W wie Wissen (K for Knowledge) and countless radio interviews. He doesn't shy away from the popular – as when the food team on consumer programme Servicezeit enquires about the expedition's menu plan – or the controversial – as when talk shows probe him about his views on the Darfur conflict.

In the framework of the Collaborative Research Centre 389 with its acronym ACACIA (Arid Climate, Adaptation and Cultural Innovation in Africa), Kröpelin together with archaeologist Rudolph Kuper of the Cologne Institute of Prehistoric Archaeology and a large number of colleagues formed expedition teams which, since 2009, have been attempting to trace "Our Way to Europe" in a third DFG Collaborative Research Centre 806.

A first milestone was the exploration of Wadi Howar in northern Sudan, a former river system and once the most important tributary of the Nile from the Sahara. On its sand-covered banks, the researchers discovered early signs of settlement. At Abu Ballas, an outlier in Egypt's Western Desert, they study rounded water jars – a refuelling point for pharaonic military and trade caravans. This is followed by expeditions to the Gilf Kebir Plateau, the Great Sand Sea with its longitudinal dunes of over 100 metres in height and hundreds of kilometres in length, Sudan, Libya, and finally Chad.

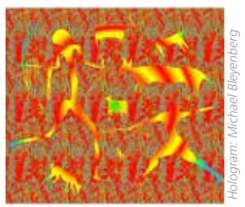
Kröpelin has now notched up over 60 expeditions. "Since I was 18, there have only been a few years of my life when I haven't been in the desert. You either love it or you hate it," he says. "Aside from my scientific curiosity, what fascinates me is the complete contrast to the way of living in the Western world. Every night means a different camp in the wind shadow of a dune, under an unbelievably clear starry sky. Sometimes it's so quiet that you can hear the hiss of shooting stars. You live very abstinently, of just a few litres of water per day, and you eat and sleep very simply. There's a feeling of being close to nature, of unlimited freedom."

Perhaps he shares this feeling with the people whose trail he is following: anatomically modern humans who once set off from Ethiopia for Europe – where they encountered people who had made the journey long before them. "Out of Africa II" probably began over 100,000 years ago when the Sahara was undergoing a green phase that allowed people to cross it. "Out of Africa III" then occurred during the last wet phase, which began 11,000 years ago. The Sahara has experienced recurrent climate changes. Sometimes it has acted as a barrier, sometimes as a green corridor between south and north. The core sample from Lake Yoa now enables researchers to reconstruct the epoch since the last cold period, the Holocene, with the transition from hunters, fishers and gatherers to Neolithic herders and farmers, at unrivalled accuracy.

This kind of work would be impossible without the support of the local population, says Kröpelin. This is why he presents the results of his research in the media in the host countries and thanks people for the help received. Kröpelin appears so frequently on TeleChad that he is even recognised in remote regions of the country. The fact that Chad now boasts two World Heritage Sites – the lakes of Ounianga and the Ennedi Massif – is due in part to his media presence. Lobbying UNESCO requires public awareness. So he never tires of telling people about these landscapes and their conservation.

As Stefan Kröpelin talks, it's hard to believe that this bundle of energy is 65 years old and due to retire in summer 2017. Will he stay at home with his wife and nine-year-old youngest son? "I'll definitely be spending more time at my desk and working on books," he says, but in November he is heading back to the volcanic Tibesti Mountains in Chad to conduct basic research for their protection as another UNESCO World Heritage Site. "It's the Hawaii of the desert", he says enthusiastically, many parts of which have yet to be explored by scientists – the kind of place, in fact, where Stefan Kröpelin well and truly belongs.

Cologne-based geologist Dr. Stefan Kröpelin *is the 17th recipient of the Communicator Award – Science Award of the Donors' Association. In addition to the prize money of €50,000, the prizewinner receives a personalised hologram created by Cologne-based painter and media artist Michael Bleyenberg. The hologram illustrates and symbolises how scientific findings are shown in the "right light" to make diversity, shapes and colours visible. The Communicator Award has been presented annually by the DFG since 1999. It honours researchers in any field who communicate the results of their research work to the media and the general public in an outstanding and effective way. The selection criteria include the breadth and variety of the communication strategy as well as its originality and long-term impact. The winner is chosen by a jury of communication researchers, journalists and PR experts chaired by a DFG Vice President.* **RU**



Hologram: Michael Bleyenberg

www.dfg.de/en/funded_projects/prizewinners/communicator_award

Illustration: Kröpelin

Broadcaster ARTE filming at Wadi Sura, at the foot of the Gilf Kebir plateau in Egypt with the "Cave of Swimmers" in the background.

Guest author
Dr. Rüdiger Heimlich
is a member of the editorial team of the newspaper *Kölner Stadt-Anzeiger*; he has been writing for many years and with considerable insight about Dr. Stefan Kröpelin's desert research and expeditions.

More information about Kröpelin's work is available at:
www.sfb806.uni-koeln.de/index.php/profile/userprofile/skroepelin

Kathrin H. Dausmann

Hibernators on Madagascar

In our latitudes, we are familiar with mammals who spend the less hospitable season of the year in dens, but it has come as some surprise to discover that dwarf lemurs in the tropics do the same. New studies show that thanks to their special thermoregulation strategies, they can adapt even more flexibly to the climate, habitats and sleeping sites.

Working platform under the tropical sun: the researcher at her desk with traps at her feet each containing a fat-tailed dwarf lemur. One by one, they are examined, measured or fitted with a transmitter.

Illustration: AG Dausmann

Marmots do it, dormice do it, bats do it and we have known for some time that monkeys do it as well: they all hibernate. When hibernating animals in our latitudes crawl out of their dens and enjoy the first rays of sunshine, Madagascan fat-tailed dwarf lemurs (*Cheirogaleus sp.*) are making their final preparations for a winter sleep (in Madagascar, winter falls between May and September). This might be surprising because usually primates are associated with a tropical climate. However, even tropical habitats are subject to strong seasonal climate variation, and also fluctuations in the availability of water and food.

During the Madagascan winter, night temperatures fall sharply and leaves, fruit and insects naturally feature less often on the menu. During this season, therefore, Madagascan mammals are confronted by the same challenges as those faced by similar species in temperate and Arctic regions of the Earth: low ambient temperatures and food scarcity at a time when they need more energy to maintain a relatively high body temperature.

Furthermore, in winter in many areas of Madagascar precipitation is considerably reduced or even stops completely (for up to eight months). This results in such extreme drought that only a few species of mammals can survive. In some areas, the night-time temperature might even fall below zero – chilly for the researchers sleeping in their tents, and also for the lemurs, these most charismatic representatives of the Madagascan fauna.

Fat-tailed dwarf lemurs have a particularly elegant strategy to

A magnificent specimen: a male fat-tailed dwarf lemur of the species Eulemur fulvus rufus.

avoid the dilemma of increased energy requirements and reduced availability of food and water: they hibernate. During this period, nearly all their bodily functions are reduced to a carefully controlled minimum. Their energy consumption can be cut to less than 5 percent. Life continues on the economy setting, so to speak, using the fat reserves in the animal's body. Our discovery (funded by the DFG) that fat-tailed dwarf lemurs genuinely hibernate was surprising. Not only because they were the first primates shown to hibernate, but because this was the first time this behaviour had been observed at all in tropical mammals. However, it was not just the fact of hibernation itself that was astonishing about our research into fat-tailed dwarf lemurs; it was the way in which this happens.

Using small radio transmitters and miniature temperature loggers to measure body temperature, we were able to track their social life and their hibernation physiology. We also used portable gas analysers connected by tubes to their sleeping dens to determine their oxygen consumption both in active periods and during hibernation. Oxygen consumption can be used to calculate how much energy an animal is using at any time. This requires some sophisticated technology as what is normally the size of a refrigerator in a laboratory had to fit into a (watertight!) portable metal box in the Madagascan jungle. Our devices were powered by car batteries which need to be charged via solar panels in a somewhat lengthy process – or in a lively barter transaction involving the tourist cars or locals' mopeds that passed through occasionally.

Fat-tailed dwarf lemurs are small, nocturnal lemurs, primates in the strepsirrhini group. They feed on fruits, leaves and sometimes insects, if they manage to catch them, and live in small family groups. Males and females mate for life and defend their shared territory and raise their young together. Males help out with babysitting duties from the offspring's birth, while the females search for food. Sometimes the young remain on their parents' territory for several years. This is all the more surprising as over 40 percent of the young are not the issue of the social father, but were conceived with a neighbour.

As the name suggests, fat-tailed dwarf lemurs store the fat reserves they need for hibernating in their tails, which grow from the circumference of a little finger to five times that size in the preparatory period. This trick, of "transferring" the fat deposits to their tails, stops them overheating in the fat storage phase.

It is always fascinating to watch how a "normal" mammal existence can change so completely within just a few days: during hibernation the animals seem to be almost lifeless. Their bodies are cold and they do not move; they take neither food nor water for months. As with other hibernators, the fat-tailed dwarf lemur's metabolism is down-regulated to a fraction of that in the active season and active thermoregulation

Field work: A lemur caught in a trap ...

... is carefully measured and then released (bottom).

Illustrations: AG Dausmann

A remarkable difference: a fat-tailed dwarf lemur at the start of hibernation, with a fat tail, and during the active period with a thin tail.

is largely switched off. The body temperature falls to ambient levels and heartbeat and respiration rate slow down. Breathing sometimes ceases for 20 minutes.

As a result, as with hibernating animals in our latitudes, the body temperature is determined by the ambient temperature and responds to the temperature in the hibernaculum. However, unlike the hibernators in our region, the patterns of thermoregulation in fat-tailed dwarf lemurs are much more flexible and adapt to differences in hibernating sites and the climate conditions in their Madagascan habitats. Western and eastern fat-tailed dwarf lemurs (*C. medius* and *C. major*) only use holes in trees for their winter sleep, which is where all fat-tailed dwarf lemurs normally sleep during their active period.

The highland-dwelling fat-tailed dwarf lemurs (*C. crossleyi* and *C. sibreei*), on the other hand, live in the coldest areas of Madagascar and dig themselves into the ground for hibernation. They are protected from even freezing temperatures under a soft layer of plant roots, humus and leaves. Depending on where they are hibernating and how much insulation this offers, the animals' body temperature and therefore their metabolic rate and energy consumption can be either almost constant (in tree holes in thick trees and in ground dens) or fluctuate more or less widely from just a few degrees to more than 25 degrees Celsius each day (in holes in thin trees). This is comparable to the mechanism in ectothermic reptiles, which take their fluctuating body heat from the environment. If these fluctuations are relatively strong and if the temperature is raised passively to over 30 degrees Celsius at least on occasion, the fat-tailed dwarf lemurs do not need the short phases of active heat production called "arousals".

The factors which bring about these energy-intensive waking phases are the subject of lively discussion. The temperature is however clearly crucial. If the fluctuations in body temperature are less extreme, the fat-tailed dwarf lemurs experience regular spontaneous arousals about once per week. This means that they can continue to sleep for months, not despite but precisely because of the high ambient daytime temperatures and the resulting hibernating body temperature of over 30 degrees Celsius. Depending on the lemurs' habitat, they sleep from three months (in the eastern rainforest) to seven months (in the western dry forest).

Tropical hibernation allows the fat-tailed dwarf lemurs to save around 70 percent of their energy consumption, regardless of hibernation site. This probably also explains why there is no preferred strategy concerning hibernation sites and why individuals change their hideaway during the winter. This is mainly practised by males, which move into their mate's hibernaculum after entering into hibernation separately and is presumably to allow them to be in the right place for the mating season, which begins immediately after they wake from their winter sleep.

However, the term "winter sleep" is misleading – it isn't actually sleeping at all. Observations of ground squirrels (*Spermophilus*

Illustrations: AG Dausmann

Dry forest in the rainy season on Madagascar. Right: Readings must be taken from the devices set up in the forest and the bush every day.

lateralis and *S. parryii*) have shown that normal sleep phases are not a part of hibernation. However, it is difficult to compare the brain waves of euthermic mammals – that is animals whose body temperature is regulated internally at a high level – with those recorded at body temperatures of less than 5 degrees Celsius. The fat-tailed dwarf lemurs are providing new opportunities to investigate this in a "natural experiment" on hibernators with higher body temperatures.

In collaboration with the Duke Lemur Center in the USA, in a project again funded by the DFG, we are researching the question of whether the lack of regular sleep phases is a physiological feature of the hibernating state itself or is merely due to the low body temperatures of hibernating animals in temperate and Arctic regions, and our results indeed indicate that temperature is the decisive parameter for regular sleeping phases. The findings so far are also important for preparing forecasts of how the physiology of hibernators might change if winter temperatures continue to rise due to climate change.

One could almost envy the fat-tailed lemurs: when it gets cold and inhospitable, the animals go into hibernation. There are no obvious fitness advantages to be had from being active and exposed to predators at a time when reproduction is not possible. And if one type of primate can do it, then there is no reason to suppose that other primates in principle cannot. The problem is, however, that so far nobody knows which factors trigger hibernation, which hormones and which nerve cells are involved and where in the cell metabolism the switch from normal to economy mode is to be found. Hibernation remains an exciting subject with many more puzzles to solve.

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www.uni-hamburg.de/biologie/BioZ/zis/oek/for/eco.html

Volker Piotter, Christoph Eberl and Oliver Kraft

Illustration: AG Kraft

Left: To load a micro tensile specimen, you need vacuum tweezers.

Miniaturisation? Yes, please!

Material and process technology: To develop and use high-resilience ceramic and metal microcomponents, the entire process chain from prototype to volume production needs to be optimised. To achieve this, researchers are using microforming processes – and the results mean benefits for vehicles, medical devices and more.

When you buy a new car, you aren't just buying an engine on four wheels but a vehicle packed with microelectronics and microsystems engineering. It houses an array of sensors even more diverse, for example, than that available to Apollo 11, the first manned mission to the moon. Modern safety systems long considered standard, such as airbags and ABS, optimised drive systems, reduced-emission combustion, and finally comfort and communication features all depend on tiny sensors that continuously measure pressure, speed, acceleration and chemical composition. It's only the interplay of these sensors that creates a car with high-performance technology. For instance, there are countless drive elements which ensure optimum fuel injection, tighten seatbelts or simply close the boot. All these are achievements of microsystems engineering. For three decades, this field of engineering has been developing applications not only in mobility but also in production and process engineering, bioengineering and medical technology. It has therefore evolved into a key technology in industrialised societies.

Many systems are developed and manufactured on the basis of tried-and-tested silicon technology or with the aid of established plastics-processing techniques. There is also a demand for wear-resistant three-dimensional microcomponents made of metal or ceramic material which can withstand high levels of mechanical and thermal stress. But precision engineering doesn't have the tools to deliver these parts – especially where miniaturisation is concerned. So since 2000, at the University of Karlsruhe, or more specifically the Karlsruhe Institute of Technology (KIT) which grew out of it, the Collaborative Research Centre "Design, Production and Quality Assurance of Molded Microparts Constructed of Metals and Ceramics" has been looking for ways to improve the process chain for the moulding of metallic and ceramic microcomponents from the basics to application readiness.

The moulding process comprises powder injection moulding and the casting of a melt and was developed for the manufacturing of parts with details measuring just a few micrometres. The powder injection moulding (PIM) of metal- and ceramic-filled compounds (MIM and CIM) has enormous potential for economical manufacturing with minimal reworking. As virtually all known metallic and ceramic materials are also available in powdered form, there is a wide range of materials to choose from.

Important insights from basic research were transferred into industrial application by a Transfer Unit. In particular, the research team wanted to evaluate MIM as a process for manufacturing components with the kind of thin steel membranes found in sensors. In powder injection moulding, a compound consisting of a powder and a binder is injected into a mould form. This produces a "green body" which is heat-treated by debinding and sintering to bring it into the final form. Dimensional accuracy is limited; it is impaired by the lack of mould constraint in the sintering process. Although this drawback can be minimised with geometrically homogeneous components, parts with large differences in wall thickness, which always occur with membrane components, present a more difficult challenge.

Then there is the difficulty of filling small cavities. This problem was the focus of the process development work. First of all, in cooperation with an industry partner, a demonstrator was defined based on real mass-produced components in the automotive industry. The geometry is traced by a very thin membrane applied to a ring-shaped base. In the design of a demonstrator like this, conflicting requirements such as wall thickness, uniformity of density and strength must be met. For this reason, modified moulding compounds are needed; supplementary simulation calculations were also used.

For the "process sequence" itself, the researchers used a tool that allows the injected compound

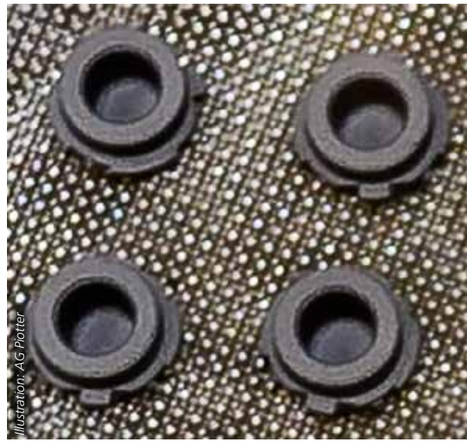


Illustration: AG Piotter

"Green bodies": components after injection moulding.

Illustration: AG Kraft

Barely there: electropolished specimens.

Illustration: AG Kraft

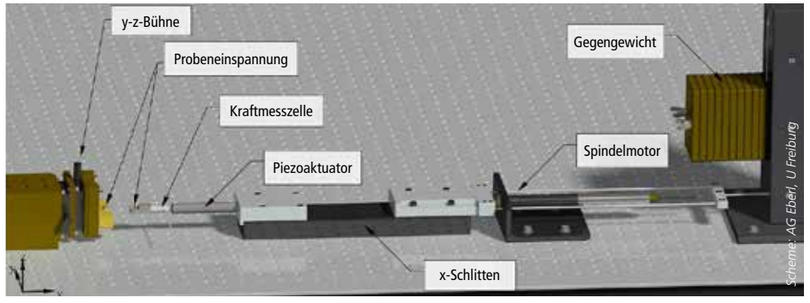
A specimen on a sensor: tensile specimen and component.

to be recompressed by two pressure pistons. By precisely adjusting the end positions of the pistons, a green body membrane can also be adjusted to a defined thickness. As extensive combinatorial test series have shown, the level of compression force and the size of the membrane gap before compression are the most important parameters. The two-stage forming process with injection and compression can create membrane thicknesses that were previously unachievable with micro-powder injection moulding alone. A minimum thickness of around 150 µm can be achieved compared with 400 µm prior to the new technique.

Ultimately, it is their mechanical properties that determine the use of injection-moulded components. It is in fact questionable whether a component produced on a powder basis has the same properties as a conventionally manufactured membrane. As well as strength, the other decisive factor is the fatigue properties. To put it a different way: Even the smallest pores in microcomponents could result in premature failure. The response to this involved methods and equipment developed in an independent junior research group. This group had produced a test concept that allowed a direct comparison of MIM (metal-filled moulding compounds) and conventionally produced microcomponents. The fundamental problem in the mechanical testing of microcomponents is the handling and mounting of the specimens, the precise application of elongation and its precise, contactless measurement. The last two are handled by using a small piezo actuator and digital image analysis. During the test, images of the specimen surface and the elongation were continuously recorded by an optical microscope and later evaluated.

Tensile tests revealed that the specimens manufactured with metal-filled compounds and then directly tested were far below the strength of conventionally manufactured components. This effect was reduced through heat treatment, which is also part of the conventional production process. The strength of the MIM-produced steel membranes achieves values of around 20 percent below the conventional components. Other tests confirm that the MIM components can achieve similar properties to conventional ones.

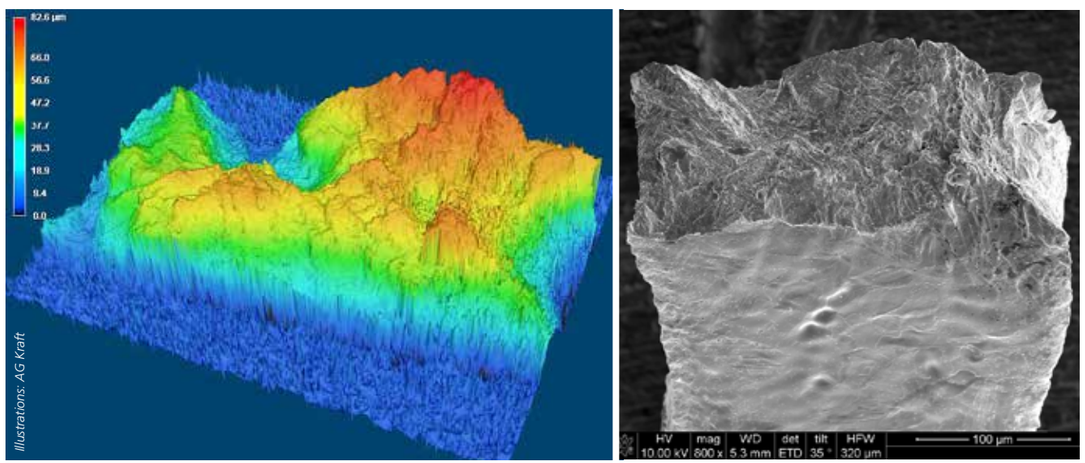
Illustration: AG Kraft



Scheme: AG Eberl, U Freiburg

Above: Surface of a tensile specimen. The highlighted areas are used during digital image correlation to track the deformation of the specimen. Below: Schematic design of a newly developed apparatus for tensile and fatigue tests on micro-specimens.

Impressive structures: microscopic evaluation of the broken tensile specimens through three-dimensional reconstruction with the laser microscope (left) and the scanning electron microscope (right).



Illustrations: AG Kraft

When we put all these pieces of the mosaic together, this is the complete picture we see: Networked basic research in microforming has further developed the process chain in many ways. We have gained fundamental insights into non-conventional production processes in microsystems engineering. And in the Transfer Unit of the Collaborative Research Centre, the team has demonstrated that these findings can quickly be put to practical use in industry. One special example of this is compression powder injection moulding, which requires significantly fewer process steps than conventional manufacturing. The process is an economically interesting alternative for the large-scale production of microcomponents that experience high load, offering the same quality standards. Now it's up to us to leverage this potential.

Dr.-Ing.Volker Piotter
was the principal investigator in the CRC and is now responsible for the work of the group "Material and Process Development, Process Technology" at KIT.

Prof. Dr. rer. nat. Christoph Eberl
led the CRC independent junior research group and is now head of the Chair of Micro and Materials Technology at the University of Freiburg and deputy director of the Fraunhofer Institute for Mechanics of Materials IWM in Freiburg.

Professor Dr. rer. nat. Oliver Kraft
holds the Chair of Applied Materials at KIT and was the spokesperson for the CRC; since 2016 he has been Vice President for Research at KIT.

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Jens Boy, Robert Mikutta and Georg Guggenberger

When the Land Turns Green

For millennia, warming and glacial retreat have been creating new land in Antarctica. A network of soil scientists, algae researchers and molecular geneticists is studying this process as it continues to be advanced by climate change. The process reveals how bare rock is transformed into fertile ground through the coevolution of plants and soil, providing a model for the whole Earth ecosystem.

Panoramic view of the east coast of the Fildes Peninsula across Fildes Bay. In front is Bellinghausen Station, a Russian research station, and behind this Profesor Julio Escudero Base operated by the Instituto Nacional Chileno.

Illustration: Boy

The South Shetland Islands, maritime Antarctica. For days the sea has been too rough to cross Fildes Bay and reach the areas at the edge of the Collins Glacier. A snowstorm also built up during the night, and yesterday's sample depot seems to have disappeared under a blanket of fresh snow. The ground is frozen hard: the last pits of the summer campaign will have to wait a little longer. There are easier ways of being a soil scientist – but few are more interesting than this. The harsh conditions of the Antarctic allow us to make a unique journey back in time to see what might have happened as plants started to conquer the land.

Here, on a corner of King George Island in maritime Antarctica, new land has been forming ever since the end of the last cold period around 7,000 years ago. This is the result of ongoing warming and the associated retreat of the glaciers. In recent times, this process has significantly accelerated due to climate change. The retreating glaciers leave behind ice-free areas which are older the further away they are from the current glacier edge. Along this imaginary line, known as a "chronosequence" – which in our case can be walked in three hours – the development of soil systems and ecosystems can be observed as if in slow motion. Neatly arranged by age, like beads on a string, the chronosequence unveils all the intermediate stages of the process. This makes it the ideal place to understand how a heap of stones is transformed into fertile ground.

In this marvellous transformation from something dead into something very much alive, a vital role is played by the organisms which have made this uninviting habitat their new home. This is because the key challenge facing these new settlers is the need to constantly adapt. To successfully achieve photosynthesis, they need water and nutrients. Some nutrients they can get easily from the atmosphere – mainly carbon, but also nitrogen in the case of microorganisms with the appropriate adaptation. However, most of the other nutrients they need are hidden in the rock, seemingly inaccessible.

Hard work in icy temperatures: Taking samples on the raised beach. In the background is Ardley Island, off the Fildes Peninsula.

Until recently it was believed that the pace of weathering was determined only by physical and chemical processes. The data now available indicates that, as the rule rather than the exception, weathering is actively influenced by organisms that perform photosynthesis. After all, an organism that can convert sunlight into sugar, changing the elusive energy of radiation into that of a chemical bond inside a molecule which can be stored, transported and converted into other substances, can certainly be expected to shape its habitat in the way it wants. And it does this quite simply, by releasing some of its sugar to other organisms which can weather the rock much better than it can itself: fungi and bacteria.

It's an efficient society based on division of labour on a tiny scale, powered by the sun and completed in darkness. It doesn't simply react to circumstances but constantly battles with them to rise to ever new heights and ultimately create something new. If this assumption is correct, then the first formation of soil on our planet could have happened much faster and more purposefully than has long been believed.

Above: Soil and plants in a sunken PVC ring. Below: The CO_2 gas flow from the micro-ecosystem is measured at various points in time. Many samples are taken directly from shoots or roots, but the CO_2 emitted by the soil must be measured using a more complex method. Below: Bivouac shelter on an ice-free spur of the Collins Glacier. The transparent measuring unit is also used for gas measurements. Bottom: Inside a laboratory in the Escudero base on King George Island, Antarctica.

Illustrations: Boy

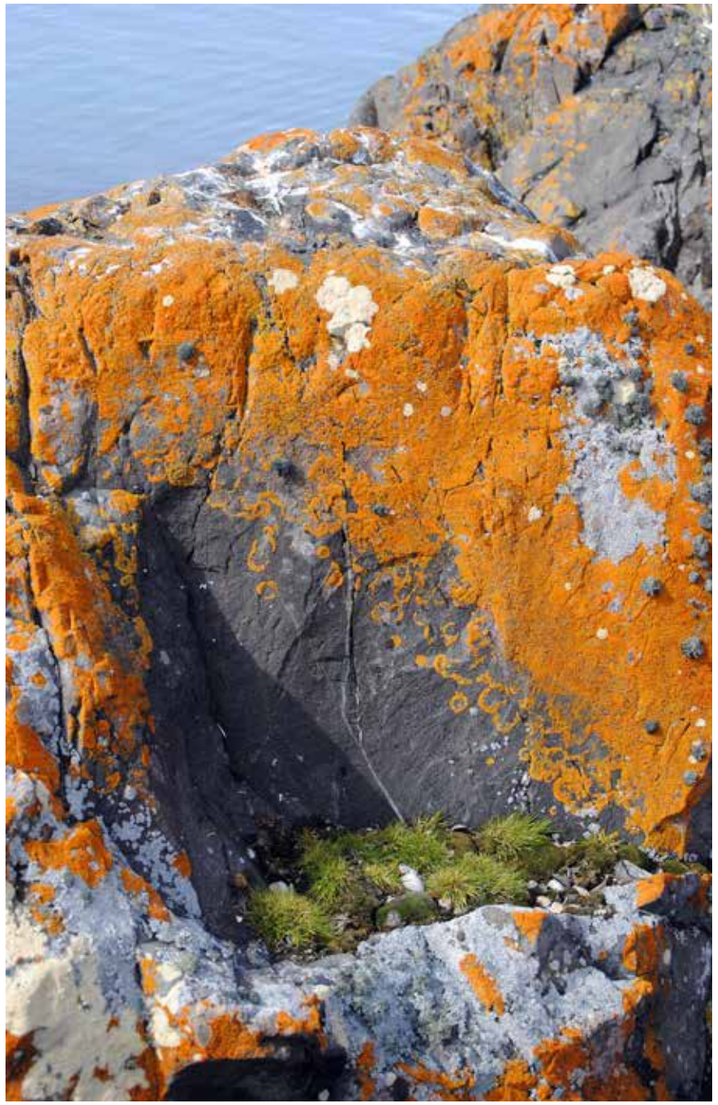
So the question being studied in Antarctica is whether this "co-evolution" between plant and soil exists and, if so, how it works. We also want to know as of what point in the development of an ecosystem such reorganisation measures start to happen in the soil habitat – and whether, as the research idea proposes, this reorganisation happens more efficiently the better networked the "sugar producers" are with the soil. These better networks could represent the increasingly complex symbioses that reach ever deeper into the soil – to the benefit of advantageously small communities.

Throughout the course of evolution, these have formed into many different algae, plants, fungi and bacteria and become established. It's a "sugar highway" in the soil which has been gradually expanded. The aim is to link ever more sophisticated and efficient producers with the organisms in an increasingly refined and direct way. In the process, the organisms supply the nutrients obtained from the minerals in a kind of fair exchange.

If that seems hard to comprehend, then perhaps it would help

if we imagined ourselves out in space. If there are green worlds somewhere "out there", the inevitable question is how the first habitats for life formed. The general assumption in astrobiology is that the basic process should be similar anywhere in the universe. Scientists use what are known as analogues, or comparable sets of conditions, to form a possible picture. Planet Antarctica.

Perennial grasses (Deschampsia antarctica) *in a site with a favourable microclimate. Only the droppings of skuas provide enough nutrients for survival.*



Carrying out analogue studies outside deserts, researchers are faced with a problem: organisms from nearby areas move into the "initial habitats" under investigation much too quickly, organisms that shouldn't be there at all if the system were being seen at the formation stage. In more temperate and less isolated regions such as areas of glacial retreat in the Alps, the first *Salix herbacea* and *Saxifragaceae* quickly move in. These are successful pioneer plants, but from a different period, being hundreds of millions of years younger. They represent what is currently the end point of development, not its beginnings.

This is the unique attraction of maritime Antarctica: the only higher plant species found here are Antarctic hair grass (*Deschampsia antarctica*) and Antarctic pearlwort (*Colobanthus quitensis*). Neither can survive long in this location without additional fertilisation by bird excrement, so they cannot spread beyond a narrow strip of coastline. So for many thousands of years, the (soil) succession in maritime Antarctica has had to make do with algae, cyanobacteria, lichens and mosses.

What has fieldwork in the South Shetland Islands and along the chronosequences revealed? What were the results of the studies in which organic settlers were "offered" selected minerals for weathering, metabolism was investigated using stable isotopes and the soils and organic legacies were analysed in detail?

Right at the beginning, nutrients from rocks are not important. Blue algae lay the foundations for ecosystem formation because they

Illustrations: Boy

Penguins on a so-called paleo beach. Their caustic droppings prevent much from growing – but there is still a thin film of algae, as seen in the foreground.

can bind atmospheric nitrogen, from which green algae can then increasingly benefit. It takes only a few decades for lichens to appear on exposed rock surfaces. Their interaction with the soil slowly increases the organic soil substance or "humus". This nutrient and food pool is increasingly taken advantage of by bacteria, which do not have any direct link to the primary producers and so still carry out their own weathering.

After around 4,000 years, the newly formed soil is capable of storing enough water and nutrients for the first lichens and mosses to appear, which penetrate into the soil and exhibit symbiosis. For the first time, a direct link is established in the soil between the sites of photosynthesis and weathering. Biologically driven weathering now starts to accelerate, though at a comparatively low level.

The manner in which the organic substance forms in the soil and how it is converted also changes radically. While organisms previously fed on litter alone, now more easily converted organic substances such as sugar and organic acids flow directly into the soil, where they cause long-term changes to the nature and properties of the organic soil substance. The end result is that the soil develops rapidly and the first biologically produced soil layers or "horizons" form, which is a main characteristic of well developed soils.

Finally, after 7,000 years, it's possible to hold in your hands soil that at first glance looks hardly any different from normal – and all without the assistance of higher plants! When we compare these end points of "self-powered" soil development with nearby areas grown with *Deschampsia* grass, which are externally supplied with nutrients from bird droppings, we can see that another tipping point in relation to weathering and substance flows has been passed. And the prognosis for the not-too-distant future? Once sufficient nutrients have accumulated in the ecosystem due to weathering by mosses and lichens, *Deschampsia* may be expected to gain a foothold outside the bird colonies as part of a natural colonisation process. Then we could see Antarctica turn green.

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Who are we? Where do we come from? These are some of the big questions which are posed over and over – and which continually prompt a bewildering array of answers. Researchers in Leipzig recently made headlines when they relocated the possible cradle of humanity from one end of Africa to the other. Could Morocco be the place of origin of *Homo sapiens*, rather than Ethiopia and South Africa? Or could it be all three? This issue of the DFG magazine also provides several perspectives on research in palaeoanthropology and archaeology and how it is communicated to a non-scientific audience. We profile Stefan Kröpelin, a Cologne-based Sahara researcher and the recipient of this year's Communicator Award, and pay a visit to the Neanderthal Museum to see an exhibition, based on the results of a DFG-funded Collaborative Research Centre, on "2 Million Years of Migration" – the second part of our series on "Migration and Refugees". Not featured in this issue, but on show in Berlin's WissenschaftsForum through mid-January 2018, is a photographic exhibition exploring the oldest traces of settlement in the Americas. The photographs by André Pessoa – a stunning example of which can be seen above – reveal the fascinating World Heritage Site of Serra da Capivara in Brazil.