

# forschung

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# german research

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**1/2005** ▶ Paddy Rice and the Water Supply ▶ Climatic Trends and the Pressure Seesaw ▶ When the Biological Pump is Perturbed ▶ Pathways as “Silent Guides” to the Past ▶ Not of this World **DFG**

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**New Methods of Agriculture**

Water scarcity is an omnipresent problem in Asia. Researchers in China are currently conducting experiments on fields of paddy rice to test a new water-saving cultivation system (page 15). Cover: Klaus Dittert

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The issue of federalism is one of the most pressing and contentious reform issues, as was revealed by the debate that arose President Köhler's recent statement on inequality and differences in living conditions throughout Germany. Anyone wishing to even out these inequalities perpetuates the subsidy state mentality and stores up an intolerable burden of debt for the younger generation.

The vociferous protest that arose against this overstepping of the line showed clearly not only the difficulty of reform, but also the difficulty of accepting plain and simple truths. According to psychologists, self-interest blurs the sense of perception; even more, it obscures the willingness to reform for the common good. Unfortunately, the realisation that inequality is not in and of itself negative – but can in fact encourage competition, motivation, and dynamism – is rare here in Germany. Federalism should neither be abused as “subsidy federalism”, nor should it be used simply as cooperative federalism or “common actions” federalism. Only competitive federalism rises above particular interests to serve the common good.

The general context for this is the integration of Germany into the European Union, where hardly any other member state has a comparably consistent federal constitution. This has consequences for European legislation.

When considering federal reform, it is essential to separate general constitutional issues from issues concerning science and higher education policy. Constitutionally, reform is driven by the excessive financial demands placed on the public purse. The complexities of legislative, administrative, and financial responsibilities, however, hamper the decision-making process and blur the lines of responsibility. Politically, the federalism issue is currently being debated by the Federalism Commission, which is expected to reach its decisions this autumn. Regrettably, the urgent issue of restructuring the federal system in Germany – Berlin-Brandenburg, the “Nordstaat” (northern state), and Mitteldeutschland (central Germany) – is not even being addressed. Indeed, why bother, as long as the tab is picked up by the next generation? Legally, the “Juniorprofessor” (junior professor-

ship) decision of July 27, 2004, by the Federal Constitutional Court's Second Senate came like a bolt of lightning out of a clear blue sky. The Juristentag (Association of German Jurists) in Bonn has just demanded a clearer distinction between federal (Bund), Länder, and community competences and a European constitutional law that would strengthen the German Bundestag while reducing the influence of the Länder.

There are three key issues as far as science and higher education policy are concerned: the shared responsibilities of the German Federation and the Länder in the realms of educational planning and scientific research (91b discussion), the authority that the Bund has over the Länder concerning the detailed running of the universities (for example, junior professorships instead of habilitation), and guidelines or directives given by the Bund and the Länder as the financiers of science and research (a Research Funding Act or the “Pact for Research and Innovation”).

1. According to Article 91b of the German Basic Law, the Federation and the Länder may, pursuant to

Klaus J. Hopt

# Federalism in the Service of Science

*A pact for research can promote freedom and self-governance on the international playing field*



agreements, cooperate in educational planning and in the promotion of research institutions and research projects of supraregional importance, whereby the apportionment of costs shall be regulated by the relevant agreement. It is on the basis of this that the Bund-Länder Commission for Educational Planning and Research, for instance, reaches its decisions on the budget for the DFG and the Max Planck Society (MPG). It is hard to convince those involved in the reform debate, who justifiably call for clear allocation of responsibilities and the disentanglement of the so-called "Gemeinschaftsaufgaben" (fields of competence where the Bund and the Länder cooperate closely), that the responsibility for educational planning and scientific research must remain a joint task. Independence and self-governance in science and research, as exemplified to the international community and practiced by the DFG and the MPG, require cooperation between the partners within a federal system. Joint financing leads to a system of checks and balances that is impressively demonstrated in the responsible bodies, such as the Bund-Länder Commission and the DFG's Joint Committee and Grants Committee. The reconciliation of interests is improved and the result hoped for is increased competition in the German scientific community. This is in view of the fact that the aim of the joint task of research funding is not the redistribution of public finances; it goes far beyond the allocation of funds to the achievement of an internationally competitive standard of education. The requirement for unanimity, however, with its paralyzing, anticompetitive effect evident both in this respect and also in the Kultusministerkonferenz (Conference of Ministries of Education) is in urgent need of reform.

2. The junior professorship decision by the Constitutional Court's Second Senate voided the 2002 amendment to the federal Higher Education Framework Act (Fünftes Gesetz zur Änderung des Hochschulrahmengesetzes, 5. HRGÄndG) with a vote of five to three because the amendment exceeded the limits

of federal authority. The centerpiece of this Act was the abolition of the habilitation and its replacement by junior professorships. The Court – quite rightly – expressed no opinion on the matter itself. This is an important measure introduced to accelerate the route to becoming a professor, to early independence, and to increased international competitiveness (the average age of those who gained their habilitation in 2002 was 40, with 22 per cent of those being women and 4 per cent foreigners). However, initial experiences with the Act and its implementation were disappointing and revealed serious flaws.

The fact that the Federation essentially took complete control of both the qualification and the appointment of professors as a result of the institution of junior professorships was viewed by the Court as being beyond the limits of federal authority. In this respect the Länder could only "adopt" federal law. This complete control attained by de facto abolition of the habilitation is neither the only way to reach the desired goal, nor is it essential for legal and economic unity or to equalising living conditions throughout Germany. In my view, the majority is right in taking this stance. The "junior professorship" as a model for reform has to remain optional and succeed in competition against the habilitation. However, the voiding of the entire Act, together with the law governing the timetable for transition, has led to a great deal of uncertainty. Swift action by the legislature is needed to correct this situation. As the Court already expressed, it may also highlight models for the German higher education system in the international arena, specify general principles for qualification of young researchers, and even define a standard target age for a first appointment to a professorship. It is, however, absolutely imperative to resist the political temptation to rejuvenate the old system in a new guise.

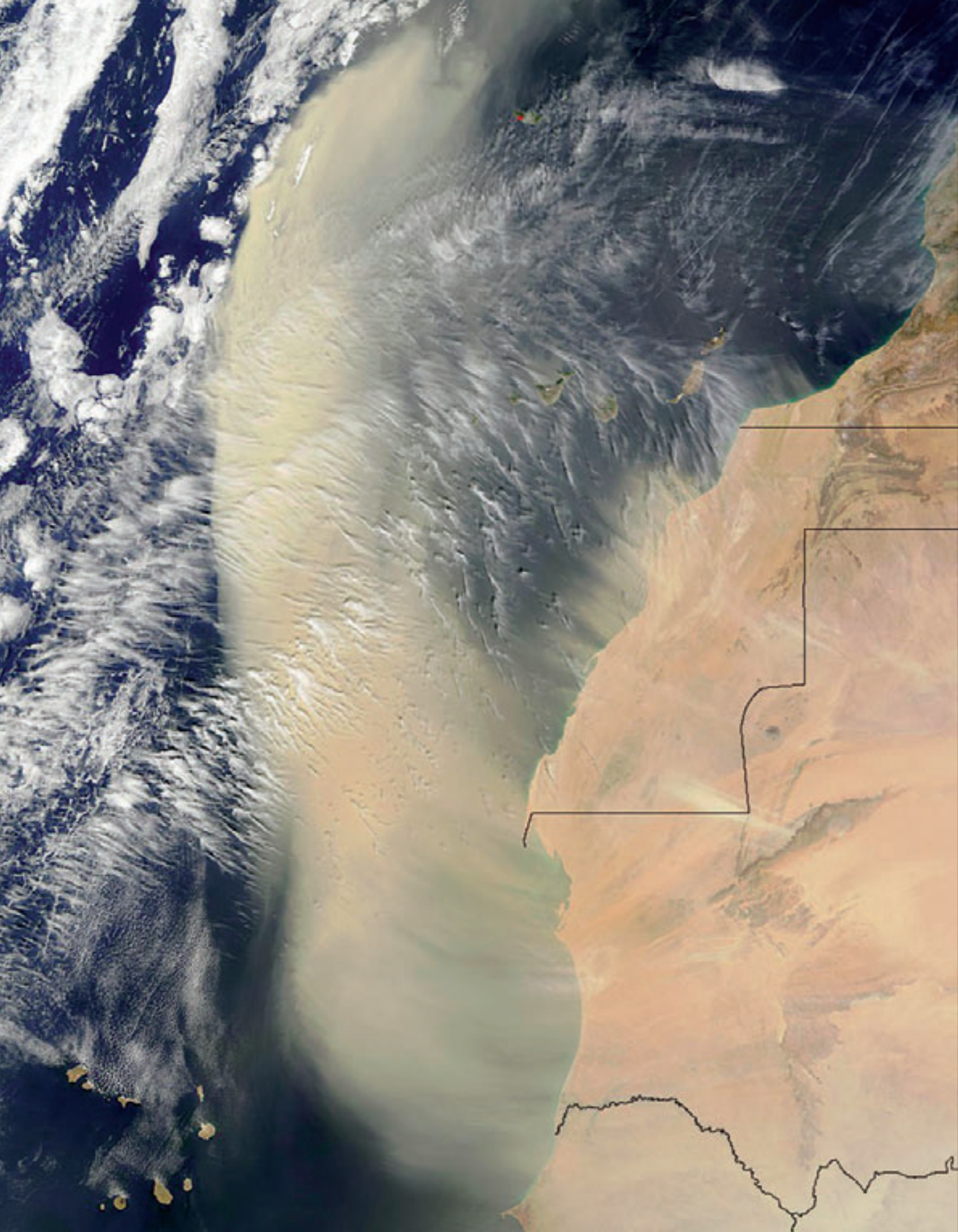
3. He who pays the piper calls the tune – does that hold for science, too? Art, science, research, and teaching are free. This is enshrined

in Article 5 (3) of the Basic Law. Neither the Federation nor the Länder can alter this. Freedom of research is only possible in real terms if adequate funding is provided. However, funding cannot and must not simply be a blank check given from the public purse. The allocation of public funds must only take place in an ordered, objective, and competitive manner. This demands strict evaluation. Is it necessary to regulate this process? A Federal Research Funding Act could be based on Article 74 13 of the Basic Law, leading to transparency and formation of opinion in Parliament, and would be controlled by the Federal Constitutional Court, acting as the guardian of Article 5 (3) of the Basic Law. Experience has shown, however, that this route tends to lead to more regulations and interference in research. This needs to be avoided at all costs. The Pact for Research and Innovation promises planning security accompanied by voluntary commitment. But the devil is in the detail. There is a strong temptation for the financier to dictate the nature or scope of research according to ideological or profit motives. It is therefore important to debate the matter thoroughly, and if necessary controversially. The guiding principle for this debate must, on all accounts, be the freedom and self-governance of research on an international playing field, because ensuring this is critical for the future of both Germany and Europe.



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Klaus J. Hopt is director of the Max Planck Institute for Foreign Private and Private International Law in Hamburg and Vice President of the DFG (German Research Foundation). The Executive Committee of the DFG comprises the President and eight Vice Presidents, as well as the President of the Donor's Association for the Promotion of Science and Humanities in Germany (Stifterverband für die Deutsche Wissenschaft).

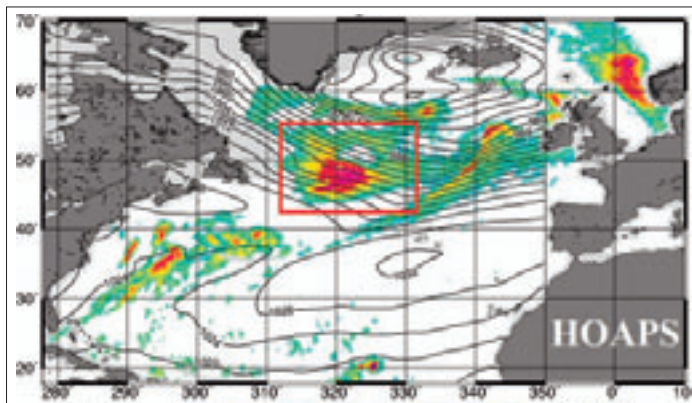


# Climatic Trends and the Pressure Seesaw

*In our latitudes, weather can be forecast for a few days. However, what determines the long-term variations and trends in the North Atlantic climate system still remains largely unknown. Meteorologists are investigating the fundamentals*

**W**hy was the summer so hot in 2003 but rainy the year before? Why was the last winter so mild? Was this purely the result of random clustering of short-lived weather systems (high and low pressure areas) or is there a long-term trend or a long-term periodicity in the clustering of short-term weather events? It is these and other questions that preoccupy scientists investigating the topic "Cyclones and the North Atlantic Climate System".

The fact that the weather in Europe is so variable and does not, as in the tropics, remain relatively stable is mainly determined by the North Atlantic climate system. This includes the North Atlantic itself, the atmosphere above it, the ice, especially the sea ice, and the surrounding land surfaces free of ice. Each component of this system influences the others. Internal interactions, especially between the ocean and the atmosphere, are responsible for short-term changes, in other words fluctuations from day to day up to fluctuations from year to year. Long-term changes, which develop over centuries or even longer periods, are mainly due to external factors, such as variations in solar radiation or even continental drift. Modern weather forecasting methods yield very accurate results for a few days, up to a week. For periods of longer than two weeks such fore-



Satellite data, such as images of the dust blown over the eastern Atlantic from the Sahara (left), are included in the meteorologists' forecast models. In order to improve the rain forecast researchers are continuously adapting their models and improving measurement methods and the input data.

casts are no longer possible. As far as is currently known, there are so-called key processes and key regions in the North Atlantic climate system, which can trigger effects to which the overall climate reacts sensitively. One such key region is the Fram Strait between Greenland and Spitsbergen. Such regions are of particular interest to researchers.

The methods for investigating the North Atlantic climate system and the processes taking place within it are both theoretical and experimental in nature. The theoretical methods range from simple principle-based models to realistic models. Again, the latter differ in their degree of complexity and coupling.

There are models that only take account of the atmosphere, and others that consider the atmosphere and ocean together. Other models couple many components, such as atmosphere, ocean, ice and land surfaces, with differences in the area covered and the degree of spatial resolution.

Field measurements are being carried out in key

regions. Through international cooperation and repeated at regular time intervals, they can record the complex key processes. The studies are based on in-situ measurements, such as airborne and shipboard measurements as well as on long-term satellite observations, together with weather analysis data that can go back up to 100 years. Using the data from these field experiments the scientists can test not only their hypotheses, but also whether the models used correctly reproduce important key processes.

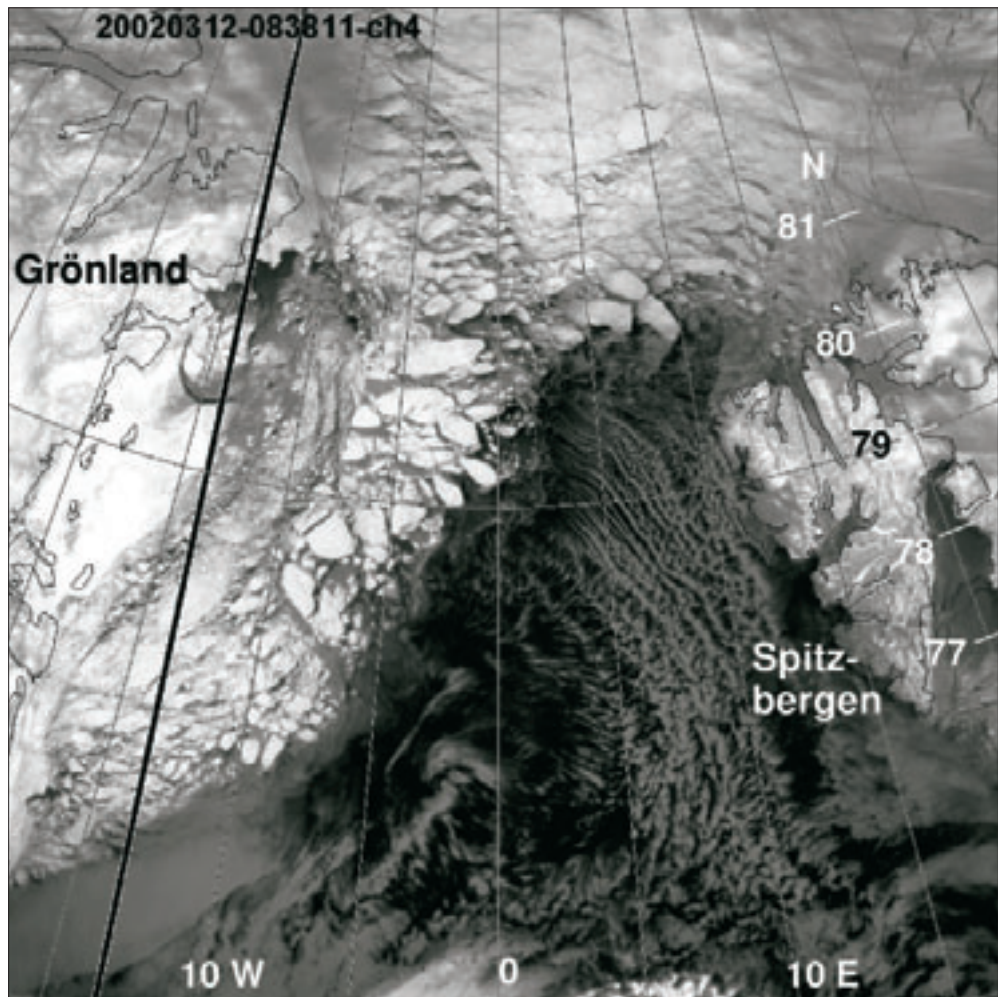
The dominant atmospheric pressure pattern in the North Atlantic region is the so-called North Atlantic Oscillation (NAO) which is characterised by fluctuations in the strength and position of the Icelandic Low and the Azores High. The typical periodicities of the fluctuations lie in the range of weeks to years. If the pressure difference between these two areas is high, the weather in central Europe is mainly governed by westerly winds; if it is low, the weather is more frequently

influenced by easterly winds. The NAO pressure seesaw has already been known of for more than a 100 years. Investigations with principle-based models show that, with the given distribution of land and sea in the northern hemisphere, the strength of the NAO depends on the distance in longitude between the almost permanent low-pressure areas over the North Atlantic and the North Pacific. The computer models are able to yield causal explanations for anecdotal findings.

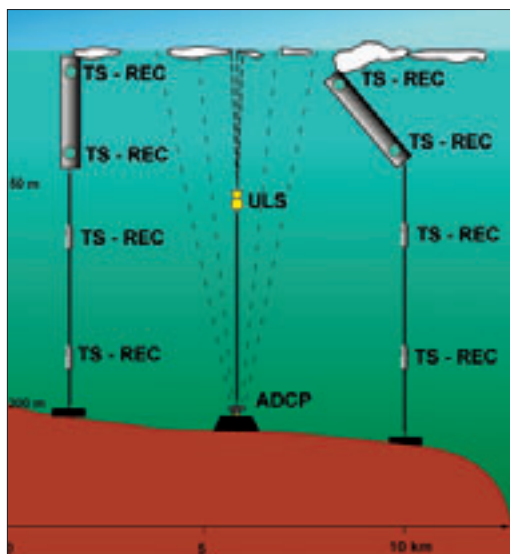
A peculiarity of the North Atlantic climate system is the interaction with the Arctic Ocean, the major area for the formation of sea ice in the northern hemisphere. When sea water freezes, salt is released into the surrounding water, which thus becomes denser and sinks. This process leads to a large-scale convective overturning of the water in the North Atlantic. Dense water flows out of the Arctic Ocean in the deep strata, and later flows over the underwater barriers between Greenland and Scotland, into the North Atlantic. This is balanced by less dense water near the surface, originating from the Gulf Stream and flowing northwards off the coast of Norway.

Most of the sea ice formed in the Arctic Ocean drifts through the Fram Strait and further southwards with the East Greenland current into the North Atlantic. There, the melting ice leaves a "freshwater lens" that renders vertical mixing more difficult because of the stable density stratification. On average, about one tenth of the Arctic sea ice flows through the Fram Strait each year, which amounts to 120 times the freshwater flow of the river Elbe. However, the ice flow through the Fram Strait varies strongly from year to year. Field observations and model calculations are used to study the degree to which cyclones accelerate or decelerate the ice export.

On two expeditions to the Fram Strait in 1999 and 2002, ships, aircraft, automatic ice buoys and remote sensing by satellite were used to measure cyclones and their effect on the sea ice. It turned out that some of the observed cyclones were not forecast in the theoretical mod-







Left: Measurements in the air and under water provide information on the processes that influence the drift of large and small ice floes in the North Atlantic, for example. Oceanographic instruments anchored to the sea floor and atmospheric measurements taken by the FALCON research aircraft (above) over sea ice are used to investigate the interactions between the ocean, sea ice and the atmosphere.

ments. Taking measurements under the sea ice is particularly difficult. The instruments are mostly deployed in the summer, when ice drifts are small, and collect data automatically for a whole year. In the following summer, they are recovered and new instruments are deployed.

In addition to momentum, heat and humidity exchange at the surface, precipitation is an important factor in the interaction between the atmosphere and the ocean. However, there is barely any measurement of precipitation over the sea. The precipitation is derived indirectly from the satellite data. Data from particular weather scenarios and from long-term climatological studies are used to test the models for their effectiveness in simulating precipitation. Comparisons indicate that the models do give a satisfactory representation of precipitation at

fronts, but seriously underestimate the quantity of precipitation from showers behind cold fronts.

Aerosols are low concentration atmospheric admixtures of natural or human origin, such as the dust raised from the Sahara Desert or industrial emissions from North America and Europe. Aerosols can have a direct or indirect influence on the radiation balance and the precipitation over the North Atlantic. Model calculations with and without the aerosols taken into account show that with aerosols the sea surface temperature in the subtropical North Atlantic is one degree Celsius lower and that the Azores High is significantly displaced. The optical properties and distributions of aerosols are determined from satellite data and the impact is investigated by means of model calculations.

In summary, insights from measurements and models are put together like a jigsaw puzzle to form an overall picture so that, step by step, we approach a better understanding of the North Atlantic climate system and, ultimately, of the global climate.

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els. The scientists are currently trying to determine which processes might be missing in the models.

The East Greenland current carries sea ice and water southwards from the Arctic Ocean. The properties of this water, such as salinity and temperature, vary with the seasons and from year to year, altering the conditions for the flow of dense water over the Greenland-Iceland-Scotland barriers into the Atlantic. For many years, the density stratification and water currents have been measured using anchored instru-

# When the Biological Pump is Perturbed

*Throughout the world, there are about 45,000 dams interrupting the natural flow of water to the oceans. This significantly affects the silicon cycle, endangering the ecological balance*





Silicon Valley is not only well known to EDP specialists. As a basic constituent of modern information technology, silicon has had a decisive influence on our communications. A not unimportant factor is that silicon is easy to obtain. After oxygen, it is the most common element in the earth's crust and a major component of our rocks. 4.6 billion years ago, the earth was formed from gas, dust and other matter. The temperature at the burning hot surface was over one thousand degrees Celsius and cooling was quite slow. Mineral compounds, such as silicates, were released from the liquid core and contributed to the formation of the crust. Then the water vapour in the atmosphere began to condense and torrential rain fell for thousands of years. This gave rise to a vast primitive ocean where it is thought that life began. There are, however, doubts that the concentration of simple organic molecules was high enough for complex biological structures to be formed.

According to one theory, it were siliceous clay minerals that acted as a substrate for the formation of simple biological molecules. These are distinguished by an ordered arrangement of silicon in crystal lattices. At the surface, they have free electrons with which they can bind molecules such as amino acids. As if on a template, these arrange themselves along the crystal lattice to form protein molecules. In the same way, long sugar chains could have



formed that are considered to have been precursors of nucleic acids, the basis of the genetic material, DNA. Thus, inorganic silicon compounds served as a kind of seedbed on which, some 3.8 billion years ago, the first building blocks of life were formed.

Billions of years later, organisms evolved that began to reverse this relationship. In the Jurassic age, the shelled plankton algae (phytoplankton) appeared, single-celled plants, floating free in the water. The calcareous algae had a shell of calcium carbonate. Much more frequent, however, are the diatoms that have a siliceous shell. Up to 12,000 species are known with a

With their intensive use of feed, floating fish farms contribute to over-fertilisation of the water. This favours the growth of shell-less algae. For study purposes, samples must be taken. Left: A drilling core taken in the Philippines and a special net (above) for harvesting plankton. Right: A diatom under the optical microscope.

multitude of shell shapes, some with very bizarre geometric patterns. Organic molecules, such as long-chain amino acids, are the basis of the regular arrangement of siliceous molecules to form a shell. This process is called biomineralisation. Whereas, when life first arose, silicon crystals provided the blueprint for bio-molecules, they now serve as a template for inorganic siliceous structures.

Of the phytoplankton, the diatoms are outstandingly successful. They inhabit the waters of the earth in unimaginable quantities. Many thousand can be suspended in a single litre of seawater. It is estimated that they alone produce about 50 per cent of all primary organic material in the seas. This abundance of diatom shells requires a continuous supply of silicon. One source is the weathering of silicate rocks. Water and carbon dioxide in the atmosphere form carbonic acid, which dissolves the rocks. Each year, the mighty water masses of the rivers wash many millions of tonnes of dissolved silicon into the coastal waters, where it is fixed by the diatoms. When they die, the silicon sinks to greater depths. In upwelling areas,

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where cold deepwater rises to the surface, currents carry this silicon up again. Silicon is thus available to the diatoms, even in the open seas.

Closely linked to the silicon cycle is the carbon cycle that is very important for the climate of our planet. Carbon is present in the atmosphere as carbon dioxide and in water as dissolved carbonates. On the continents, it is bound in limestone rocks and in fossil fuels, such as coal, oil and natural gas. While animals are continuously exhaling carbon dioxide, plants bind it by photosynthesis. In an intact ecosystem, there is a balanced carbon cycle. Mankind, however, with his intensive burning of fossil fuels, produces increasing quantities of carbon dioxide and destroys the carbon sink by destroying large areas of forest. One consequence is the greenhouse effect that warms the earth's atmosphere.

The oceans, which cover 71 per cent of the earth's surface, are the largest active carbon dioxide sink. In those layers of the water that are penetrated by sunshine, the phytoplankton gather and absorb carbon dioxide for their growth. A part of this goes into the food chain, where marine animals incorporate it in their bodies or exhale it. What is not directly metabolised is mostly decomposed by bacteria. Here, too, carbon dioxide is produced. Thus, much of the carbon dioxide that is bound in the surface water is released again and returned to the atmosphere by the gas exchange.

In times of global climate change, a process that removes the greenhouse gas from the atmosphere deserves special attention. Part of the phytoplankton sinks down the water column: in clumps or fecal pellets, the dead cells carry the carbon dioxide down to the depths. Because of their wide distribution, the diatoms play an important part in this so-called "biological carbon pump". Furthermore, their siliceous shells make them significantly heavier than shell-less algae. Many species secrete a sticky jelly, with which they form colonies. When they die, they sink because of their weight

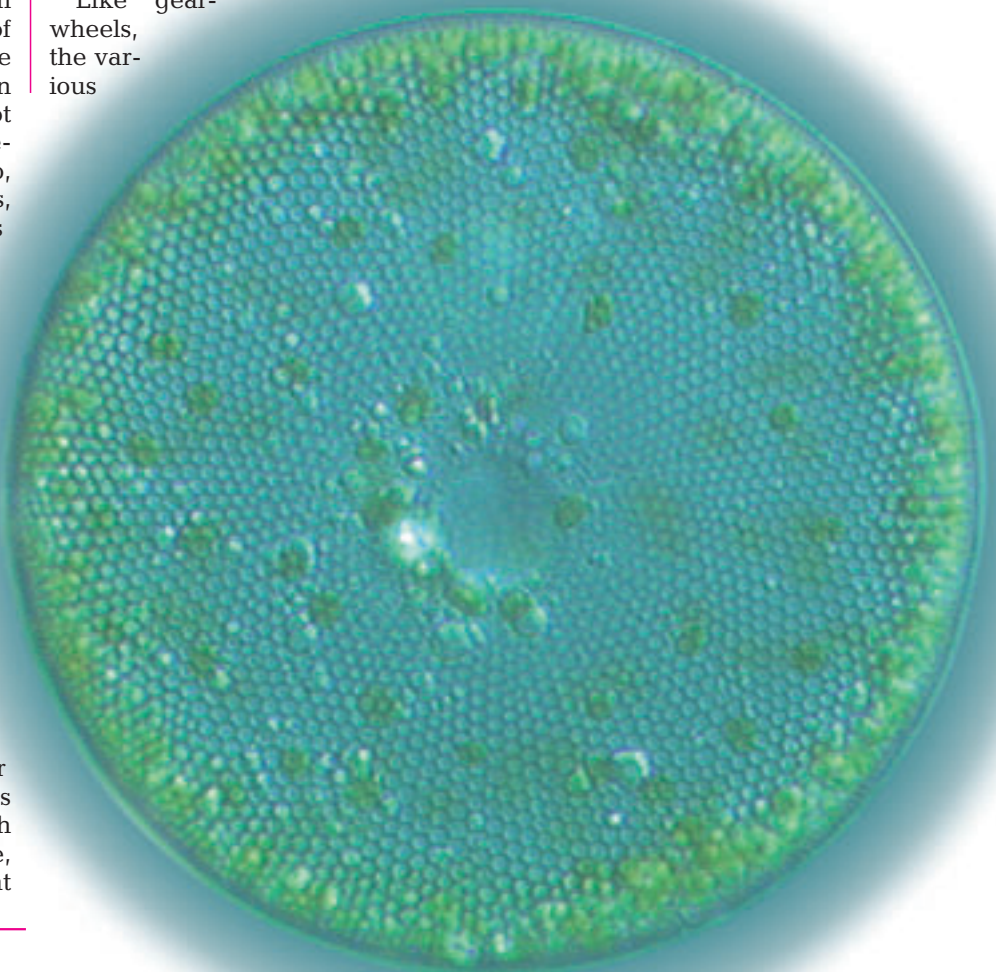
and so some of them escape their predators. Usually, dust and mineral particles are also trapped in the resulting deposits, which cover distances of up to 100 metres per day. In our latitudes, they cloud the seawater with "marine snow" in spring and summer, when the rays of the sun cause algal growth to increase.

It is true that, even in the deeper layers of the sea, a part of the biomass is decomposed. However, the carbon dioxide released can be stored there for several hundred years before it is brought to the surface again in upwelling areas. A great deal, however, sinks still deeper and reaches the sea floor and thus goes into the rock cycle. The organically bound carbon is then buried in sediments for over 100 million years. World-wide, millions of square kilometres of the sea floor are covered with diatomaceous ooze. With the passage of millennia, massive fossil layers can form with strata several hundred metres thick.

Like gearwheels, the various

material circuits are meshed together and form a closely woven structure. If one wheel fails, the whole system can be thrown out of kilter. The oceans are regarded as a regulator in the carbon cycle, as they store about 50 times as much carbon dioxide as the atmosphere. The continuous gas exchange means that changes in the natural process have a 50 times greater effect on the carbon dioxide in the atmosphere. This also affects our climate.

Meanwhile, there are an increasing number of alarming signs that the silicon cycle is being increasingly disrupted by human intervention. The economic exploitation of rivers is leading to massive environmental problems. As was first shown by biogeochemical investigations in the Black Sea, the building of dams has far-reaching consequences for coastal ecosystems. At the border between Romania and Serbia, the giant dams of the "Iron Gates" hold back the Danube. Throughout the world, about 45,000 large dams and a



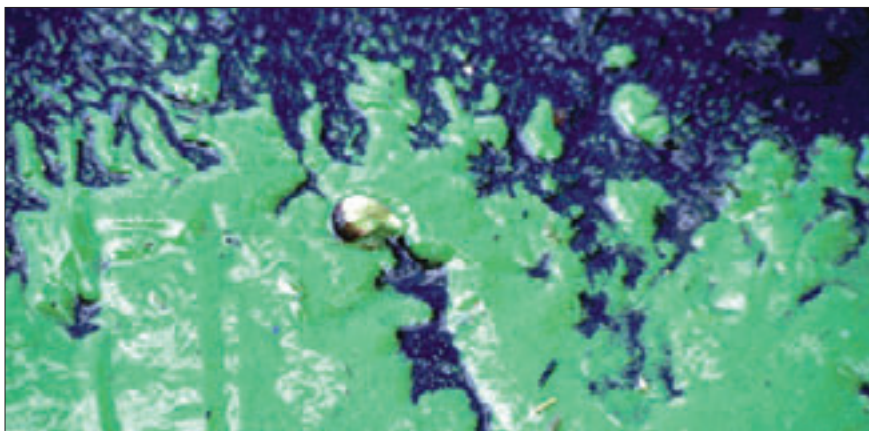
much greater number of smaller dams interrupt the natural flow of water to the oceans.

Unlike rivers, the still water in reservoirs, well lit by the sun, provides an ideal environment for phytoplankton to develop in large quantities. These include diatoms, which trap a large proportion of the silicon. The flat land below the dam is a preferred settlement area, where intensive agriculture is usually a major activity. This can lead to significant quantities of sewage and fertiliser finding their way into the river. At their mouths, the rivers then discharge a "cocktail" of nutrients into the sea that is rich in phosphates and nitrates but poor in silicon. This shifts the mix of phytoplankton in the direction of the shell-less species with frequent

"toxic" algal blooms. These can have drastic consequences for the biodiversity of coastal regions and, finally, for fish stocks.

As the silicon is retained in the reservoirs, it is no longer available to the biological carbon pump in the oceans. Human intervention in natural river flows could thus represent a further contribution to the feared climate change. However, atmos-

Right: Drilling cores are extracted from the Arabian Sea to investigate the silicon cycle. Below: A thick carpet of slimy green algae has formed on the banks of an Indonesian reservoir. This is the result of over-fertilisation. Bottom: Diatoms frequently occur in long chain colonies. Their cylindrical cells are characteristically attached to one another by long bristles.



pheric warming alters the water cycle. This also affects the weathering process and finally, in its turn, the silicon content of the seas.

In view of these dangers, the silicon cycle has become a major pre-occupation of international biogeochemical research. The topic was also taken up by SCOPE (Scientific Committee on Problems of the Environment), a world-wide group of scientists that considers environmental problems and their social and political consequences.

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# A Protein Appears in a Different Light

*APP is assumed to play a role in causing Alzheimer's disease. Its biological functions in the human body are currently unknown but of increasing interest in basic research, especially in investigating the process of wound healing*

**A**lzheimer's disease is probably the best known illness of the nervous system. Scientists assume that it is caused by deposits (senile plaques) of a short-chained protein, the so called  $\beta$ A4-amyloid peptide, in the brains of affected patients. Less well known is the fact that the  $\beta$ A4-peptide is created by splitting a larger precursor protein of the cell surface, the  $\beta$ -amyloid precursor protein (APP). Both substances occur in nerve cells as well as in almost all other tissues of the human body.

It appears reasonable that the body itself does not produce proteins in order to cause diseases of the nervous system. But what, then, is the normal physiological function of APP? It belongs to a whole family

of similar proteins that differ from APP by lacking a particular section. Some members of this protein family are partially exchangeable with respect to their functions. The proteins in this family are evidently of such importance for the organism that they have several "functions".

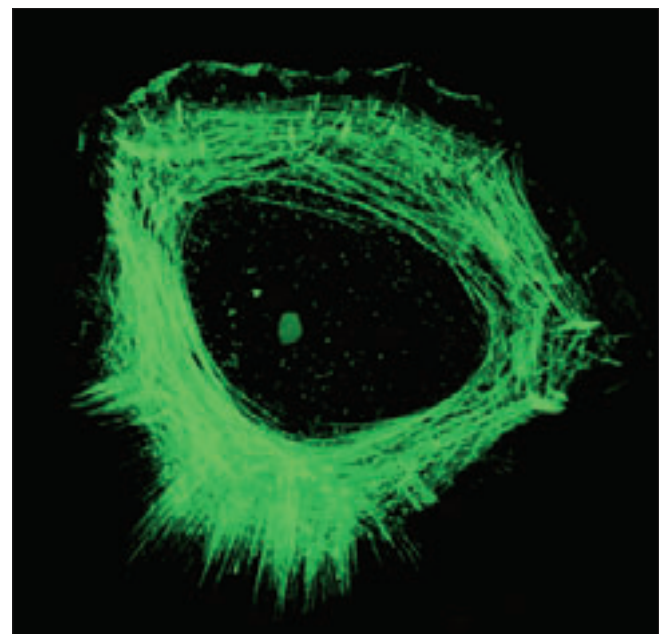
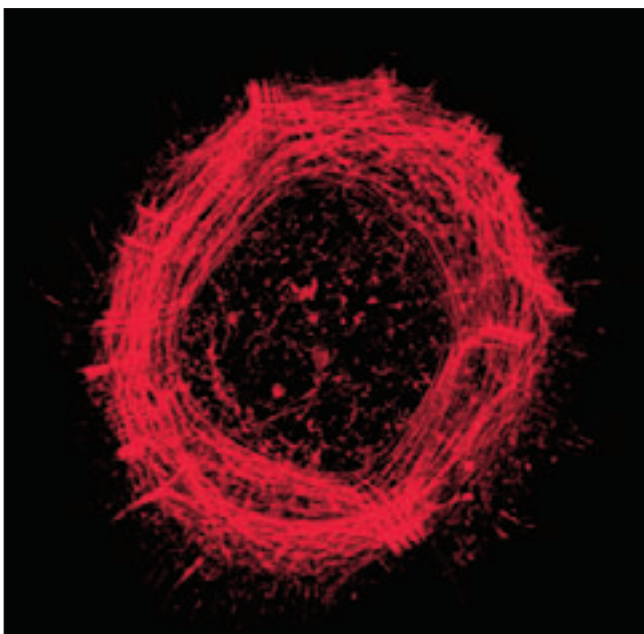
By genetic modification it is possible to breed mice that are unable to produce proteins of the APP family. These animals, however, die within days of their birth, which indicates

Growth factor sAPP: the protein is able to accelerate cell migration in the skin. The migrating cell (right) differs significantly from the resting cell (left) through the activity of its mobile leg-like extensions. The cell is stretching its "legs".

the vital importance of these proteins for the organism.

Enzymatic splitting of APP results in a smaller quantity of the  $\beta$ A4-peptide and in a larger quantity of sAPP, the soluble form of APP. It appears that sAPP also plays a role in cell growth. Several studies have demonstrated that sAPP promotes the growth of thyroid cells and may, therefore, be responsible for goitre formation. Researchers have discovered that it is formed in large quantities in the upper skin layers (epidermis). Research currently being conducted at the University of Bonn is investigating the specific role of APP in wound healing.

The epidermis consists of several layers of skin cells (keratinocytes) that each fulfil a different function.



The external layer acts as a water barrier that prevents the body from dehydrating. The underlying layers are involved in cell/cell interaction and consequently in mechanical cohesion. Disruptions of this cohesion may result in serious blister-forming skin diseases. Other functions are the communication among cells of the same type or interaction with other cell types, for example melanocytes, which form the pigment melanin and consequently effect tanning and the skin's protection against UV radiation. Other cells that also occur in the epidermis are the Langerhans cells, which are responsible for the skin's immune defence.

The bottom layer, the basal cell layer, contains stem cells that make up for the continuous loss of the outer epidermis layers (about one to two grams daily) through cell division. During their life, skin cells move through the different layers, from their origin in the basal cell layer to their death, which results in the formation of the stratum corneum (horny layer). Therefore, the new formation of keratinocytes and the cell death must be precisely balanced against each other. This requires a complex control of cell re-

New cells are required during the healing of a wound. In skin injuries the protein sAPP acts as a signal that can trigger and improve cell division. The yellow-coloured cells are capable of division.

production and the development of specialised cell functions across several cell layers. Disorders of this mechanism result in pathological tissue modifications. For example, psoriasis is caused by excessive keratinocyte multiplication. In the epidermis, APP is almost exclusively found in the basal cell layer. It seems possible that APP and sAPP participate in these regulatory processes with their possible growth functions. The necessity of these regulatory processes is particularly evident during wound healing.

Wound healing is based on the migration and multiplication of keratinocytes, which are controlled by a multitude of signals. It was found that sAPP acts as a signal that very strongly increases cell production. However, before cell multiplication compensates for a skin defect, skin cells must migrate from the uninjured area into the wound and cover it. In fact, keratinocytes can be stimulated to move at any time. Our body would not be able to close skin wounds without them as fast as we are used to.

At the University of Bonn a new computerised technique for quantitatively recording the details of keratinocyte migration has been developed. With this technique it can be documented that sAPP can double the migration pace of keratinocytes.

Migrating keratinocytes differ from resting ones through the activity of their mobile leg-shaped cell extensions. This procedure makes it possible to analyse the dynamics of these cell extensions and their acceleration by sAPP.

If sAPP increases cell multiplication and migration, it is also reasonable to assume that it accelerates the wound healing process. In

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### A computerised procedure helps to analyse the dynamics of cell migration in a new way

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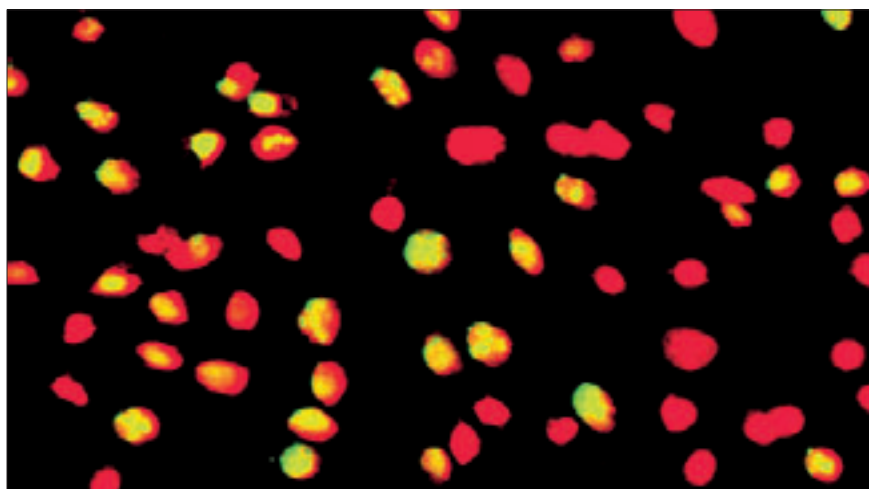
wound healing it is important that the keratinocytes migrate directly into the injury to achieve a quick closure. This process is controlled by chemical signals.

Normally, the wound is initially provisionally closed by a clot that consists primarily of a fibrin mesh, a sticky insoluble protein molecule. Embedded in this mesh are blood platelets that release sAPP along with a number of other growth factors. Possibly, the sAPP released by the basal layer cells activates the general cell mobility while sAPP from the blood platelets directs keratinocytes towards the wound by forming a gradient.

It is already known that sAPP is only one of many growth factors that control the wound healing process. Individual factors act through specific series of signals. The transfer paths of the sAPP signal can only be examined precisely once the respective receptor has been identified. It is hoped that experiments with mice whose genetic material has been specifically modified (knockout mice) will identify the role of sAPP in the whole organism.

So far, the results obtained shed new light on the physiological role of a protein that normally is considered to be the precursor of Alzheimer's disease.

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# Paddy Rice and the Water Supply

*Over half of Asia's fresh water is used for growing rice. A new procedure in China has been developed to test a new water-saving cultivation system*

Rice has been cultivated in South East Asia for more than 15,000 years. From the very beginning, it was cultivated as "paddy rice" in flooded soil. Paddy rice is downright wasteful in its water consumption, requiring – based on the grain yield – three to four times the amount used by other types of cereal. This means that currently almost half of Asia's fresh water resources are used for growing rice. Continuing economic change means that water is increasingly becoming a limited commodity. Estimates show that 15 million hectares of paddy rice in Asia will be suffering from a lack of water by 2025. Even today, there is a huge discrepancy between the amount of water con-

sumed by agriculture and the formation of new ground water. This leads to a drop in the water table in large regions and regular failures of the water supply in rural areas. China's currently water resources per capita and per unit of cultivated land amount to just a quarter of the world's average. The rapidly-growing industrial demand is also heightening the water shortage problem, meaning that the situation is worsening in precisely those populous regions in Eastern China where the best agricultural land is to be found. Around three-quarters of the water used for paddy rice cultivation is lost to seepage or evaporation, making saving water a huge challenge. Over the next five to ten

years, increasing food consumption accompanied by reduced water availability will create a tremendous social need for the development and use of water-conserving cultivation systems in many Asian countries, especially in China. To quote UN General Secretary Kofi Annan, "We need a blue revolution – more crop per drop".

The first attempts to cultivate modern high-yielding types of paddy rice using intermittent irrigation instead of flooding were carried out in the USA. In the market conditions there, however, the large savings in water consumption could not offset the 20 to 30 per cent drop in financial returns; so corresponding research and development plans were not followed through. In South East Asia though, the lack of water has not only caused a severe drop in financial returns, but has also led to a considerable increase in production costs. So another problem arose, which has led to the development of various water-con-

Rice is very sensitive to water stress and can even wilt in flooded ground. Therefore a new cultivation system in China has been developed in which very thin sheets of plastic are used to prevent the rice from drying out.



A close-up view of the water-saving cultivation system: Thin plastic sheets can be seen on the left-hand side while a protective covering of straw mulch is shown on the right. Below: For technical reasons the fields are divided into strips, each 3 metres wide.

servicing cultivation systems. One of these is the "Ground Cover Rice Production System (GCRPS)", in which the soil is constantly kept very moist, but is not flooded. The surface of the soil is covered with a layer of mulch to prevent it from drying out and developing deep cracks, that would allow all irrigation water to drain away. The protective layer consists of either thin plastic sheeting or a mulch of pre-composted straw. This technique was originally not a water-saving method; instead, it was designed to increase the temperature of the ground in spring. In cool mountainous regions this enabled rice to be planted earlier, resulting in considerably higher yields. Water conservation was originally a side effect of this process, but it led to the system being tested in other regions with this new objective.

As part of a German-Chinese cooperative research project, two-year field research programmes were set up in three regions of China with very different climatic conditions. The new GCRPS was compared with the traditional paddy system in Beijing, Nanjing and Guangzhou. Provided that the water supply was kept carefully controlled in the GCRPS areas, only very minor losses in yield were recorded. Even minimal drying-out of the ground resulted in a considerable reduction in the harvest. Paddy rice is very sensitive to lack of water and can even wilt if grown in flooded ground. In this respect, paddy rice differs fundamentally from dry

using other, much lower-yielding rice varieties.

The savings in irrigation water were pronounced in all areas, being around 90 per cent in Nanjing and up to 50 per cent in Beijing and Guangzhou. The lower water conservation in these areas was due to sandy soil with high levels of seepage in the Beijing region and to very high rainfall in Guangzhou in both years of the experiment. So the efficiency of the water usage was increased particularly in Nanjing and Beijing. This was achieved primarily by reducing seepage. Despite the compaction of the sub-soil ("puddling") which usually occurs in paddy rice cultivation, seepage rates are relatively high. This is due to the considerable hydrostatic pressure caused by the flood layer. The grain yield per unit of nitrogen

fertiliser used was, contrary to expectations, significantly lower in the GCRPS. This was surprising; the new system should have reduced the significant nitrogen loss which usually occurs in paddy rice production as a result of the volatilisation of gaseous ammonia. In paddy rice cultivation, ammonium is the predominant form of nitrogen in the soil and in the floodwater. Nocturnal respiration and the photosynthesis by algae during the day lead to considerable fluctuations in the water's pH value during the course of the day. The consumption of carbon dioxide from the floodwater causes a reduction in the carbon dioxide concentration and therefore an increase in the floodwater's pH. Under these conditions, the physicochemical balance of ammonium and ammonia gas is tipped heavily in favour of ammonia gas which, in this case, quickly disperses into the atmosphere. This ammonia volatilisation therefore represents a significant nitrogen loss in the paddy rice cultivation method. It should be considerably less with GCRPS. Although measurements were able to



prove that this was indeed the case, obviously other, previously less significant processes (such as nitrate leaching) have now come to the fore. It was also shown that changes in fertiliser dosage are necessary to increase the yield. The nitrogen demand appeared much later in the growth cycle with GCRPS than with planted paddy rice. On-demand fertilisation tested on a smaller scale resulted in the first improvements. The altered nutrient dynamics in the soil also had an effect on the quality of the harvested rice.

Paddy rice fields are a source of methane gas emissions and therefore also contribute to global climate change. As the continuous flooding of the rice fields causes the oxygen in the water to be used up by microbial activity, organic substances such as leftover plant matter decompose, producing methane. This is, to a considerable extent, released into the atmosphere by the plants themselves. As expected, the water-saving cultivation system considerably reduced methane emission levels in all areas, which is, from a climatic point of view, extremely positive. However, the measurements also showed a considerable increase in nitrous oxide emissions in all the areas tested. The international IPCC index, which classifies the global-warming potential of different gases, was used to compare the climatic effects of different trace gases. GCRPS in its current form presents no overall advantage over paddy rice. The results show that it is possible to use water-saving rice cultivation methods without significant losses in yield. However, they also highlight the complexity of agricultural production and show that changes due to individual factors can have unexpected consequences. Before the new cultivation system can be recommended for large-scale agricultural production, however, further improvements in the overall system are necessary.

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# Sperm on a Scented Trail

*Messages from the realm of scent: human sperm have a sense of smell too. This means that chemical scents play a major role in reproduction*

**D**o you wish you could turn back the clock and relive those heady days when you first fell in love? If so, don't start rummaging around to find your old photos or records. Instead, take a sniff of a scent that you connect with those days. A smell can transport us back in time in an instant, bringing back memories and reawakening long-lost emotions. This is because, in contrast to acoustic or visual impressions, scents are not primarily processed by the cerebrum, but rather in the limbic system, one of the oldest regions of the brain, where desires, emotions and memory are seated. Although the sense of smell is generally portrayed as being one of the "lower" senses by the textbooks, and the philosopher Immanuel Kant even claimed that our sense of smell is an "inferior" sense, it actually plays a far more important role in our lives than you may suspect. Without it we would neither be able to enjoy a delicious meal, nor savour a fine wine, we would miss out on many emotions and memories, and would not be warned of spoiled or poisonous food. Recent psychological research has revealed that scents play a far more pivotal role in our lives as they make a significant contribution to our choice of sexual partner. Psychologists refer to this as chemical communication. Our nose is primarily guided by a person's personal odour, which is as unique to each individual as a fingerprint. This odour signals our genetic background. The greater the difference in body odour – and thus the genetic cocktail – the more attractive two poten-

tial partners are. What works on a macroscopic scale appears to apply as a fundamental principle on the microscopic cellular level too, as scent also plays a crucial role in successful fertilisation of the human egg. On their long dark journey to the egg, chemically "scented trails" apparently act as a beacon and guide for the sperm. To follow this trail, sperm use olfactory receptors only recently identified as being the same as those usually found in the sensory nerve cells of the nose. To put it simply, sperm can smell.

The olfactory epithelium in the nose contains highly specialised receptor cells, capable of recognising and distinguishing between thousands of different odorants with remarkable accuracy. These olfactory receptor neurons convert the chemical information into electrical nerve signals, the universal language of the brain.

**A**fter binding to specialised odorant binding proteins (OBPs) in the mucus layer covering the olfactory epithelium, odorants interact with so-called G-protein-coupled receptors (GPCRs) located in the ciliary membrane of olfactory neurons, according to the lock and key principle. Olfactory receptor activation triggers a biochemical signalling cascade inside these neurons that increases the concentration of a "second chemical messenger", cyclic adenosine phosphate which causes by opening of ion channels the influx of positively charged ions and cell membrane depolarisation. This so-called sensor potential can induce the genera-

tion of action potentials that propagate to central brain regions. The molecular components involved in this complicated amplification cascade mechanism have been identified by scientists in the past decade. The year 1991 was a milestone in this work, as it was the year the gene family of olfactory receptors was identified. Linda Buck and

Richard Axel were awarded the 2004 Nobel Prize in Physiology or Medicine in recognition of their landmark discovery. By 1992, Belgian scientists had sug-

gested that certain members of this extraordinary large gene family not only reside in the nose, but are also expressed in mammalian testes. Interestingly, researchers at the Ruhr University in Bochum, Germany, succeeded recently to show for the first time that olfactory receptors are not only present in the nose, but fulfil signalling functions in also mature human sperm cells. It comes as no surprise that there has been a great deal of speculation on the potential significance of these receptors in sperm physiology. Their exact role in reproduction, however, remains unclear.

**A**t a mere 60  $\mu\text{m}$ , spermatozoa are the smallest cells in the human body and their form and function are perfectly adapted to accomplishing their only physiological task, to successfully find and then fertilise the ovum. And yet an estimated 300 million sperm set off on this incredibly perilous journey into the female body. Following ejaculation, these carriers of the paternal genetic information enter the uterus through the narrow cervix, locate the opening to the fallopian tubes and then travel onwards through the oviduct until they reach the ampulla, where fertilisation takes place after the sperm are temporarily bound to the membranes of the oviduct cells in the narrow passage (isthmus) preceding the ampulla. This binding is broken when

the sperm become capacitated, and thus competent of fertilising the egg. They then need to swim through the ampulla to meet with the ovum in order to fertilise it. Only a couple of hundred of the 300 million or so spermatozoa initially ejaculated into the vagina come anywhere close to the ovum. Each individual sperm is thus faced with

an incredible navigation challenge, a fact which makes it highly unlikely that fertilisation is simply left to chance. Chemical signposts, either released by the egg or else-

where in the female reproductive system, may act as beacons for the sperm in their search for the egg. The existence of such sperm-attracting substances is already well established, but it has yet to be shown what sperm are actually attracted to. As far as the sperm are concerned, not only do they have to detect the attractant, but the presence of the signal also needs to be transformed into movement in the direction of the source of that signal. This is precisely where sperm olfactory receptors come into play.

One of the larger clusters of olfactory receptor genes is located on chromosome 17. At least one member of this gene cluster, a receptor called hOR17-4, is expressed in the developing male germ cell and embedded in the membrane of mature sperm prior to ejaculation. Which scent is this receptor capable of smelling, and what purpose does it fulfil on human sperm? The main sticking point encountered during the experimental work to answer the question of the function of this

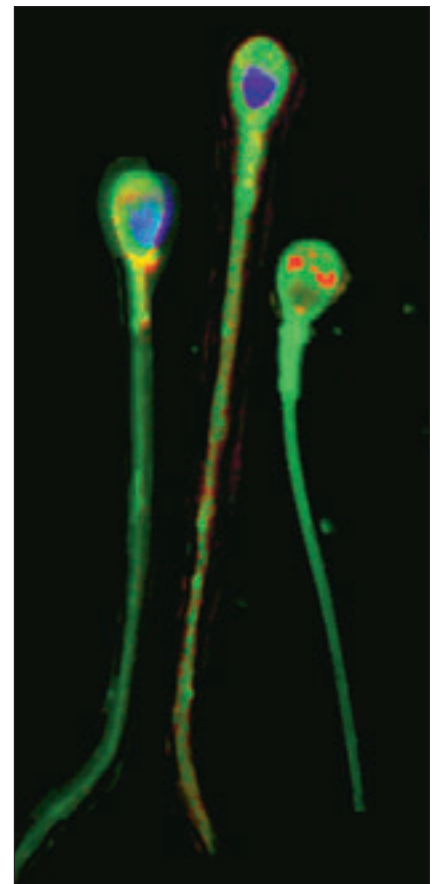
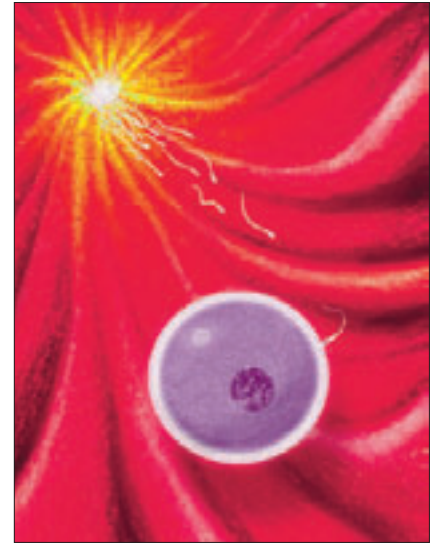
Scents act as chemical signposts, giving sperm a sense of direction on their long and arduous journey to the egg. The source of the scent is either in the egg itself or in the cells surrounding it. Human sperm (right) not only have to be able to smell the scent, but also convert this sensation into directed motion.

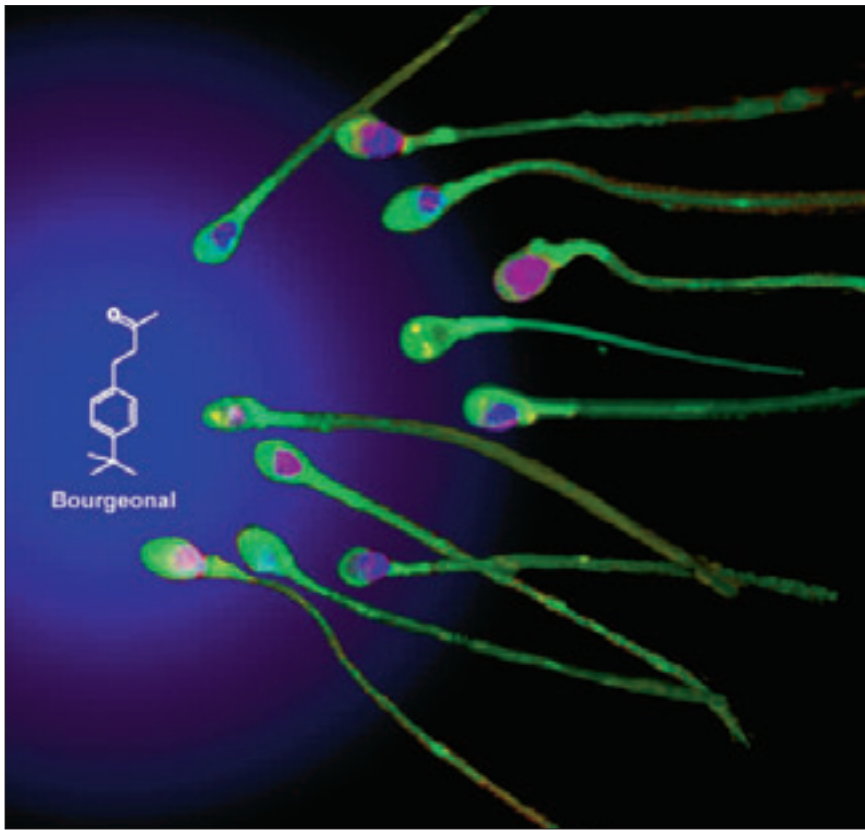
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### One of the larger clusters of olfactory receptor genes has been located on human chromosome 17

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receptor was the immense number of potential activating odorants. Each olfactory receptor is only activated by a very small group of structurally similar odorants, whilst the researchers have – in theory – an almost limitless number of potential odorants to choose from. The archetypal search for a needle in a





A stimulating scent. Bourgeonal®, a synthetic lily of the valley scent, attracts sperm by activating their olfactory receptors. Even at low concentrations (nanomolar range), the sperm are oriented towards the source of the scent.

haystack! This has now been made possible by the use of standardised cell lines (for instance human embryonic kidney cells, which certainly can't smell) modified to clone the receptor. Optical methods can then be used to measure the receptor activity, and so study the specific activation potential of a multitude of different odorants and mixtures of odorants. From a mixture of a hundred entirely different odorants they were able to single out one particular substance that activated the olfactory receptors, Bourgeonal®, a synthetic compound smelling of lily of the valley. Further experiments using other molecules with a similar molecular structure identified a number of other scents which also activate this receptor, including Lilial®, and Cyclamal®. The "molecu-

lar receptive field" determined in this way, in other words the structurally related molecules to which the olfactory receptor reacts, was highly restricted, however. Even minute changes in the molecular structure had a drastic effect on the ability to activate the receptor, while significant changes resulted in total inactivity. Working on the assumption that this receptor is also present on human spermatozoa, the next step was to test whether live sperm could detect the scent. If mature human sperm are exposed to Bourgeonal® under experimental conditions, the reaction is a sharp rise in the calcium ion concentration in the cells. The signalling cascade within the spermatozoa that this is based on is currently under investigation. What is certain is that olfactory activation initially results in an enzymatic production of the chemical messenger, which either directly, or indirectly

via other cascade molecules, opens a gate which allows the calcium ions to enter the cell. This sharp increase in the calcium concentration is responsible for changing the flagellar beating pattern, the primary factor directing sperm movement. The biological effect of Bourgeonal®, as a chemoattractant was then studied in behavioural experiments. Motion analysis of spermatozoa demonstrated an orientation of swimming motion towards an artificial odorant and subsequent concentration of spermatozoa around the source. Bourgeonal® was also found to almost double sperm speed. Interestingly, the chemosensory response in sperm cells can also be blocked by addition of another odorant, structurally unrelated to Bourgeonal®, called undecanal (a competitive antagonist). This has far-reaching consequences. In spite of the presence of the chemoattractant, the sperm swim around aimlessly and no increase in swimming speed is evident. The orientation function of certain chemoattractants for sperm can thus be suppressed using appropriate antagonist scents. These findings open the door to the use of odorants in novel ways, both for in-vitro fertilisation (IVF) treatments and for contraception. The results of

### Odorants may open the door to new, promising opportunities in the important area of in vitro fertilisation

laboratory studies to date are very promising, at least. Whether these results can also be applied in humans waits to be seen. Success rates for IVF treatment are not as high as sterile

couples and medical doctors would like. The use of a chemoattractant may help to improve the chances of success significantly. On the other hand, it may be possible to develop new, hormone-free contraceptives on the basis of chemosensory inhibitors. It would literally be possible to hold the sperm's noses, thus preventing them from finding their way to the egg.

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# Pathways as “Silent Guides” to the Past

*Paths shape the appearance of parks and gardens. This was already realised by the pioneers of landscape gardening. The reconstruction of historical paths today can be extremely revealing – and not just from the point of view of historical preservation*

**P**aths are an essential element of many parks and gardens. In his book “Notes on Landscape Gardening” published in 1834, which became well-known even outside Germany, Count Hermann von Pückler-Muskau (1785-1871) formulated the essential criteria for laying out pathways in the parks and gardens of the 19th century. According to Pückler-Muskau, “1. Paths should gently guide visitors to the best viewpoints. 2. Paths should form practical lines that are pleasing to the eye. 3. Paths should only intersect the open spaces they traverse into picturesque shapes. 4. Paths should never wind without obstacles or cause. 5. Finally, paths should be well-constructed, always firm, even and dry.”

Path design is shaped by landscape or architectural design ideals. Their form – whether straight or winding – in other words their function (particularly in extensive landscaped gardens) as “silent guides” leading strolling visitors to attractive viewpoints, has, however, less of an influence on the method of construction chosen. The technical and constructive layer composition of a weight bearing foundation layer, a levelling intermediate layer and a visually-pleasing surface layer as well as the camber, which is usually designed for maximum drainage, remain essentially the same; variations tend to be found in materials or layer depth. Differences in construction techniques due to aesthetic preferences affect mainly the visible components of the pathways – their kerbs and sur-



face layers. Pückler-Muskau tried to imitate English examples in this respect, but his experiments failed. Rather than being determined by fashions of the time, the construction of roads and footpaths is fundamentally determined by the way in which they are used, the relief of the landscape and the local soil type. In addition to width and visual appearance, other important factors are the construction costs and the availability of materials. The usability of pathways ideally in every season also has a decisive influence on the construction method selected. All of these factors are ultimately expressed in the path's structure. According to the classical author Vitruvius (born around 84 BC), every construction contains to varying degrees the basic components of firmitas (construction), utilitas (conception) and venustas (composition), which can be analysed later using appropriate techniques. For example, the quality and workmanship of the path's foundations or the kerbs alone can tell us a great deal about the builder's propagandistic intentions and his financial means. Usually, however, examination of historical monuments also reveals the

Paths made of natural stone, bordered by lush flowering plants, have traditionally been used in designing parks and gardens. Right: Conservation activities have restored the garden path behind the former villa of the painter Max Liebermann in Berlin's Wannsee area to its former glory.

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origins of the materials, construction phases, errors in planning, and deficiencies in construction.

Unfortunately, many historic pathways have been severely neglected and need to be provisionally reinforced. Both this state of disrepair and intensified basic research in garden preservation have brought up the issue of finding suitable methods of cataloguing the substance which remains. Only since the mid 1990s, has research into gardening and landscape construction existed alongside traditional historical building research.

Many recent publications describe historic gardens, parks or areas of cultivated landscape in terms of the places along their pathways, focusing on the sights, the events in the garden's history, or its unique features. This study focuses entirely on the pathways themselves: on their structure, the characteristics of their construction, the relief of the landscape as it relates to the pathways and the drainage and maintenance techniques used. Focusing on different types of path, this study documents experiences of using different cataloguing meth-

ods and uses this to develop improved and generally-applicable methods. This study is carried out not so much from an antiquarian perspective, but rather from a landscape gardening and historical point of view. It is not simply a case of taking stock, but more a matter of learning about the history of the pathways and of ensuring their future survival. Historical developments in construction, conception and composition should not just be read about or imagined but, instead, should be seen and understood. In a first step, specialist sources such as





Above: The great driveway at Windsor Castle. The master gardener Count Hermann Pückler-Muskau brought many of his ideas back from a study trip to Great Britain in the 19th century. Right: Visitors could stroll through Bad Muskau's historic park just as in an English garden. Here, an iron bridge adorned with fuchsias.

contemporary manuals and textbooks or historic planning information are used to gain an overview of historical construction methods and material usage during the last 250 years. This is done using portfolios, materials catalogues, military dossiers, construction records, and public or private archives and collections of pictures. For the analysis of these sources, it is important that historical constructions are examined in situ and that their construction is also compared with the relevant sources.

Pathways can also provide us with information about their own creation and construction – provided we know how to read the signs.

As a starting point, measurements of the structure to be examined should be taken. Every observation which is subsequently recorded

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### The evaluation of historical artefacts on site is complemented and consolidated by documentary sources

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provides an opportunity to ask further questions, which, in turn, lead to new answers. The on-site evaluation of these historic monuments is added to and enhanced by information from written sources, resulting in a kind of “stimulated dialogue”, which – once started and documented – can be picked up at any point and which can also be followed by

for the first time, selected examples are used to develop methods for cataloguing and documenting this cultural inheritance. In addition to the source study, supplementary structural recordings comprise the bulk of this research. Comprehensive examinations of the terrain are required to analyse

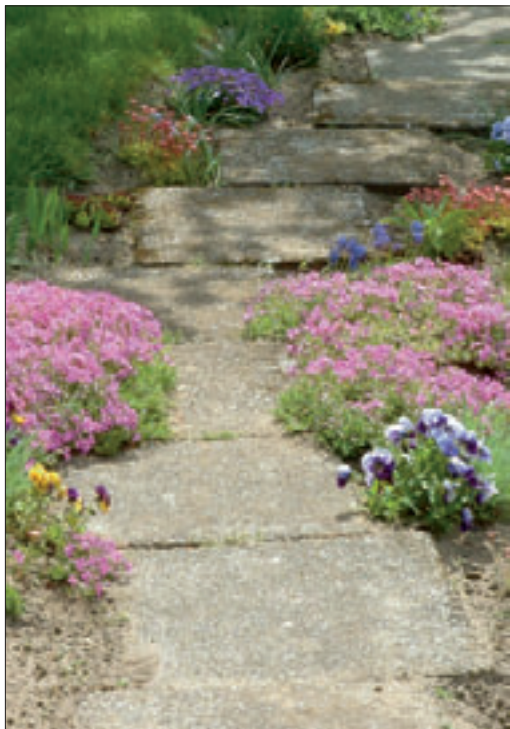
the layering of such historical structures and to pinpoint the materials used in each case. Correct determination of the building materials used is essential

for the quality of the results and provides a vital foundation for this type of study. Research conducted on-site is particularly time-consuming, all the more so because such gardens are usually under protection.

Drilling, digging or even excavation work requires authorisation from the appropriate conservation authorities. The evaluation of the local construction methods and visi-







Accents in parks and gardens: The large fountain (above) of the artificial water basin in the Großer Garten in Dresden. Left: The restored park at the Schlossinsel Rheinsberg. Archaeological studies were carried out for its reconstruction. Below: A historical stepping-stone path with ground cover plants. This picture shows the close relationship between the path itself and the plantings along its edges.

historic open-air monuments. They can be used in the continuing development of evaluation tools and methods, and they provide important information for maintenance. They also provide information about the "culture of restoration" itself, which enables historical reconstruction methods to be critically evaluated in hindsight. Many of the surviving historical monuments are endangered. Precise knowledge of the restoration required is an important prerequisite for research into gardening and landscape architecture from a cultural or conservation perspective. In helping us to communicate with our past, this research can contribute to the establishment of our cultural identity. For without our memories of the past, how can we speak to the future?

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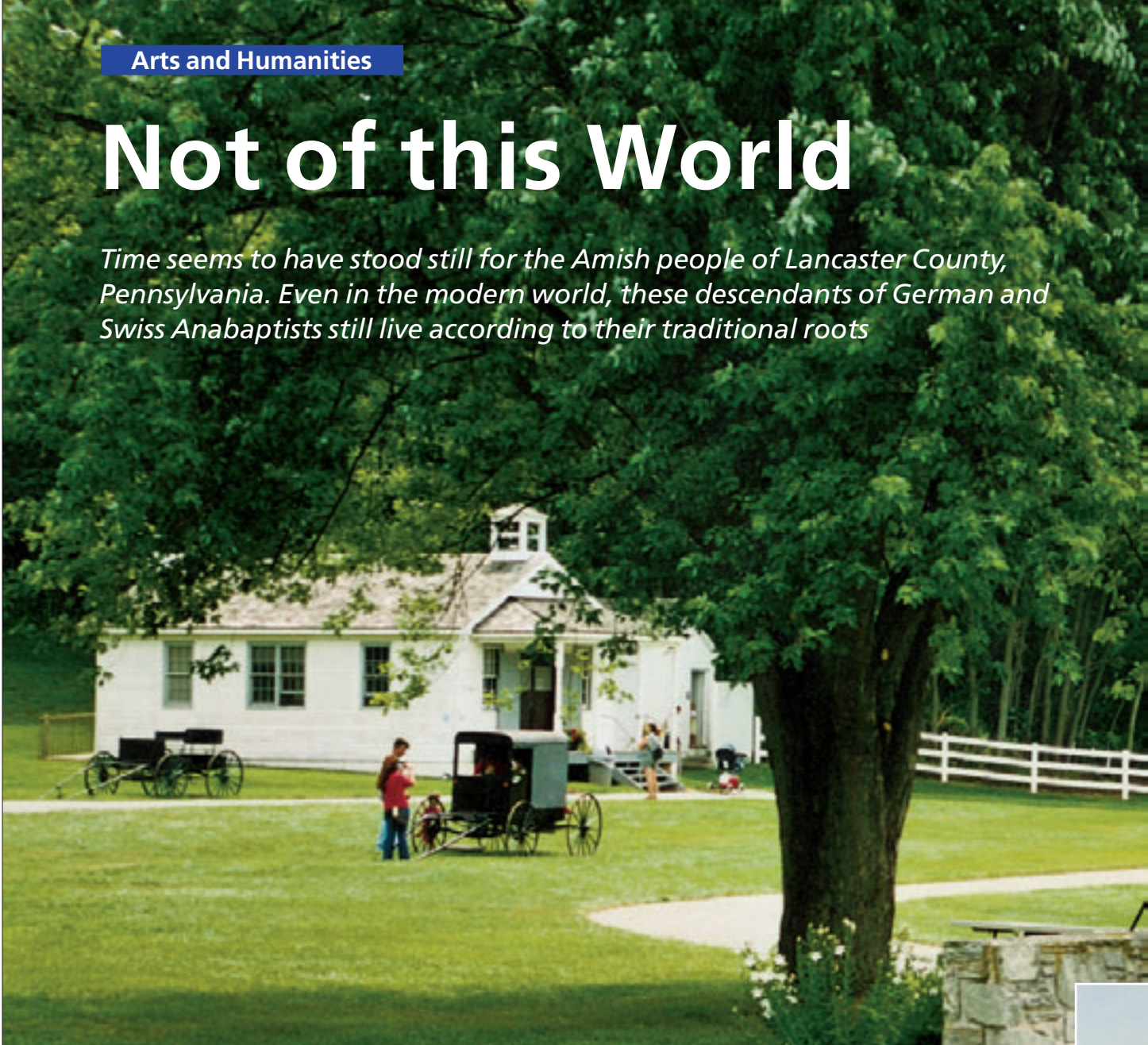
ble building techniques is supplemented by sources such as maps of country roads and construction plans, building applications, historical views of towns and cities, or paintings and etchings. The practical experience in dealing with historical building materials and methods gained in the preservation of historic gardens comes into play here. Improved cataloguing methods are being used to increase our knowledge of historical construction methods and materials. This, in turn, enables the cataloguing methods to be improved.

These results are relevant for a wide range of practical applications. They can also be used in the future cataloguing and renovation of such

► [www.gartenpatina.de](http://www.gartenpatina.de)

# Not of this World

*Time seems to have stood still for the Amish people of Lancaster County, Pennsylvania. Even in the modern world, these descendants of German and Swiss Anabaptists still live according to their traditional roots*



After a two-hour drive southwest from America's east coast metropolis, New York, you will reach Pennsylvania where you will discover a completely different world. Grey horse-drawn carriages mingle with modern traffic, teams of mules, driven by archaic-looking bearded farmers in dark clothing and wide-brimmed straw hats, plough the region's fertile fields, while women and children in plain and obviously old-fashioned clothing are to be seen in nearby shops. The Old Order Amish's overt cultural alienation still fascinates and impresses everyone who comes into contact with them. For centuries the Amish have insisted, in

accordance with their core biblical tenets, that they are "in the world, but not of it". This is their way of maintaining their identity in an ever more rapidly changing environment.

For almost 300 years, the Old Order Amish has been one of the most stable religious groups to develop from the so-called "radical wing" of the Reformation. Arising in around 1693 from a branch of Anabaptism, they fled religious intolerance in Europe during the 18th and 19th centuries, arriving in the New World in several migration periods. Today, their approximately 180,000 members make them a conspicuous part of the American population

mosaic. The most populous Amish settlements are in Ohio, Pennsylvania and in Indiana. Lancaster County in Pennsylvania is the oldest continuously-settled Amish region of the United States, and is the largest contiguous Amish settlement.

In addition to the Bible, the foundations of the Amish community's religious beliefs are the Dordrecht Confession of Faith of 1632 and the so-called Amish "Ordnung". While the Dordrecht Confession of Faith's 18 articles lay out the traditional fundamental principles such as defencelessness, adult baptism, foot washing during communion, excommunication and shunning the "world", the Ordnung describes the



Welcome to Old Order Amish country! In accordance with their conviction that "Close to the land is close to God", around 180,000 Amish in the United States live without electricity, radio or television. With their traditional culture and their separation from the world, the Amish community in south-eastern Pennsylvania has become a tourist attraction (small photo).

current implementation of the Amish faith in the modern world. The Ordnung defines what is "worldly" and therefore "non-Amish" and calls upon every member of the Amish community to distance themselves from harmful worldly pleasures, practices and ambitions in the interests of their

own salvation. These demands are embodied in pronounced social, cultural and economic symbols and customs, the most conspicuous and far-reaching of which are the regulations on the use of modern technology. Amish homes are not connected to the public utilities such as electricity and therefore do not have phones, radios, televisions, electric light, electrical tools and appliances or central heating. As well as this, Amish communities have their own education system of parochial schools or "one-room-schools", in which children between the ages of six and fifteen are taught together, require their members to adhere to a dress code and still speak their 25



own language – “Pennsylvania Dutch”. Even in their business dealings, the effects of the Ordnung are clearly evident. Traditionally the heads of Amish households have earned their living as farmers or craftsmen.

Farming has long been considered by the Amish to be the ideal lifestyle, as it serves the Amish principles of pursuing a modest, simple lifestyle and shunning the world. As they say, “Close to the land is close to God”. They maintain close contact with their families and limit

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**Despite their belief in separation from the modern world, Amish are affected by their surrounding society**

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their interaction with the rest of society. Despite its stable religious foundations, however, the Amish community of today cannot remain completely unaffected by the American society surrounding it. The core of the Amish settlement in Pennsylvania – Lancaster County – is located directly in the catchment area of the Atlantic megalopolis. The urbanisation of the area, high levels of tourism and traffic as well as general economic growth have put pressure on the Amish settlements and 26 have led to fierce competition over

land use. A further factor is the Amish’s unchecked population growth, which results from their religious beliefs and which creates large households, even leading to a kind of “Amish overpopulation” in some counties. This is even exacerbated by the fact that the Amish are strongly family-orientated – or “clannish”, as a member of the community once described it. The Amish’s close-knit family structures and their limited mobility mean that members of the group often choose to live near their families, a choice

which means that more households are springing up in already densely-populated Amish communities, creating a greater demand for land for homes and workplaces. As land is, however, both expensive and in short supply, buying a farm is now practically impossible due to limited availability. One result of this development is that the non-agricultural professions are becoming increasingly important to the Amish. The number of small and medium-sized Amish businesses has skyrocketed in the last few years and the jobs



they provide have been embraced by an increasing number of households. Whereas once 90 per cent of the heads of Amish households were farmers, this figure has now dropped to 50 per cent.

This development has not been without consequences for the Amish. For a long time now, the Amish have been doing more than just producing goods for the local or Amish market. Amish producers even provide wood and metal articles, food and skilled manual labour



gard this "threatening" development with concern, but cannot stop it, since half of all households in Lancaster County already depend on such economic activity.

Some bishops, however, formulate the link between the farming lifestyle and the membership of an Amish community very clearly: "If they get away from the farm, they soon get away from the church, at least after the first generation". Despite their many ideals to the contrary, progress has not completely

Opposite: Horse-drawn vehicles on modern roads are an everyday sight in Amish communities. Below: Even children adhere to the Amish dress code. Left: Amish people are known for their craftsmanship: a bookbinder at work. Below: The "buggy" is the most common means of transport and can also be found on road signs.



to large numbers of customers who live far beyond the county and state boundaries. This has dramatically increased the Amish's contact with the non-Amish world, and the adolescent Amish are losing the sense of separation from the non-Amish world still cultivated in farming households. The new professions also create new challenges concerning the technical equipment used. Hydraulic tools, powered by pressurised oil or compressed air, which only differ marginally from their

electrical equivalents, are used in production. Their energy requirements are met by high-volume diesel generators. Spacious modern workshops and sales premises, illuminated by state-of-the-art solar panels, are in no way inferior to their non-Amish counterparts. Fax machines and electronic cash registers are increasingly becoming standard equipment in Amish businesses and are indispensable for doing business with "worldly" customers and suppliers. Amish bishops re-

passed the Old Order Amish by. In many aspects of their lives they are having to establish closer connections with the society which surrounds them, and to implement new innovations in the interests of economic survival. They still, however, manage to maintain a certain distance from the high-tech culture that surrounds them, thus continuing to preserve their cultural identity.

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## 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 area of basic research through to applied research. Particular attention is paid to promoting young researchers. Every German scientist and academic is eligible to apply for DFG funding. Proposals are submitted to peer reviewers, who 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 12 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. Transregional Collaborative Research Centres 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 focuses 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*.

*Humanities Research Centres* were created in the new federal states to improve the existing research infrastructure. These centres have been established for a specific time period and serve to promote interdisciplinary research.

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 submitted within the framework of the *Hochschulbauförderungsgesetz*, a legal act which provides for major equipment and the construction of institutions of higher education in Germany. 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.

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The legal status of the DFG is that of a private association. Its member organisations include research universities, the Academies of Sciences and Humanities, the Max Planck Society, the Fraunhofer Society, the Leibniz Association, the Helmholtz Association of National Research Centres, research organisations of general importance, 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.

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## Illustrations

Dittert (cover, pp. 15, 16; private (p. 2); SFB 512 (pp. 4-7); Superbild (p. 8/9); Jennerjahn (pp. 10, 12 a. 12 c.); Klöpffer (pp. 11, 12 b.); Kirfel (p. 13); Siemes (p. 14); Hatt (pp. 18, 19); Forner (pp. 20-23); Hüsen (pp. 24/25, 26 a., 27 b. r., back); Vossen (pp. 24/25 b., 26 b., 27 a., 27 b. l.)

Layout of pictures: l.: left; r.: right;  
a.: above; c.: centre; b.: below

**M**oscow: 1st  
Kazachiy Per.  
5/2. That is

the address of the DFG liaison office  
in Russia. This is where contact and  
cooperation between Russian and  
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supported from.

