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Cover: CRC 484 / Bernd Müller
Work on a computer-controlled, ultra-high vacuum chamber, in which laser pulses are used to stack ultra-thin layers of various materials on top of one another with maximum precision.



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Where Have All the Physician Scientists Gone

The number of young clinical investigators in Germany continues to decline. Only better training and career options can prevent lasting damage to our healthcare system. Medical schools and policy makers are called on to act now

Rumour has it that Germany is currently suffering from a shortage of doctors. Reports by the media and certain medical associations and health policy makers often point in this direction, but is there any truth to such claims? If, for example, we compare the number of general practitioners to the population, there is certainly no evidence of a shortage. If anything, we have a problem of uneven distribution – between individual regions, between urban and rural areas, and presumably also between the various fields of medical practice.

There is one field, however, in which the number of physicians in Germany is indeed decreasing: in clinical research, at that vital intersection of science and medicine. The dearth of physicians in this area is already acute, and it is becoming increasingly problematic.

This shortage has many faces. It is most keenly felt in the lack of young investigators. Clinical research depends on a constant supply of physician scientists. However, fewer and fewer medical trainees are opting for research. The number of funding proposals for clinical research projects is also steadily declining, and little is being seen or heard from this field at scientific conferences.

These problems are particularly apparent when it comes to medical theses. Students usually work on them during their regular studies at medical school. Systematic research training before, or parallel to, doctoral research happens only in the rarest of cases. A culture of structured doctoral training is all but non-existent at Germany's medical schools. As a result, many medical dissertations do not produce significant findings and end up not being published.

This situation is aggravated by the medical schools' increasingly one-sided curricular focus on the clinical training of future practitioners and by the new licensing regulations for physicians. These two factors have already led to a certain "de-professionalisation" and "de-academisation" of medical training. In the future, even fewer medical students are likely to pursue a doctorate, much less undertake scientifically ambitious – and therefore time-consuming – research projects.

And the problems persist even beyond the doctoral level. Many postdoctoral physicians engage in research during their advanced clinical training; this research is conducted in addition to their clinical duties, but is not rewarded with any type of structured qualification. In fact, many of those who gain such qualifications abroad face difficulties when they return to German hospitals. In addition, physicians wanting to specialise in a particular field are better off eschewing scientific research entirely. Such activities are not recognised as part of the advanced training required of specialists – a fact that is preposterous in every respect.

As early as 1999, the DFG brought attention to many of these sombre findings in its white paper "Clinical Research". Indeed, some things have changed for the better since then. But the root of the problem persists: young medical researchers still lack access to systematic, reliable and transparent training structures and early-stage counselling on potential career options and prospects in academic medicine.

The DFG Senate Commission on Clinical Research has, therefore, once again addressed this issue and



formulated far-reaching recommendations on how to structure the training of medical researchers. These recommendations begin with designing the curriculum and address all stages of medical training.

Talented students must be attracted to clinical research much earlier on. This requires allowing a great deal of latitude. Medical curricula must be (re)organised to ensure a basic level of scientific training that can also serve as the foundation of a high-quality doctoral thesis. Training should not be limited to the practical, "hands-on" aspects of medicine.

Qualified doctoral research work should be supported by doctoral training groups in order to ensure scientific training beyond the scope of the doctorate itself. This requires that doctoral researchers be excused from coursework for at least one semester and granted a research period of at least one year; they should be financially supported during this time because such a system will make an already lengthy education even longer.

Options for further scientific training for postdoctoral researchers must also be created. This requires structured programmes for sabbaticals and rotations. DFG funding, in particular, should also be used more intensively to this end. The same holds true for principal investigators' option to request DFG funding for their own temporary positions. Periods of disease- or patient-oriented research must finally be recognised as part of a specialist's training; residents should receive credit for at least one year of such research.

Finally, working conditions for young doctors at university hospitals should be made more family-friendly and accommodate different life plans. The medical profession, by definition, involves complicated, irregular work schedules that include night and weekend shifts as opposed to pre-planned overtime, and emergencies are a natural part of hospital life. It is, therefore, all the more important to improve the general research framework – including measures to promote gender equality according to DFG standards. Thus, clinical research will become more enjoyable and enrich the work of young physicians.

The DFG Senate Commission feels that the implementation of these recommendations is primarily the responsibility of the medical schools. They must assume institutional responsibility for their researchers. In doing so, they should be supported in every respect by the appropriate state ministries. The medical associations and other healthcare stakeholders can also do their part to improve conditions for early career investigators.

Swift action is needed. In the absence of it, clinical research in Germany will sooner or later run out of young physician scientists. This would cause lasting damage not only to medical research, but also to clinical practice and thus to patients.

Prof. Dr. Jürgen Schölmerich
is Vice President of the DFG.

Matthias Glaubrecht

Witnesses for Darwinian Theory

A visit to the freshwater snails of Sulawesi: the exotic gastropods in the tropical lakes of Southeast Asia provide fascinating insights into evolutionary pathways



The zoology of archipelagos would be well worth examining”, noted British naturalist Charles Darwin of his visit to the Galapagos Islands during his return journey in summer 1836 on the survey ship “Beagle”. Particularly because it was exactly in such a place that he observed natural phenomena that undermined the theory relating to the stability of species.

I often thought of Darwin’s prophetic remark during my own research trips through such an archipelago in Indonesia. Similar to the oceanic islands of the Galapagos, Hawaii or the Canaries, large freshwater lakes are a sort of evolutionary microcosm. In such insular habitats we can observe the biological processes associated with the emergence and adaptation of species bundled together as if they were under a microscope. The diversity of life – biodiversity – must thank its existence and abundance to this fundamental process, known as

“speciation”, which leads to the emergence of new species.

With their twofold isolation by land and sea, the lakes in the central highlands of the Indonesian island of Sulawesi are a true evolutionary workshop. These lakes, hundreds of meters deep in places, are a kind of natural laboratory in which we can watch nature at work. Sulawesi lies in the middle of the Indo-Malayan Archipelago, in a biogeographical region with a high diversity and disparity of species. The complex processes of plate tectonics have prepared a stage on which nature can showcase one of her evolutionary masterpieces: the perpetual interplay between genetic isolation and ecological adaptation.

The main focus of our research lies on *Tylomelania* – a genus of limnic, viviparous snails that are endemic to Sulawesi. Their shells can grow to several inches in length and more than an inch wide. Like their nearest relatives living all over Southeast

Asia east of India – in the Indonesian islands, the Philippines and even as far as the Torres Strait Islands north of Australia – *Tylomelania* lives in Sulawesi’s streams, rivers and, of course, in the large lakes of the central highlands. These lakes lie in a tectonic graben, a fault zone, which has shaped them (similar to the large lakes in the East African Rift Valley). Complex geological processes folded up the island’s highlands, and around two million years ago, the unique tropical lakes were formed, which is why these ancient lakes represent a sort of “lost world” – a Noah’s ark for species from another, earlier era.

For more than a decade, our research group at the Berlin Museum of Natural History has been studying these gastropods upon which geology has bestowed almost paradisiacal living conditions in ancient lake systems in East Africa and on Sulawesi. Like the limnic gastropods of Lakes Tanganyika, Malawi and Turkana in East Africa (which we are also studying as part of other DFG-funded projects), the previously neglected snails of Sulawesi are ideal models for research into evolutionary ecology for several reasons: on the one hand, we are continuously discovering new species and adaptations, whether during our dives in lakes or in rivers of the hitherto barely researched region; on the other hand, the snails exhibit morphological plasticity, an ecological diversity and adaptational flexibility. Using these snails as witnesses of evolution at work, we hope to find out why and how quickly new species emerge.

In many parts of the lakes, the fringe of green rainforest still extends to the water line and sometimes even further – the trunks and crowns of fallen trees offer the snails

new habitats. The different species of *Tylomelania* have strict divisions with respect to their habitats in and near the water. With some of them, we found the first evidence that individual snails are always found either on mud, on rocks or on submerged trees. We believe that the key to solving Darwin’s question on the origin of species could lie here.

Together with my former student and postdoc Thomas von Rintelen, we have so far been able to identify 44 different *Tylomelania* species on Sulawesi and to uncover their relationships to each other by means of molecular genetics. According to these results, more than 35 of these gastropod species live in the six highland lakes of Sulawesi. This means that more closely related species live adjacent to one another than in any other lake system on Earth – this is indeed a flock of species. There are still dozens of new and scientifically unidentified species to be found and described, including *Tylomelania bacara*, *Tylomelania helmuti* and *Tylomelania hannelorae*.

With the aid of a genetic family tree, we were able to show that there had been several colonisation waves within all riverine and lacustrine gastropods of Sulawesi. For example, an independent species flock was identified in Lake Poso, which has its own catchment basin and is completely isolated from the other lakes. In contrast, the three large

Flawless beauty of a shelled gastropod: a recently discovered, bright yellow Tylomelania species. Below: Some species prefer the leafy banks. Below: The thick ribbed shells protect the snails from their voracious enemies.

Diving for undiscovered species: the highland lakes on the Indonesian island of Sulawesi are true evolutionary workshops.



Illustration: Glaubrecht



Illustration: Lukhaup



Illustration: Glaubrecht



Illustration: Lukhaup



Left: Field researchers at work: snails of the *Tylomelania* genus are endemic to the island of Sulawesi, where they live in streams, rivers and mountain lakes. Below: The collected animals are exhaustively examined immediately after their arrival at the Berlin Museum of Natural History.

tion of species that proposes the use of “bar-coding” by comparing only mtDNA as a standard procedure. Although molecular genetics studies have become indispensable for our biosystematic and evolutionary biology research, the latest insights were obtained, in particular, from a systematic comparison of such procedures with morphological studies in the laboratory in conjunction with ecological observations in the field.

It was only after making sure that, during each lake dive, we collected the individual snails separately from the different substrates – mud, rocks, or fallen and submerged rainforest trees – and by examining their morphology

lakes in the Malili region – Lakes Matano, Mahalona and Towuti – were repeatedly and, at least three times, independently, colonised by *Tylomelania* ancestors that were originally riverine and which subsequently evolved into separate species in their new lake habitat.

Although the distinctive shell characteristics of the individual snails often allows their identification as independent species, we soon realised that differentiation using only external features was not always successful for this young species flock. In many cases, the populations in the various lacustrine habitats could not be unambiguously assigned to a particular species. After many investigations and comparison of all available data from the snails collected over many years at the site, we also recognised that the previously used sequence analysis using a fragment of DNA from the animal’s mitochondria (cell organelles), comprising almost 600 base pairs, did not provide reliable differentiation between the individual species.



Illustration: Glaubrecht

This finding, which is also reported using other organisms by an ever increasing number of research groups, is relevant not only to our own research in evolutionary biology. It also has implications for the currently popular taxonomy based solely on DNA, that is, identifica-

and molecular genetics, were we able to recognise a crucial relationship: the scanning electron microscope revealed subtle differences in the fine teeth on the “tongues”, or radulae, of the individual snails. The differences in the fine structure of these radulae are found not only between different species, but they are also related to the particular substrate colonised by the respective species. Surprisingly, these differences were also found within a species. For example, specimens of *Tylomelania zeamais* from Lake Matano and *Tylomelania sarasinorum* from Lake Towuti that live and feed on rocks exhibit significantly different radulae compared to those living preferentially on the wood of fallen and submerged trees.

Many dives coupled with laboratory investigations confirmed that the individual snails prefer a particular substrate from which they graze using their specially adapted radulae. Our molecular genetic studies, which also included DNA from the cell

nucleus, proved that these wood and rock inhabitants also differ genetically from one another within an individual species. Evidently, certain reproductive barriers may already develop between the various ecological trophic variants within a particular species.

The fact that the radulae differ according to the substrate indicates food-related differentiation. We therefore presume that ecology plays a key role in the origin of new species. If the individual snail populations specialise with respect to a rocky substrate, whereas others adapt to the wood of submerged trees, and they no longer mate with each other, then it is possible that they are able to evolve separately – even without spatial segregation into different lakes or lake sections. This would lead to the emergence of reproductively isolated daughter species. Thus a single species could give rise to two new species despite living in close proximity because they no longer share a habitat and the associated food supply. This ecological segregation would thus represent the start of the *Tylomelania* species flock.

If the emergence of new species does not require geo-

graphical barriers or long periods of time, and ecology is playing the decisive role instead, then these snails in the lacustrine laboratories of Sulawesi would point the way to a new evolutionary mechanism. Using this combination of field research with morphological and molecular genetics studies in the laboratory, we hope to solve part of Darwin’s question about the origin of species.



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Composition: von Rintelen

T. turiformis

T. matannensis

T. kristinae

T. confusa

T. dubiosa

T. wolterecki

T. marwotoi

T. twesseli

T. inconspicua

1 cm

M. Vetter, C. Thomssen, N. Harbeck and F. Jänicke

With or Without Chemotherapy?

For over two decades, clinical researchers have been studying the invasion markers uPA and PAI-1 in women suffering from breast cancer. The long-term studies enable them to perform more accurate risk assessment and give more individual care to the patients



Illustration: Universitätsklinik Halle a. d. Saale / Gandhya

Each year, about 58,000 women are diagnosed with breast cancer in Germany. The diagnosis of a mammary carcinoma is a major blow in the life of many patients. The message of hope for those affected and their relatives is that, in most cases, it is now possible to heal breast cancer. However, this depends on the

tumour being diagnosed early and treated by consistent adjuvant medication such as chemotherapy or anti-hormone and antibody therapy to prevent the growth and spread of metastases in the body.

In the light of this, many patients run the risk of overtreatment. One of the most important objectives of

modern-day breast cancer treatment is therefore to tailor the type and extent of treatment to the individual patient. The way to individualised cancer treatment makes it necessary to improve risk assessment of the expected course of the disease for each patient. For this reason, clinical researchers have been seeking to de-

velop new and additional biomarkers that will give clinicians and patients more information on the biology and aggressiveness of the individual tumour for many years.

The course of the disease is determined by the tumour's ability to start cell invasion and thus metastasis. Adjuvant chemotherapy after surgery aims to destroy tumour cells in the patient's body at an early stage and thus prevent a relapse either in the breast or in any other organ.

For breast cancer patients whose lymph nodes under the armpits have already been invaded by cancer cells, the risk of the cancer cells spreading throughout the body is very high. These patients generally receive adjuvant treatment. Now doctors are of the opinion that patients whose lymph nodes under the armpits are free of cancer cells (lymph node-negative) would also benefit from adjuvant treatment. However, due to a lack of factors for predicting the individual risk of relapse accurately, as many as 80 percent of the node-negative patients receive chemotherapy although they take no advantage of this therapy, they are overtreated. The decision on how to treat the node-negative patients is thus very unsatisfactory and additional information on the aggressiveness of the individual tumour is needed. Obviously, the aim is to be able to identify those patients with a high risk of relapse and those with a low risk of relapse. The reason for this is that high-risk patients would benefit from chemotherapy, whereas low-risk patients could be spared the rigours of chemotherapy.

As long ago as the 1990s, the data available from various research labs and hospitals already suggested that the proteins known as uPA and

PAI-1 could indicate how aggressive the breast cancer is. The protease uPA and its inhibitor PAI-1 (plasminogen activator inhibitor type 1) are involved in a number of biological processes, including cellular invasion, cell migration and vessel formation in the tumour. When cancer cells invade in the body, individual cells break away from the group of cells that make up the tumour, multiply and proceed to invade the surrounding tissue, including the vascular systems. This explains the raised concentration of the proteins uPA and/or PAI-1 in the tumour tissue.

Professor Fritz Jänicke conducted the first clinical study based on the uPA/PAI-1 values in the tumours of breast cancer patients at the gynaecological department of the University Hospital of the Technical University of Munich between 1987 and 1991. Raised levels of the invasion markers uPA and/or PAI-1 were found to correlate with an aggressive course of the disease. More than half of the lymph node-negative patients had lower uPA and PAI-1 concentrations in the tumour and displayed a milder course of the disease, even without medication. There were also similar findings for other types of tumour.

On the basis of these findings, a Clinical Research Unit under the guidance of Prof. Manfred Schmitt, named "Tissue-associated proteases and their receptors and inhibitors in malignant tumours and gestational diseases" was funded by the DFG. This Clinical Research Unit initiated the "Chemo-N0" study. The main aim of this multi-centre clinical study was to confirm the prognostic significance and reliability of uPA/PAI-1 found in the pilot study in field tests and, at the same



Illustration: Universitätsklinik Halle a. d. Saale / Brandt

Left: Senior consultant Christoph Thomssen deep in conversation with a patient receiving chemotherapy. Above: A mammogram of a breast. A sample needs to be taken from the dense areas of tissue. Below: A micrograph of a malignant mammary carcinoma.



Illustration: Universitätsklinik Halle a. d. Saale / Holhausen

Invasives Mammakarzinom
1. Ductus mit Tumorzellen
2. Tumorzellennester

time, to determine whether chemotherapy is able to improve the prognosis for patients with a high risk of relapse.

Between 1993 and 1998, 647 breast cancer patients were recruited at eleven centres in Germany and one centre in Ljubljana, Slovenia. Of these 647, 283 had a tumour with uPA and PAI-1 levels below the cut-off values and did not receive chemotherapy. At the time, it was still standard procedure not to offer lymph node-negative patients adjuvant treatment, although more widespread use of various forms of treatment was already under discussion.

364 of the 647 patients had a tumour with uPA and PAI-1 levels above the cut-off values. These women, who were suspected of having a higher risk of relapse due to the uPA and/or PAI-1 level, were randomised and either received chemotherapy or no further treatment as part of the study. Of course, participation in the study was voluntary.

At the American Society of Clinical Oncology (ASCO) 2009 meeting, in Orlando, Florida, Professor Nadia Harbeck from the University of Cologne spoke on behalf of the group that was conducting the Chemo-NO study and presented the data collected on the course of the disease in the patients following ten years of follow-up observation. Even after this length of time, it has been confirmed that those patients who had uPA and PAI-1 levels below the cut-off had a relatively low recurrence risk (risk of a relapse) of less than ten percent in ten years. Those patients who had levels above the cut-off, on the other hand, had a high recurrence risk. In addition to this, the data from the study also showed that the risk of a relapse is halved in

(1) Breast tumour tissue samples about to be examined for the prognostic markers. (2) The samples are cooled with liquid nitrogen and crushed. (3) The proteins from the samples are dissolved in an aqueous solution, which is then (4) mixed using a shaker. (5) During processing, the samples need to be kept cold. (6) The concentration of each protein is determined using a microtitre plate assay.

high-risk patients if they are given chemotherapy.

The evaluations performed by the Chemo-NO study three and five years after completion had also already indicated that measurement of the uPA and PAI-1 levels allows reliable risk assessment. To demonstrate the power of these prognostic factors, a second large-scale clinical study, the NNBC-3 Europe study (node negative breast cancer), was launched in Germany and France in late 2002. This study included 4150 patients at various clinical sites. The good news is that, even at this stage, it is already possible to say that the risk assessment based upon measurement of the uPA/PAI-1 levels has allowed about 40 percent of the patients to be spared chemotherapy.

In order to be able to assess the clinical relevance and quality of prognostic markers the standards are very demanding. After the Chemo-NO study, as a prospective clinical study, had already shown the prognostic importance after five years, the evaluation of a meta-analysis of various retrospective studies covering over 8000 patients in 2002 provided an impressive demonstration of the prognostic significance of the invasion markers uPA and PAI-1.

In response to this, various national and international bodies have adopted these research findings in their recommendations for the treat-



ment of breast cancer (in lymph node-negative patients) as part of routine clinical care since 2002. The Working Group on Gynecological Oncology's breast cancer group (Arbeitsgemeinschaft für Gynäkologische Onkologie, Kommission Mamma) has also based its evaluations on the benchmark Oxford classification system for clinical target criteria for the significance of the prognostic markers uPA/PAI-1 at the highest level since 2002.

Since 2008 the prognostic markers have also been incorporated in the interdisciplinary guidelines published by the German Cancer Society (Deutsche Krebsgesellschaft; www.ago-online.de, www.krebsgesellschaft.de). Their inclusion in the European recommendations in 2005 and in the international recommendations in 2007 (jco.ascopubs.org/cgi/content/full/25/33/5287) underlines their international importance too.

The invasion markers uPA and PAI-1 can now be measured in 14 labs in Germany. To perform the analysis, a representative sample of tumour tissue (100–300 milligrams fresh tissue) is taken from a surgical specimen or fresh tissue from three punch biopsies from the primary tumour in the breast, flash frozen and sent to the lab packed in dry ice. The tissue is crushed while still in its frozen state, the uPA and PAI-1 proteins dissolved and the concentrations of uPA and PAI-1 determined by immunological assay using the ELISA test. About a week after the operation, the clinicians receive the results, which they then discuss with gynaecologists, radiologists and pathologists.

Because a fresh tissue sample from the tumour is needed to determine the uPA and PAI-1 levels, before the operation the gynaecolo-

gist should discuss with colleagues and the patient whether the uPA/PAI-1 test is considered. The results of the test primarily affect the patients with an intermediate risk of recurrence so-called G2 tumours. If the result of the test is below the cut-off values then it is not necessary to give chemotherapy. And, vice versa, if the patients find that chemotherapy is to form an important part of their treatment due to a high uPA and/or PAI-1 level, then they can at least cope better with the unpleasant side effects (such as nausea and hair loss).



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www.jco.asco
www.jco.org (as the ASCO homepage)

Thomas Schneider von Deimling and Stefan Rahmstorf

Reading the Weather

Learning from climate history: Temperature fluctuations and greenhouse-gas concentrations have been recorded for centuries. Researchers in Potsdam are using measurements from the past to optimise future scenarios for global warming



In 1957, American chemist Charles David Keeling made an alarming discovery on volcano Mauna Loa in Hawaii, where he observed the world's first continuous measurement of carbon dioxide. Even then, the measurement series, now known as the Keeling curve, revealed a constant increase in the greenhouse gas in the atmosphere. As a result of the continued burning of fossil energy sources and the increased release of CO₂, we now measure concentrations of this greenhouse gas far above the values from the past millions of years of climate history.

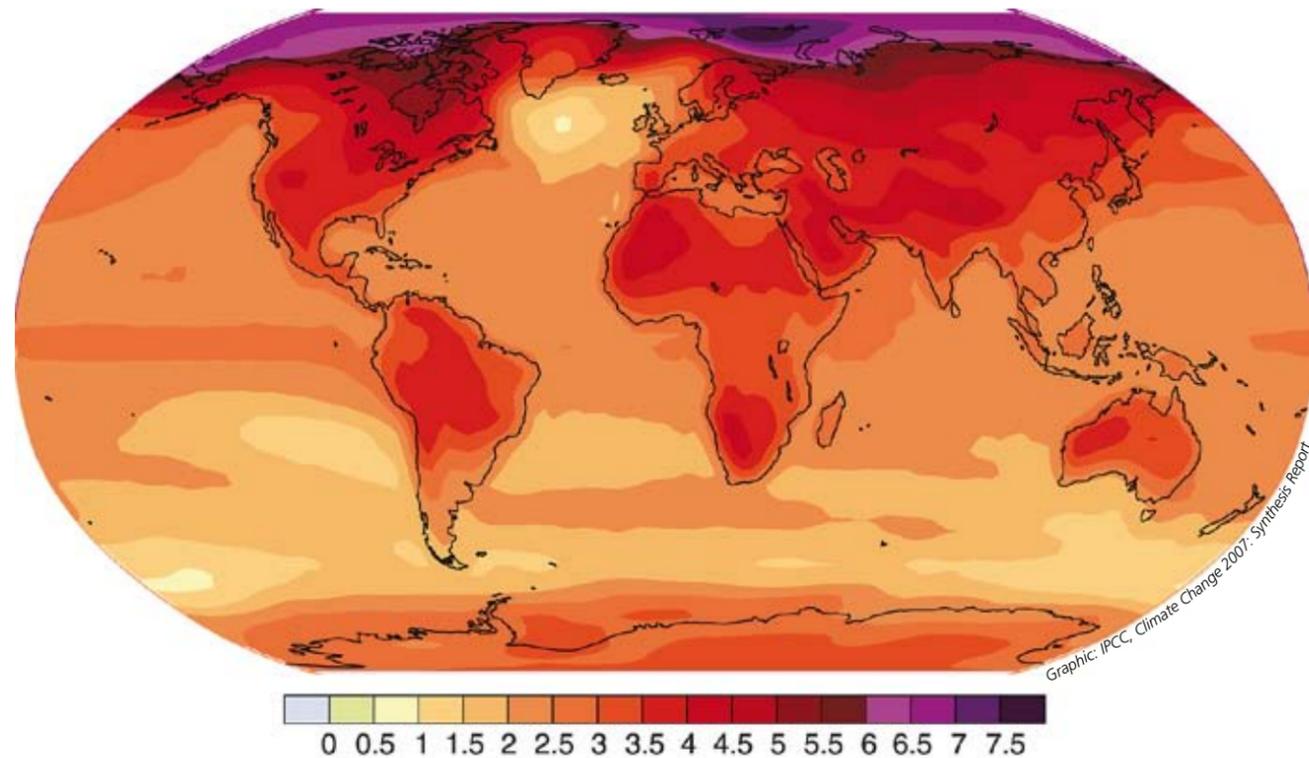
Repeated measurements of air composition prove that this increase is caused by humans and their technical civilisation. Approximately half of the emitted CO₂ remains in the atmosphere, while the other half is absorbed by the oceans and the biosphere. After analysing his data, it was clear to Keeling that this release

of greenhouse gases would result in a warming of the earth. But how extreme will this be? And what level of global warming is to be expected for a given increase in the concentration of carbon dioxide in the atmosphere?

To answer this question, the Swedish physicist, chemist and later Nobel Prize winner Svante Arrhenius performed a thought experiment in 1896. He calculated the global warming that would result from a doubling of the atmospheric CO₂ concentration. His finding: 4 to 6 degrees Celsius. In the year 2009, this question is more relevant than ever. If the combustion of fossil energy sources, such as oil, natural gas and coal, continues at the present rate, the concentration of atmospheric carbon dioxide can be expected to double by the middle of the 21st century, as compared to the value of the last 10,000 years. During this – geologically speaking – recent time, the global average temperature

was nearly unchanged, and the atmospheric CO₂ concentration levelled off at a value of 280 ppm (parts per million).

The temperature increase expected by the year 2050 will, however, be characterised by other climate-changing gases and particles (such as methane and sulphur aerosols), in addition to the CO₂ concentration. Various model studies have shown that the understanding of changes in CO₂ concentration in the climate system can also be applied to other climate-influencing variables. Thus, the temperature increase calculated years ago by Arrhenius has become a key parameter in climate research – the so-called “climate sensitivity”. It indicates how sensitively the climate system reacts to a disturbance in its energy balance. The more precisely this value can be specified, the more exact the model projections will be.



Left: Projected temperature changes on the globe through the end of the 21st century. The greatest warming is expected in the Arctic region. Right: Parched soil. In some regions, changes in the global water cycle mean drought.

Since the time of Arrhenius, numerous studies have attempted to determine this value. In its last status report, dated 2007, the Intergovernmental Panel on Climate Change (IPCC) estimated the uncertainty of climate sensitivity at 2.0 to 4.5 degrees Celsius. It was possible for the IPCC to reduce this range somewhat in their fourth status report, after remaining nearly unchanged for the last 30 years at 1.5 to 4.5 degrees Celsius. Even though this reduction in uncertainty appears small, the range can be stated with much greater confidence today than was possible just a few years ago. Furthermore, climate model studies have helped us to understand which processes in the climate system complicate a more-exact estimate of the climate sensitivity.

Hindsight provides a helpful perspective with respect to climate sensitivity as well: In the year 1824, the French mathematician and physicist Jean-Baptiste Fourier wrote on the warming effects of atmospheric trace gases. This view was subsequently confirmed in numerous laboratory experiments. Climate models can accurately calculate the effect: A doubling of the CO₂ concentration in the air will result in a direct warming of 1.2 degrees Celsius on account of the increased atmospheric absorption of thermal radiation, i.e., due to a stronger greenhouse effect. Various climate models provide a conclusive assessment. The direct warming describes only part of the expected tem-



perature increase, however. Feedback mechanisms, which could dampen or amplify an increase in temperature (once started), also become apparent in the climate system.

And this is precisely where the uncertainties with respect to the actual magnitude of climate sensitivity come into play. The real challenge for the climate models lies in the realistic description of these feedback mechanisms. For example, a warmer atmosphere can hold more water vapour, which, like CO₂, acts as a greenhouse gas and results in further warming. This effect is referred to as a positive, i.e., amplifying, feedback.

The extent of snow and ice cover, on the other hand, has a lasting effect on the portion of sunlight that is reflected back into space. A drop in snow and ice cover caused by rising temperatures also acts as positive feedback. The decisive uncertainty lies with the behaviour of clouds: How do they respond to a warming planet, and how do they affect subsequent climate development? Does their cooling or their warming in-

fluence prevail on the climate? This is where the greatest differences are seen in the models.

Climate researchers have, particularly in recent years, made intense efforts to more accurately determine the sensitivity of the climate system to changes in the concentration of greenhouse gases. Through advances in computing power, it has become possible to run large sets of various climate model versions (up to several thousand simulations per model). This process involves systematically changing the still-uncertain parameter values for a given climate model (e.g., the parameters used in calculating the optical properties of clouds).

In this way, a large number of different model versions with varying sensitivity are generated – for example, some models in which the clouds respond strongly to a change in global temperature and have a large climate sensitivity value, but also models with a considerably smaller sensitivity, with which clouds exhibit relatively small changes.



An ice core being studied by a researcher as a climate archive – the clues from the past can go back as far as several hundred thousand years.

The key question remains: which of these models is best suited for explaining temperature history? A look back into the thousands of years of the earth's history is revealing. A range of different climate archives now facilitate the reconstruction of past climate changes.

For example, ice cores from the Antarctic can be used to decipher climatic development from the past 700,000 years. The data contained in the ice cores provide information on the previous composition of the atmosphere, as well as the temperatures in the Antarctic at that time. A recurring sequence of warm and cold cycles, caused by the known cycles of the earth's orbit, is apparent as a characteristic pattern. Climate researchers have also determined that, during the coldest phases of the ice ages, the temperature in the Antarctic was approximately 10 degrees Celsius below the current value; at the same time, the prevailing CO₂ concentrations were considerably lower.

Thus, knowledge of the climatic past offers a promising opportunity to test the quality of climate models: By performing the same ice-age simulation experiments with different versions of a model, it is possible to examine how the individual models react differently to the low glacial CO₂ concentrations. The various, simulated ice-age cooling events (which take into account other influencing factors, such as the expansion of inland ice masses) can then be compared with observational data from the climate history.

As a result, it is possible to distinguish between realistic and unrealistic model versions: a model that reacts too sensitively to changes in the CO₂ concentration simulates an ice-age climate that is too cold, and a model with insufficient sensitivity simulates an ice age that is too warm. In this way, it was possible, for example, to confirm the estimate made by the IPCC (2.0 to 4.5 degrees Cel-

sus for the climate sensitivity value). Considering the climate sensitivity, a value of approximately 3 degrees Celsius appears to be most probable. Is the climate sensitivity calculated from the considerably colder climatic past a good measure for future warming? It is conceivable that clouds may exhibit a different behaviour in a cooling climate than they do in a warming climate. Such differences can be represented in models and are a relevant topic in climate research. It would be extremely interesting to look back further into the earth's history – to times at which there were considerably warmer temperatures and higher CO₂ concentrations. It would then be possible to study how strongly the temperature responded to higher greenhouse-gas concentrations.

Unfortunately, these times lie in the very distant past (many millions of years ago), making the level of uncertainty in the data very high and, up to now, a precise determination of the climate sensitivity impossible. Our current knowledge of the sensitivity of the climate system – namely, the description of physical processes in climate models – does, however, provide indication of the range of the expected global warming with high probability. Now, it is a matter of further reducing this range.



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Jens Jäger



Of Pickelhauben and Pistols

The police in the public eye: The state's first line of defence is the public's perception of the police, not the actual police force itself

His wrath is easily roused, and he sets great store by his uniform and the authority invested in him by the state. Constable Dimpfelmoser, one of the most well-known figures from Otfried Preußler's best-selling children's book "The Robber Hotzenplotz", is hardly a likeable character. In the book illustrations and the legendary performances of the Augsburger Puppenkiste (a German marionette theatre), Dimpfelmoser is readily identifiable as an imperial era German police constable. In keeping with this role, he is depicted wearing a uniform and Pickelhaube (spiked helmet), and sporting a meticulously groomed handlebar moustache. Dimpfelmoser epitomises the role of the police officer, and its powers and

responsibilities; only he has the authority to arrest, imprison, and bring villains to justice. And on top of this, Dimpfelmoser is the sole mediating instance between the town mayor and the populace.

In the hugely popular Hotzenplotz books, Dimpfelmoser represents nothing less than the authority of the state in everyday life. Dimpfelmoser's actions seem so "normal" that they barely register as particularly noteworthy. And this reflects, by and large, our own experiences. But a closer look reveals that his public image is anything but a matter of course; the history of this image speaks volumes about the police as an institution and, more significantly, about the fundamental relationship between

the state and the public. Examining this history opens a pathway to an exploration of the practice of governance in the modern era.

State formations did not begin to employ "modern" police forces until the 19th century. With their introduction the state established a new presence in everyday life. Unlike the military, the police maintained a permanent, uniformed presence on urban streets and could be called upon by ordinary citizens. The newly-established police forces took an active role in public life through patrols, inspections, observation measures, and other interventions. Since the 19th century, the public's interactions with the state and its claim to the monopoly on the legitimate use of force

have largely comprised of interactions with police forces. The public engaged with the police through conversations with local constables, at traffic checkpoints, when reporting crimes, in the course of criminal investigations, or when notifying the police of missing property or persons. But interactions between the public and the police could equally entail violent altercations, as seen during strikes, civil unrest, and riots. In all of these various encounters, citizens experienced the “state” and the authority of the state through their interactions with police officers.

The authorities began to shape these relationships at an early stage. In their most general form these efforts were initially directed towards the officers’ visual appearance. Later, the authorities began to focus increasingly on the individual officer’s communication skills and the image of the police force conveyed in the media. In the final third of the 19th century, press offices were established in the police headquarters of larger cities, which were dedicated to managing this image. This develop-

ment marks the birth of police public and media relations.

What were its aims and what did it achieve? To answer these questions we must examine a number of underlying trends and lines of inquiry. How successful were the police public relations efforts? How did the communicative aims of these activities interact with the unintended effects which characterise the use of images – an often ambivalent medium – in media practice?

And finally: what was presented as the main activity of the police force in these images and public relations efforts? The unflinching interest of both the public and the media in crime and criminality plays an important role in this phenomenon. Demand for information on these topics enabled the authorities to present the state’s criminal investigation agencies in a favourable light, with arrests and manhunts evoking the image of an active and largely successful institution. This underlying positive image by no means precluded “negative” reporting, but it did create a counterbalance. In other words: textual and visual representations of the police formed a counter-

model to the circulating images of “the criminal”. These images, whatever their origins, adhered to representational conventions that have remained in effect until today. One effect of this is the tendency to equate policing with the act of tracking down individual criminals. The manhunt is, of course, just one of the numerous responsibilities of a police force, and yet it is this image which has burnt itself into our minds.

This phenomenon is documented in a range of sources, including newspapers, illustrated and satirical magazines, and popular representations of the police. Interestingly, it was the police and their endeavours in the field of public relations that provided the material for many of these representations. Other important sources include crime novels, murder mystery plays and films, and last but not least, children’s fiction and comics. These various materials combine to produce a particular image of the police and their practices, shaping the public’s attitudes and behaviour towards the police, and creating expectations, which play a significant role in interactions between the individual and the institution.

Historical studies conducted to date have focussed primarily on the image of the criminal. But to complete the picture we must turn our attention towards the image of the law enforcer himself. The police, incidentally, are already present in images of criminals, to the extent that these images are produced and provided to the media by the respective police records department. Such

Crime-busting silhouettes: Cries of “the police are coming” send children scuttling. Postcard, 1921.



Illustration: Universität Hildesheim / Institut für Angewandte Erziehungswissenschaft und Allgemeine Didaktik

Right: London’s Bobbies – depicted here on a postcard from 1913 – provided the template for community-oriented policing. Centre: “Chivalrous” German police officers in the public eye (photo from 1930). Below: Mobility and readiness were the watchwords in Germany after 1945. The German highway patrol parading their fleet of Porsche patrol vehicles before French guests in 1959.

material highlights the interdependent relationship between our images of “the criminal” and “the police”.

The diverse range of available material demands an interdisciplinary approach which combines historical, sociological, politological and media analytical methods with the insights of political iconography and visual studies. The complex interaction of images across borders calls for a transnational perspective to this subject. The image of the English constable, or “Bobby”, for instance, provided the template for those continental law enforcement agencies which pursued the vision of democratic and community-oriented approaches to policing. But even this image was, to a certain degree, shaped and put into circulation by the English police authorities. One example of this interaction is the fusion of both the public and the self image of the English police force in the conception of the Prussian police force of the Weimar Republic. This pattern is repeated in the efforts of the Allied occupation forces to re-establish the police force in West Germany after 1945. Similarly, during the imperial era the authorities considered using “charm offensives” to improve public relations and to brand police officers as social partners rather than watchdogs.

The idea that the police constitute the state’s first line of defence against



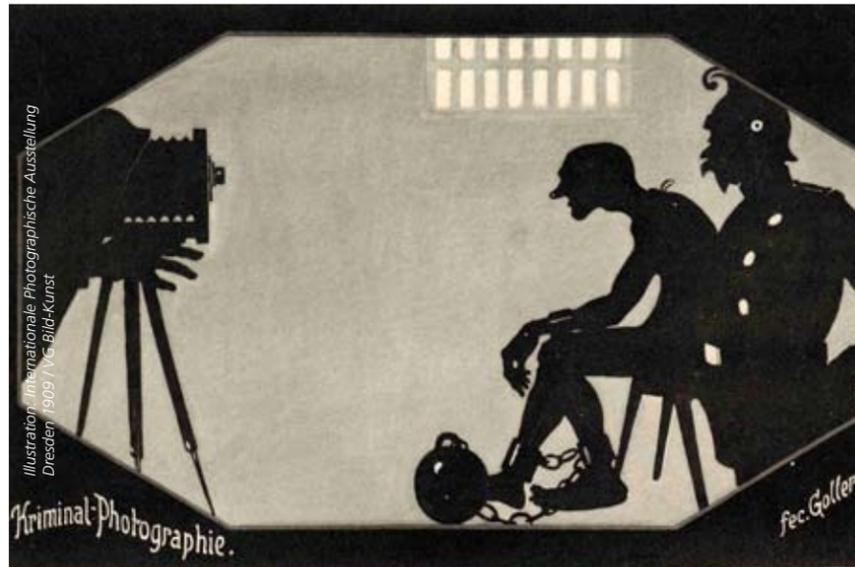
046.K. THE LONDON POLICE COMMAND WELL MERITED ADMIRATION FOR THE WONDERFUL MANNER IN WHICH THEY DIRECT AND CONTROL THE CEASELESS FLOW OF VEHICULAR TRAFFIC PASSING THROUGH THE CITY. BEADLES POSTCARDS. Illustration: Archive



Illustration: Polizeihistorische Sammlung, Berlin



Illustration: Bundesarchiv, Bild 145_F00698-0004 / Egon Steiner



A stooped prisoner has his photograph taken under the watchful eyes of a police officer of the German Empire. This motif from 1909 is an example of early “crime photography”.

the opponents of public order needs to be amended: the state’s first line of defence is the “image” of the police, not the police force itself. Roughly speaking, a positive image facilitates cooperation and stabilises the public’s confidence in the state and its organs. While a more negative image complicates relations between the public and the state – and the image of the police conveyed by the media plays a crucial role in this relationship.

At first glance this hardly seems a particularly original insight. And yet several decades passed before police forces and their governing bodies began to consciously shape their public “image”. The Prussian police force of the Weimar Republic provides an excellent case in point: the campaign initiated by the head of the police department in the Ministry of Internal Affairs, Dr. Wilhelm Abegg, sought to create an image which clearly distinguished the new Prussian police officers from their imperial era predecessors. The new

officer was to be a representative of the democratic order; a role which demanded a more amiable manner and the lowering of communication barriers. In spite of these changes, the new police officer was also expected to be readily identifiable as a figure of respect and a representative of the state.

The creation of the new police force in Prussia led to a new motif in police caricatures. While earlier depictions of the police in satirical magazines such as “Simplicissimus” and “Kladderadatsch” had featured rotund and dull-witted figures, in the 1920s the police were portrayed as younger and “snappier”, but no less critically for that. This trend was also evident outside of Germany; comics, such as “Tintin au pays des Sowjets” (1929/30) by Hergé (Georges Prosper Remi), adopted the slimmer fashion of the new force while retaining the mannerisms and harsh tone of the imperial era images. The inherent tension between these two elements proved to be a goldmine for satirists.

All this brings us back to Officer Dimpfelmoser in Preußler’s “The Robber Hotzenplotz”. The image of the police evoked in Preußler’s works is hardly flattering, and no doubt differs starkly from that of contemporary readers. Dimpfelmoser embodies the negative image of the imperial era police officer; a figure which draws heavily on the traditions of Kasperle puppet theatre. Despite these artistic embellishments, however, the mannerisms and actions of police officers in this and other works underscore their importance as representatives of the state.

Ultimately, it is the image of “the police” which defines the interactions of the citizenry and the powers of the state, just as it reflects a society’s expectations vis-à-vis its law enforcers. These historical representations, images, and attributes cast a shadow which extends far beyond their real existence and impacts on contemporary society. The reconstruction and interpretation of these often complex phenomena has much to contribute to our understanding of our past and present.



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For information on the work of the Arbeitskreis Historische Bildforschung:
www1.uni-hamburg.de/Bildforschung

Hans-Dieter Bienert

Treasure Chamber Number Two

Gold mine for archaeologists: Seven years after their first coup a team of researchers discovers another untouched burial complex in the royal palace at Qatna

The air is humid and musty. The interior of a rock tomb consisting of two chambers is revealed through a low opening. In the light of two small floodlights it almost has the appearance of an operating theatre. The scientists work in stooped positions, wear protective masks and hold in their hands operating instruments, used to carefully reveal the numerous burial offerings and bones in the burial chamber. Each individual object must be precisely documented. “We

did not expect a yield on this scale”, the Tübingen archaeologist Professor Peter Pfälzner emphasises, overjoyed during a site visit. He has been working at the royal palace at Qatna with Syrian and Italian colleagues since 1999. It was once the capital of a kingdom that controlled the central and southern regions of today’s Syria between 1800 and 1600 BC.

In 2002 researchers caused an archaeological sensation (see forschung 1/2004) when the inter-

national team discovered the first untouched royal tomb below the palace complex.

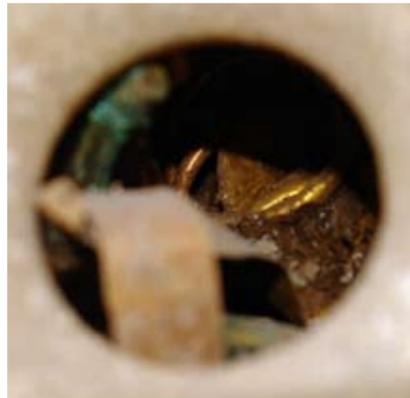
When the archaeologists discovered the entrance to this second tomb in one of the palace’s excavated

View of the north-west wing of the former royal palace of Qatna. During the 2009 digging campaign archaeologists uncovered the entrance to a perfectly preserved burial complex.





Finds from the newly discovered tomb in Qatna. Left: a glazed receptacle for makeup from Egypt dated approximately 1800 to 1600 BC. Adjacent: view into a calcite-alabaster vessel filled with gold jewellery. Right: a monkey sitting upright, clutching a makeup pot.



Illustrations: Bienert

cellar rooms during this year's field campaign, they were very surprised. It meant rescheduling in order to quickly and professionally document the new finds. Two anthropologists from the University of Hildesheim in Germany were quickly flown in and assisted in recovering the human bones, which covered almost the entire floor of the tomb. Initial analyses indicate that they belong to 50 to 60 individuals. The local dig leader, Heike Dohmann-Pfälzner, believes that the dead here have been subject to "secondary" burial to make room somewhere else: "More detailed information, including on possible family relationships among the dead," says Dohmann-Pfälzner, "will only be forthcoming following the impending anthropological investigations."

Sweaty work: the archaeologists work more than 14 hours a day in the tomb, although the musty, hot-humid climate inside the ap-

proximately 30 square metre burial complex forces them to work in shifts. They nevertheless all work with great dedication and full concentration. "We have a highly motivated international team here", Pfälzner praises her 50 colleagues. The scientists uncover new finds on an almost hourly basis.

The burial offerings demonstrate that Qatna was an important trading centre – with long-ranging contact to Egypt, Mesopotamia and the Baltic region. Ceramic and stoneware pots, small pieces of jewellery, Egyptian scarabs and Mesopotamian cylinder seals form just part of the remarkable repertoire of objects. An alabaster vessel was even discovered still filled with jewellery. "A lot of time will be needed to evaluate the enormous information potential offered by these finds", underlines Heike Dohmann-Pfälzner.

Because the work of the Tübingen scientists has been funded in a long-term project since 2006, the possibility of funding by the DFG exists until 2018. It will take this long to archaeologically investigate the 18,000 square metre palace complex alone, where three storeys are still preserved in some places, in the approximately 100 hectare ancient city. It was destroyed around 1340 BC in an attack by the Hittites.

But it was precisely this warring demise that also provided some ideal preservation conditions over the centuries. The Pfälzners are sure that the soil of Qatna will reveal more archaeological surprises in the years to come. In the coming year a dig house must be built with the support of the Syrian partners of the antiquities service and the Tübingen University – this will pave the way logistically for the work needed in the coming years.

The exhibition "Treasures of Ancient Syria – The Discovery of the Kingdom of Qatna", in the Württembergischen Landesmuseum in Stuttgart, Germany, gave an excellent and multi-faceted insight into the research results to date. The German exhibition book "Schätze des alten Syrien" was published in 2009 by Konrad Theiss Verlag, Stuttgart.



Dr. Hans-Dieter Bienert is a programme director in the DFG's Humanities and Social Sciences Division.

www.landesmuseum-stuttgart.de/qatna

Walter Michaeli and Thomas Kamps

Tiniest Parts, Greatest Benefit

Microsystem technology: How engineers are seeking new ways of making components

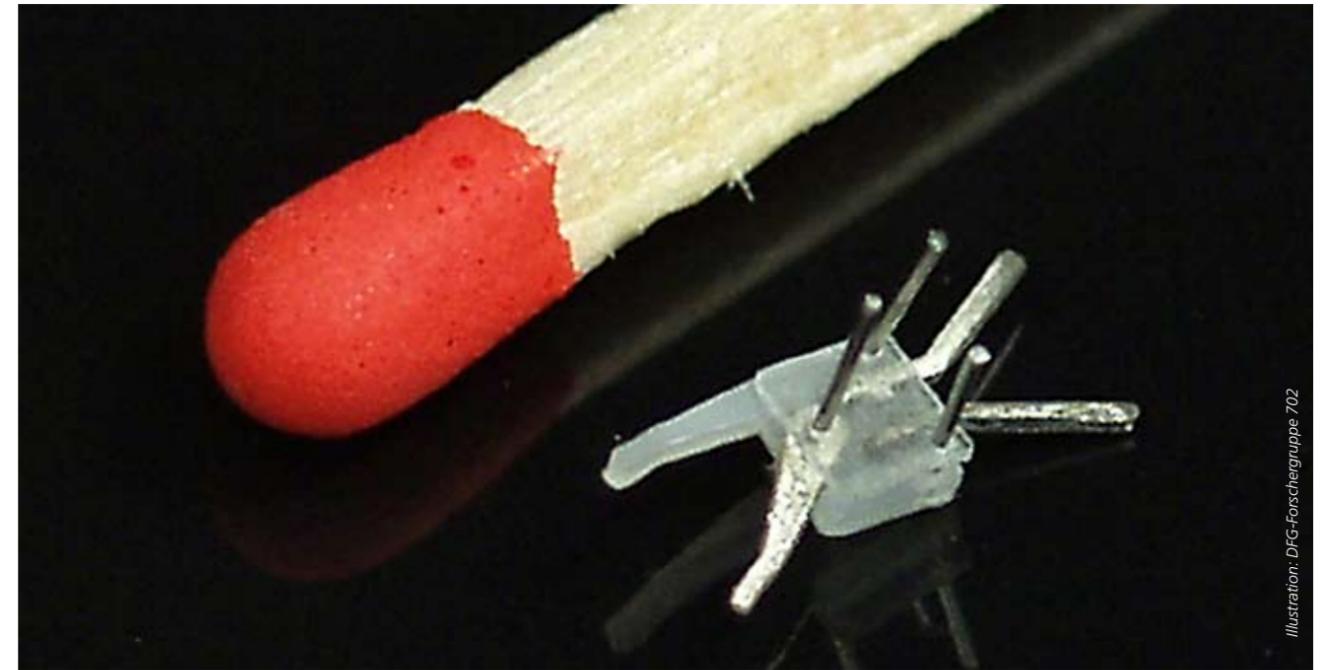


Illustration: DFG-Forschergruppe 702

High-tech in the tiniest of spaces: In microtechnology, bodies and structures that are in just micrometres in size (0.1 μm –1000 μm) are made and assembled. When such minute components are also equipped with mechanical, optical or chemical functionality, experts refer to this as microsystem technology.

The components used in microsystem technology are minute in size yet highly functional. This means that the design of the miniaturised parts used in microsystem technology is very complex, and the range of materials very broad. Electronic functions, for instance, generally require the use of metallic materials in the components. Ceramics are useful due to their great hardness and heat resistance, and polymers are

used due to their tailorable properties and ease of processing. Polymers are also needed if the components are to come into contact with substances that they are not meant to react with, for example in order to avoid changing their chemical composition. These properties are often desirable or even essential for products used in medical technology.

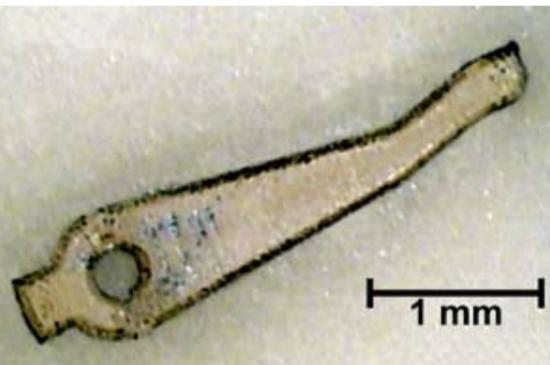
The challenge facing engineers is to find the right material with clearly defined properties, turn it into minute components and then to assemble the end product – and all of this as part of an efficient and economical manufacturing process. The microgripper, developed as a demonstrator by DFG Research Unit 702 "Development of Machine, Tool and Process Technologies for New Methods to Manufac-

A microgripper made of metal and plastic components. The gripper's jaws open and close if the upper or lower terminal is magnetised.

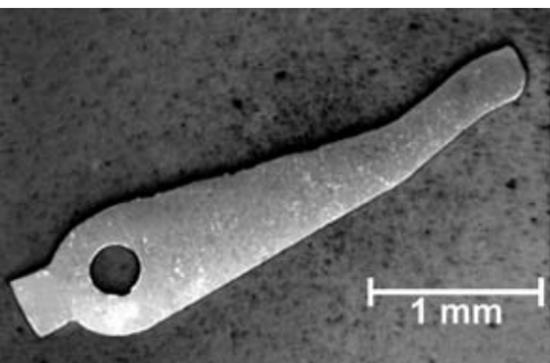
ture Micro Parts via Liquid Phases", is a typical example. The magnetic properties of its metal parts allow the lower arm to be used for opening and closing, depending on which of the two connecting rods is electrically magnetised. At the same time, the plastic housing has to be magnetically passive so that only the metal components are magnetised, not the entire gripper. The movable gripping arm is thus only able to function if the right materials are selected.

The new microgripper and its development are based on the work and

the cooperation in the Research Unit, which contributed the individual parts to make the whole system. This was possible because the researchers involved are using novel approaches and thinking beyond material boundaries to make tiny components. The focus of the research work isn't on the components themselves though, but on the manufacturing processes used to make them. The four institutes in Aachen, Erlangen, Hanover and Karlsruhe that are collaborating in the Research Unit are using processes that have never been used in microtechnology before. What they have in common is that they all create finished components from the liquid phase. This may either be a melt, or a low-viscosity electrolyte containing metal or ceramic precursors.



Above: The micromould used for the metal-capillary pressure casting process.
Below: The finished cast gripping arm.



In processes on the microscopic scale physical effects that are negligible on the macroscopic scale, such as capillary action, which draws liquids into narrow gaps, come to the fore. It is only in microtechnology that these effects really become significant and can even be used to shape the micro-components efficiently.

This allows the movable magnetic microgripper used by the gripping arm to be made using "metal-capillary pressure casting" process. This micro-casting process is based on the effect that is already used in soldering that molten metal is able to flow into narrow gaps due to capillary force. The advantage of this is that this process allows components that are smaller than 100 µm in size to be made.

The micromoulds used for this process are made of technical ceramics. The mould cavities in these moulds are "burnt" into the ceramics using high-energy lasers. The wettability of even the finest structural details of the mould surface by the melt, which is essential for capillary action to take place, can be achieved by coating the ceramic mould with a thin metallic coating before each casting operation.

The casting principle is that the casting material is placed between the lower and the upper half of the mould in the form of a feed-stock film or foil or as a fine powder. Then the entire casting chamber is evacuated and heated to the melting point of the casting material. Once the casting material has completely melted, the upper half of the mould is pressed down hard onto the lower half to encapsulate the melt so that it fills the mould. This results in the excess melt being forced out through the gap between the two halves of

the mould. The finished castings are free of sprues, meaning that no finishing is required.

Any casting material that can be used in conventional casting can also be used in this process, making the metal-capillary pressure casting process suitable for producing micro-components for a wide variety of micromechanical products. Potential applications envisaged include minimally invasive surgery – for example for grippers and endoscope elements – as well as in microactuation.

The distinctive connecting rods used in the microgripper are made by "electroforming". This uses metal contained in a liquid electroplating bath as an electrolyte, which can be deposited on a surface by applying a voltage to the electrolyte, causing a layer of metal to gradually grow from the solution (electroforming), in the shape of a microcomponent, for example.

Electroforming is already used to make microcomponents, but only for small batches. At present, there is no suitable process for making large numbers of microcomponents with sufficiently high surface quality and with a sufficiently large aspect ratio (the ratio of the structure's height to its width). It is for this reason that one of the Research Unit's projects is developing and studying this novel process of plastic multi-component injection moulding using electroforming.

This process uses special moulding panels made of plastic for subsequent electroforming. These moulding panels are made up of two layers of plastic, of which the lower one is electrically conductive, but the upper one is not. The mould cavities are formed by voids in the upper layer that go down as far as the bottom layer, meaning that only the base of each void is electrically conductive. These voids are



The metal-capillary pressure casting system is used to cast new microcomponents.

negatives of the microcomponents. Starting from the conductive base, metal is then deposited in the voids, thus creating the microcomponents by electroforming. The resulting component, for example the metal connecting rods for the microgripper, can then be released from the plastic mould.

The decisive advantage of this process is that even the tiniest details can be cast with excellent surface quality, which is critically important for microcomponents.

Another important factor is that the rest of the components that the microgripper is made of are plastic, meaning that the low weight of the components poses a serious challenge. To illustrate this problem, the plastic gripper arm for the microgripper weighs just two milligrammes, and the casing cover even weighs less than one milligramme.

When making such tiny plastic castings by injection moulding, the strong forces exerted on the material during processing, the high cooling rates and the demanding processing procedure, with rapid machine move-

ments and high pressures, need to be managed in order to guarantee the quality of the components, because when plastics are cast using the conventional injection moulding process they need to be held at temperatures of 200–400 degrees Celsius for a considerable length of time. This damages the material due not only to the intense heat, but also due to the oxygen in the air, worsening the performance characteristics of the finished component. Also, small component cool very fast due to their very large surface area relative to their volume.

Two of the projects are therefore developing a novel processing strategy for making thermoplastic microcomponents. First the oxygen is removed from the plastic in order to reduce the damage to the material during processing. Then the molten plastic is injected into tool inserts which have very low thermal conductivity (in this case made of temperature-resistant plastic), thus reducing the cooling rate. Both of these steps improve the performance characteristics.

The melt is injected into the tool using the "expansion injection

moulding" process. In this process the molten plastic is compressed and used to store the pressure for high-speed injection. Another approach is to melt the plastic before shaping. The casing cover for the microgripper is made using ultrasonic energy, which makes it possible to do away completely with conventional injection moulding. The idea of using this process for microtechnology was based on the concept of heating and then melting small quantities of plastic using ultrasonic vibration in the same way as in ultrasonic welding.

During the melting process, the cold plastic is stretched and relaxed 20,000 times per second. This deformation causes internal and external friction in the plastic, part of which is converted into heat – triggering a process that is fast and gentle to the material. The resulting melt is then pressed straight into the mould cavity, producing the finished micro-component.

The potential for innovation is far from exhausted, and there still remains a lot to discover – in the interests of microprocessing technology and its many and varied applications.



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www.forschergruppe-mikro.de



Illustration: CRC 484 / Bernd Müller

Physics – Simply Beautiful

An award-winning series of photographs on the work of Collaborative Research Centre 484. CRC Spokesman Dieter Vollhardt on top-level research and outstanding images

Impressive images from the solid state research laboratory: With precisely detailed photographs from Collaborative Research Centre (CRC) 484, science photographer Bernd Müller was awarded this year's PUNKT Prize for technology journalism, presented by the German Academy of Science and Engineering (acatech), in the photography category. The series of photographs visualises four research projects of the CRC, "Cooperative Phenomena in Solids: Metal-Insulator Transitions and Ordering of Microscopic Degrees of Freedom", which were located at the University of Augsburg. The CRC, which ended in 2009, was funded by the DFG for ten years. CRC Spokesman Professor Dieter Vollhardt commented on central research topics, methods and objectives of a broad-based public relations programme, as well as provided suggestions for communications work in other Collaborative Research Centres.

german research: Professor Vollhardt, the CRC is dedicated to the physical inner workings of solids. How do you explain this to the non-expert?

Material design under extreme conditions: scene from a floating-zone melting process in which the radiation from two halogen lamps is focussed by gold-plated concave reflectors into a focal point. The rod, made of ruby, is slowly pulled through this focal point, where, at a temperature of 2000 degrees Celsius, it melts. Upon cooling, it solidifies in crystalline form.



Physicist Dieter Vollhardt was spokesman of CRC 484 in Augsburg. His area of research is electronic correlations and magnetism. In 2006, he received the Agilent Technologies Europhysics Prize, awarded by the European Physical Society, for his groundbreaking work; he is the 2010 recipient of the Max Planck Medal, the highest award of the German Physics Society for theoretical physics.

Dieter Vollhardt: We are researching the behaviour of electrons in solids. Electrons are negatively charged particles that also have a magnetic direction specified by nature. Studying the collective behaviour of electrons and their interactions with the atomic lattice of a solid as a many-particle system helps us to better understand the various properties of solids.

What aspect of this do you find most interesting?

Vollhardt: Focus is placed on the transition from metallic behaviour

to insulator behaviour, which is generated by the electronic interactions in the solids. Our work essentially involves the conductivity of solids and two questions: How does such a transition occur, and what happens in the system during this process? Answering such questions requires cooperation between experimental and theoretical physicists. With this collaboration comes significant added value.

Keyword "added value": Do your results have practical applications?

Vollhardt: Our studies are basic research, but they pave the road to practical applications. Once the metal-insulator transition phenomena are better understood, i.e., once research has been conducted on the physical parameters necessary for changing the conductivity of a solid by a defined factor – such as temperature or pressure conditions – a great deal will be possible. For example, a class of innovative materials with completely new properties might be created, leading to a new generation of switches and sensors in the area of micro- and optical electronics. To give a concrete example, I expect that, within the next 15 years, we will have "intelligent" windows whose translucency can be automatically adjusted depending on the weather with the aid of materials in the form of the tiniest ("nano"-)particles. The metal insulator transitions that we research will be at work here as well.

Your research isn't exactly intuitive – yet you are still committed to public relations?

Vollhardt: Research and public relations should go hand in hand. In my opinion, it is a matter of responsibility for those who, like us, are funded by tax money to inform the general public. Second, we are committed to conveying the fascination and beauty of physical phenomena, particularly to young people whose interest and potential we need in physics. Consider our CRC brochure "Exotic States in Solids" from 2007, which aims to graphically familiarise non-experts with our research programme. One thing is clear: the physicists' quest for the fundamental principles of nature and their consequences is received much better by people when the respective questions and answers are prepared and conveyed in such a way that they can be generally understood – this is a

prerequisite of a suitable communication medium.

With the award-winning series of photographs by Bernd Müller, you have found such a medium ...

Vollhardt: It was a lucky coincidence that we met Mr. Müller and, at the same time, began to receive funding for public relations work in 2006. Mr. Müller is an enthusiastic science photographer, and we are enthusiastic physicists. The quality of his individual photographs and that of the entire series won us over immediately.

The photos can also be seen on posters. What was the idea behind the series of posters?

Vollhardt: They should capture and make understandable current research in our laboratories and do so in a way that is aesthetically pleasing and yet absolutely authentic. With the posters, we wanted to optically

Right: The photograph "Organic Field-Effect Transistors" shows a sample of the new generation of electronic switches made of flexible polymers. Far right: "Electrons in Nanoring" is part of the award-winning, four-part poster series.

appeal to the feelings of the viewer. Now, the posters hang in many high schools and public education establishments in Bavaria (and at the DFG) and promote both solid state research as well as physics in general.

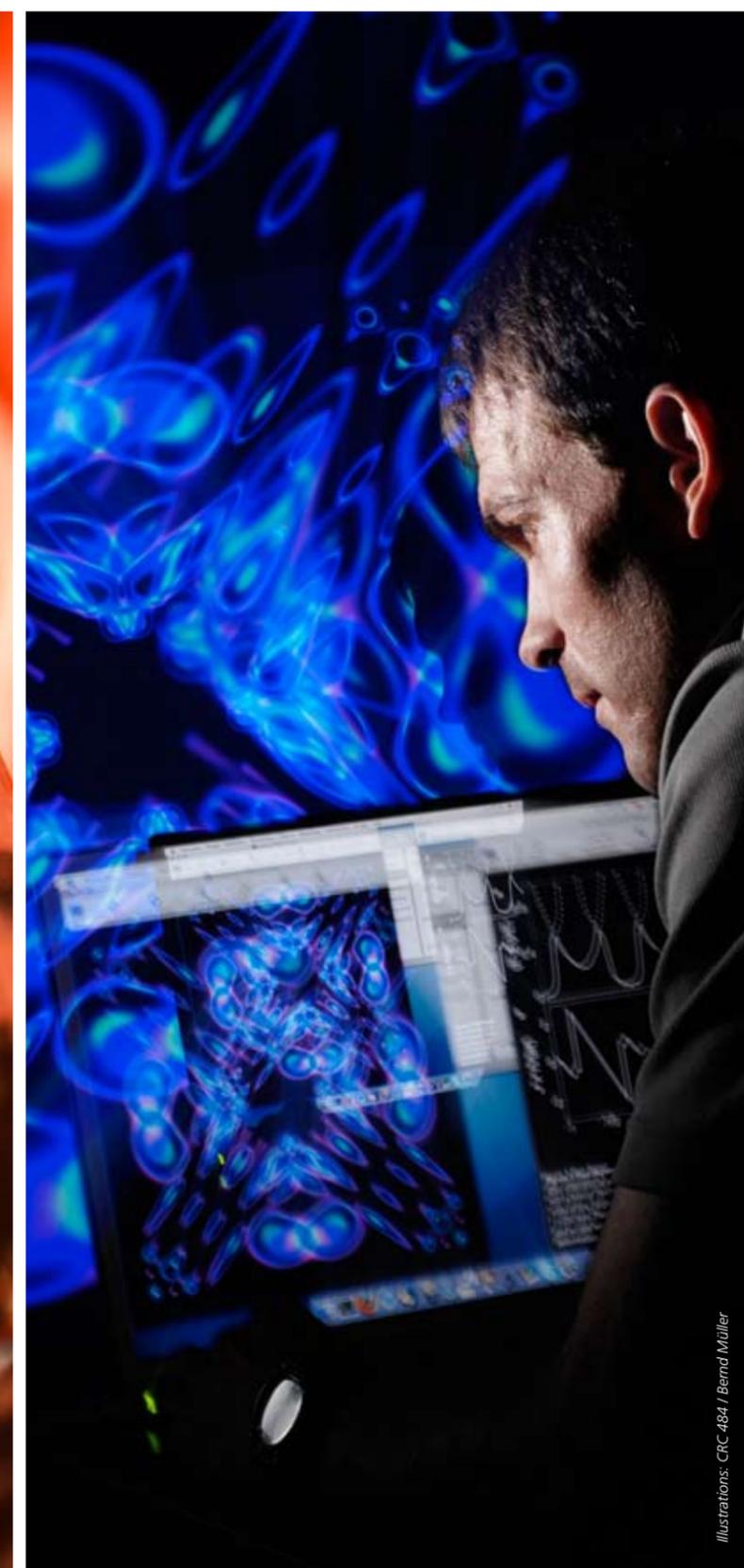
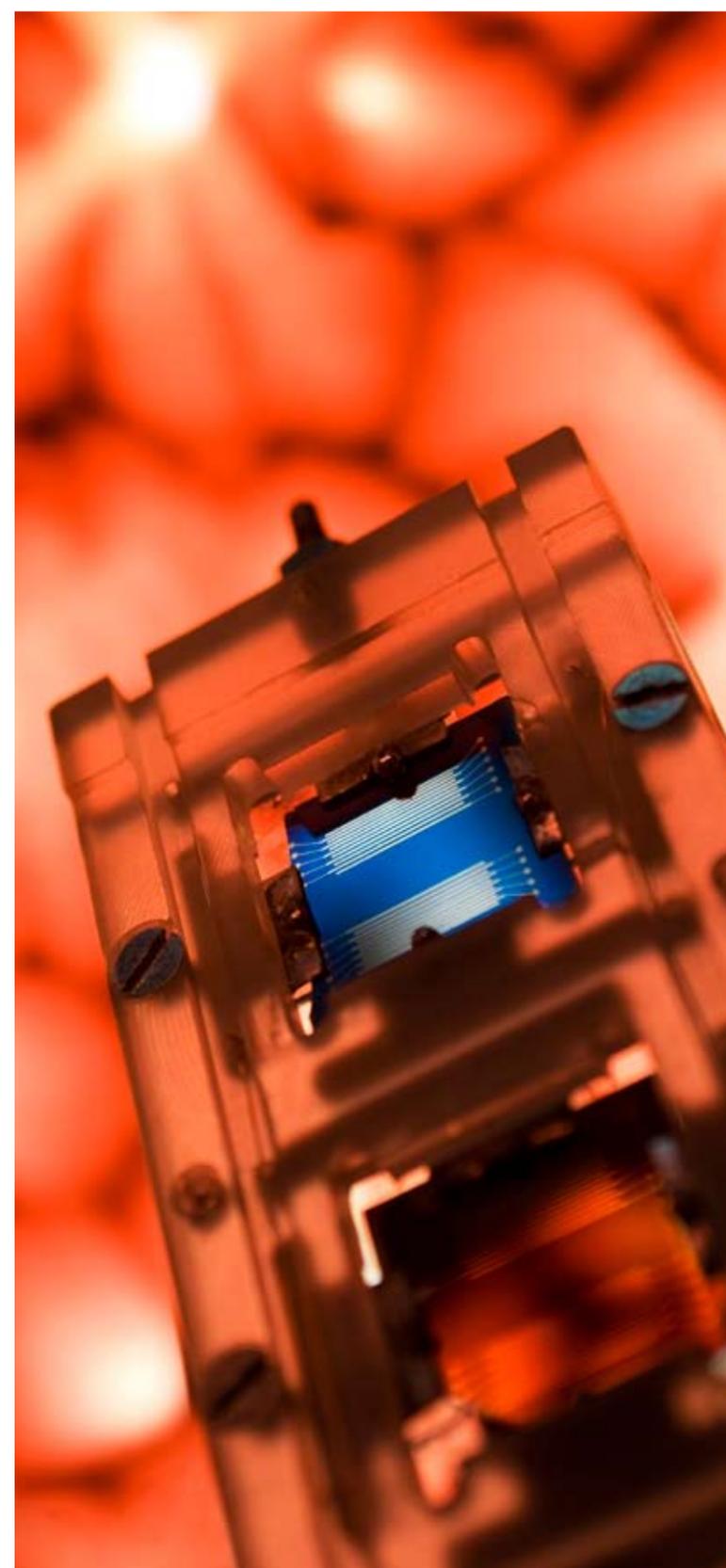
What is the foundation of effective public relations work in research associations?

It needs specialist scientists who can become enthusiastic about this work. Dedication is essential, because science communication requires a great amount of time. The annual public relations funding from the DFG creates opportunities, even if it is exhausted quickly. This is especially true when professional know-how is purchased and work is performed together with a science journalist or a science photographer. But professionalism is important – in fact, essential – here as well.

If you could give other Collaborative Research Centres a hint, what would it be?

Vollhardt: It is worthwhile to bring one's own science to the general public. I am always pleased to see how great the interest and willingness to learn actually are – greater than one might expect at first. But competent communication work doesn't simply happen "on the side", perhaps by a talented doctoral researcher. Rather, it is the job and obligation of the entire research team.

This interview was conducted by **Dr. Rembert Unterstell**, Publishing Executive Editor of "german research".



The four winners – two journalists and two photojournalists – of the PUNKT Prize for Technology Journalism were honoured at the Academy of Science and Engineering gala. Science photographer Bernd Müller (second from left) received the award in the "Photo Series" category for his series of photographs on CRC 484, located in Augsburg.

The Deutsche Forschungsgemeinschaft

The Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) is the central self-governing organisation responsible for promoting research in Germany. According to its statutes, the DFG serves all branches of science and the humanities. The DFG supports and coordinates research projects in all scientific disciplines, in particular in the areas of basic and applied research. Particular attention is paid to promoting young researchers. Researchers who work at a university or research institution in Germany are eligible to apply for DFG funding. Proposals will be peer reviewed. The final assessment will be carried out by review boards, the members of which are elected by researchers in Germany in their individual subject areas every four years.

The DFG distinguishes between the following programmes for research funding: In the *Individual Grants Programme*, any researcher can apply for financial assistance for an individual research project. *Priority Programmes* allow researchers from various research institutions and laboratories to cooperate within the framework of a set topic or project for a defined period of time, each working at his/her respective research institution. A *Research Unit* is a longer-term collaboration between several researchers who generally work together on a research topic at a single location. In *Central Research Facilities* there is a particular concentration of personnel and equipment that is required to provide scientific and technical services.

Collaborative Research Centres are long-term university research centres in which scientists and academics pursue ambitious joint interdisciplinary research undertakings. They are generally established for a period of twelve years. In addition to the classic Collaborative Research Centres, which are concentrated at one location and open to all subject areas, the DFG also offers several programme variations. *CRC/Transregios* allow various locations to cooperate on one topical focus. *Cultural Studies Research Centres* are designed to support the transition in the humanities to an integrated cultural studies paradigm. *Transfer Units* serve to transfer the findings of basic research produced by Collaborative Research Centres into the realm of practical application by promoting cooperation between research institutes and users.

DFG Research Centres are an important strategic funding instrument. They concentrate scientific research competence in particularly innovative fields and create temporary, internationally visible research priorities at research universities.

Research Training Groups are university training programmes established for a specific time period to support young researchers by actively involving them in research work. This focusses on a coherent, topically defined, research and study programme. Research Training Groups are designed to promote the early independence of doctoral students and intensify international exchange. They are open to international participants. In *International Research Training Groups*, a jointly structured doctoral programme is offered by German and foreign universities. Other funding opportunities for qualified young researchers are offered by the *Heisenberg Programme* and the *Emmy Noether Programme*. In so called *Reinhard Koselleck Projects*, the DFG supports especially innovative research undertakings by outstanding scientists and academics.

The *Excellence Initiative* aims to promote top-level research and improve the quality of German universities and research institutions in the long term. Funding is provided for graduate schools, clusters of excellence and institutional strategies.

The DFG also funds and initiates measures to promote scientific libraries, equips computer centres with computing hardware, provides instrumentation for research purposes and conducts peer reviews on proposals for scientific instrumentation. On an international level, the DFG has assumed the role of Scientific Representative to international organisations, coordinates and funds the German contribution towards large-scale international research programmes, and supports international scientific relations.

Another important role of the DFG is to provide policy advice to parliaments and public authorities on scientific issues. A large number of expert commissions and committees provide the scientific background for the passing of new legislation, primarily in the areas of environmental protection and health care.

The legal status of the DFG is that of an association under private law. Its member organisations include research universities, major non-university research institutions, such as the Max Planck Society, the Fraunhofer Society and the Leibniz Association, the Academies of Sciences and Humanities and a number of scientific associations. In order to meet its responsibilities, the DFG receives funding from the German federal government and the federal states, as well as an annual contribution from the Donors' Association for the Promotion of Sciences and Humanities in Germany.



Illustration: DFG / August

Spacious, clearly laid-out and with even more space for impressive images from the world of science and the humanities: This is the first issue of the new look of *german research*, which reflects the modern image of the DFG, incorporating science and aesthetics in a pleasant layout. A more readable basic font and portrait photos under the articles written by researchers are just a few of the changes that we have made. The editors and publishers (shown above from left to right: graphic designer Tim Wübben, Publishing Executive Editor Rembert Unterstell, Editor-in-Chief Marco Finetti and the Head of the DFG's Press and Public Relations Division, Eva-Maria Streier) hope that you will like the new look of *german research*.

Impressum

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