

# forschung

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# research

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Tropical forests shrouded in mist and cloud are a habitat for very diverse communities of species. But these mountain rain forests are endangered. Globally they now account for less than one percent of the world's total forested area. In Costa Rica scientists have studied this fascinating flora and gained new insights into this threatened ecosystem. **Page 4**

**Hot on the Heels of a Medieval Bestseller**

Jean de Mandeville was one of the best-known globetrotters of the 14th century and rose to fame as one of the first modern travel writers. His travelogue, commonly known as the *Voyages* or the *livre de Mandeville* was widely read in the late Middle Ages and was translated into ten European languages. Now researchers have been able to reconstruct the circulation of the French manuscripts of this "bestseller". **Page 12**

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An interdisciplinary research project involving zoologists and computer scientists has resulted in the Automated Bee Identification System, or ABIS for short. Using automated image analysis of the bees' wings, ABIS makes it possible to identify the bee species quickly and reliably, opening the door to the development of computer-aided methods for the determination of species. **Page 19**

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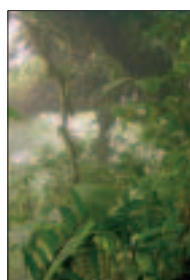
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**Montane Rain Forest Habitat**

The vegetation in Costa Rica's tropical cloud forest has adapted to the extremely wet climate. Researchers are studying the impact of changes on the ecosystem. (Page 4)  
 Cover: Achim Häger

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Companies have targets and mission statements. For the DFG, as a registered association, the first sentence of the first Article of its statutes includes both of these elements: "The DFG serves all branches of science and the humanities by funding research projects and facilitating cooperation among researchers." One of the other Articles says that the Executive Committee is "responsible for the management of the daily affairs of the DFG" and "is served" by Head Office to conduct the daily affairs. In other words, the Executive Committee determines the direction and bears the responsibility, while the administrative staff at Head Office do the actual day-to-day work. The DFG is a self-governing administrative organisation which serves the German science community.

These few provisions sum up the key principles for the work done by Head Office. And the same principles apply for Head Office as they do for the DFG itself, since it is – as a general rule – Head Office which acts on behalf of the DFG.

First things first: The DFG, as an organisation, is a service provider. The "research funding" is intended for "research projects" which are not specified by the DFG, but are devised by the researchers and scientists themselves. So it is all about research proposals, not contracts. At the DFG's Head Office you thus quickly realise that knowledge-oriented and applied research are not contradictory in terms, but in fact are complementary aspects of an indivisible scientific activity and that all the rhetorical expressions of such contradiction (such as "curiosity driven" or even "blue skies research") that are churned out by research policy utilitarianism are in fact hollow and misguided. This is an important realisation to make as soon as possible.

The service provided by the DFG does not consist solely of providing funding, but also – nowadays more than ever – of careful, competitive selection of the recipients of this funding. The recipients are from "all branches of science and the humanities". This puts the onus on

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petition between all of the disciplines and areas of research and to select the projects funded according to appropriate criteria.

Competition for research funding has become much more intense over the past decades. Just 30, or even 20, years ago, the DFG used to send a few hundred rejections each year. Now this has risen into the thousands. Less than half of the proposals submitted for the most important funding instrument, project funding through the Individual Grants Programme ("research grants"), were successful in 2003 and 2004, for the first time. In the period from January to October 2005 precisely 50.1 percent were successful. This makes fair competition particularly important. For each proposal Head Office begins by finding reviewers who are both able and willing to do justice to the project and those involved in it. Reviewers are sought both in Germany and – increasingly in recent years – abroad. Ability requires competence and neutrality, willingness requires availability and motivation. This is much easier said than done in real life though, and is anything but trivial. It demands not only cognitive abilities (such as understanding the projects, making decisions or being familiar with the applicants and the reviewers) of the staff at Head Office, but also administrative skills as well as persuasiveness, endurance and the willingness to learn and, if necessary, to revise one's opinion.

For the decision-making process, which is based on the reviews, Head Office is supported primarily by the Review Boards and the Joint Committee as well as by the Grants Committees on Collaborative Research Centres and Research Training Groups. According to the DFG's statutes the Review Boards are responsible for the quality of assessment of all proposals. They ensure that quality is maintained in the review process and reach their funding decision recommendations on the basis of the reviews. Generally Head Office drafts these recommendations, just as it is always active at every stage of a research proposal, as if it bore sole responsibility.

The fact that the responsibility actually rests with corporate bodies such as the Review Boards and the Joint Committee neither reduces the significance of the work done by Head Office in achieving the end result, nor the qualifications required to do it. (If you're wondering whether this doesn't go without saying, then you're quite right. It was the Federal Court of Auditors (Bundesrechnungshof), however, which put forward the argument that it isn't actually the DFG's employees who make the decisions and that they are thus overpaid.)

In November 2005 members of the Executive Committee and the Senate held a joint conference with the spokesmen of the Review Boards who had been elected at the end of 2003. The agenda for the meeting was "how to achieve best practice." The reservations about the principle that reviewers are selected by Head Office, which had been expressed during the preparations for the reform of the DFG's



peer review system, were all laid to rest. The consensus that the comparison of large numbers of proposals in an effort to select the very best is only possible by working together through discussion and aided by a consistent information base was of great importance to the Review Boards. Competition for DFG funding has not only intensified. The make-up of the participants has also changed. In addition to researchers and scientists as those conducting research, there are now also the universities and research institutes.

**C**ollaborative Research Centres, the first funding instrument intended for universities as institutions, was devised for the DFG by the German Science Council in order to enable the universities to enhance their research profile and bolster their competitiveness. This was accompanied by the intention to provide the DFG with more money to fund university research. In the same way, the Research

Training Groups, introduced in 1990, the Research Centres, introduced in 2000, and now the new Excellence Initiative have expanded the DFG's portfolio, all with new money, although the new programmes are, admittedly, earmarked. The fact that the proportion of the DFG's research funding budget allocated to the Individual Grants Programme has fallen is by no means due to a reduction in the amount of funding which it receives, but is a consequence of the addition of new money for new tasks.

The change in the make-up of those competing for funding from the DFG has initiated new forms of partnership between the DFG as a funding body and the scientific institutions. Nurturing and developing these partnerships is one of the key responsibilities of Department III – Coordinated Programmes and Infrastructure, which is located at Head Office, as well as Department II – Scientific Affairs, which is responsible for individual projects as

well as the development of entire disciplines. Not only has the scope of this responsibility widened with the addition of the Excellence Initiative's programmes, but the spirit of cooperation in the work at Head Office has also grown and reached new levels.

At the end of 2005 the DFG employed around 750 people, of whom slightly more than 175 occupied what may be described as "higher positions". What (apart from outstanding qualifications in their respective subject) does serving science require from them? What can they expect – in return, so to speak – from serving science?

**S**erving science at the DFG requires total personal commitment and a keen interest in research and in people. It requires the ability to be a good listener, empathy, discretion and common sense, all combined with unshakable loyalty to the DFG – to the DFG as an institution of all of the sciences and the humanities as well as those, who carry out research at the various research institutions (at least in Germany). Only if you are genuinely able to listen to, advise, act as an intermediary and – where necessary – console scientists and researchers in an unbiased manner, can you maintain trust and confidence in the DFG as an institution (and its Head Office), which is so crucial to its effectiveness. Confidence in the DFG, both from the scientific community as well as from politicians, is the most important reward for the good work they do. The German federal and state governments would not have given the DFG the incomparably demanding task of finally preparing Germany's best universities for the 21st century if they did not have full confidence in its abilities. This confidence needs to be newly won every working day.



Dr. Christoph Schneider

Dr. Christoph Schneider

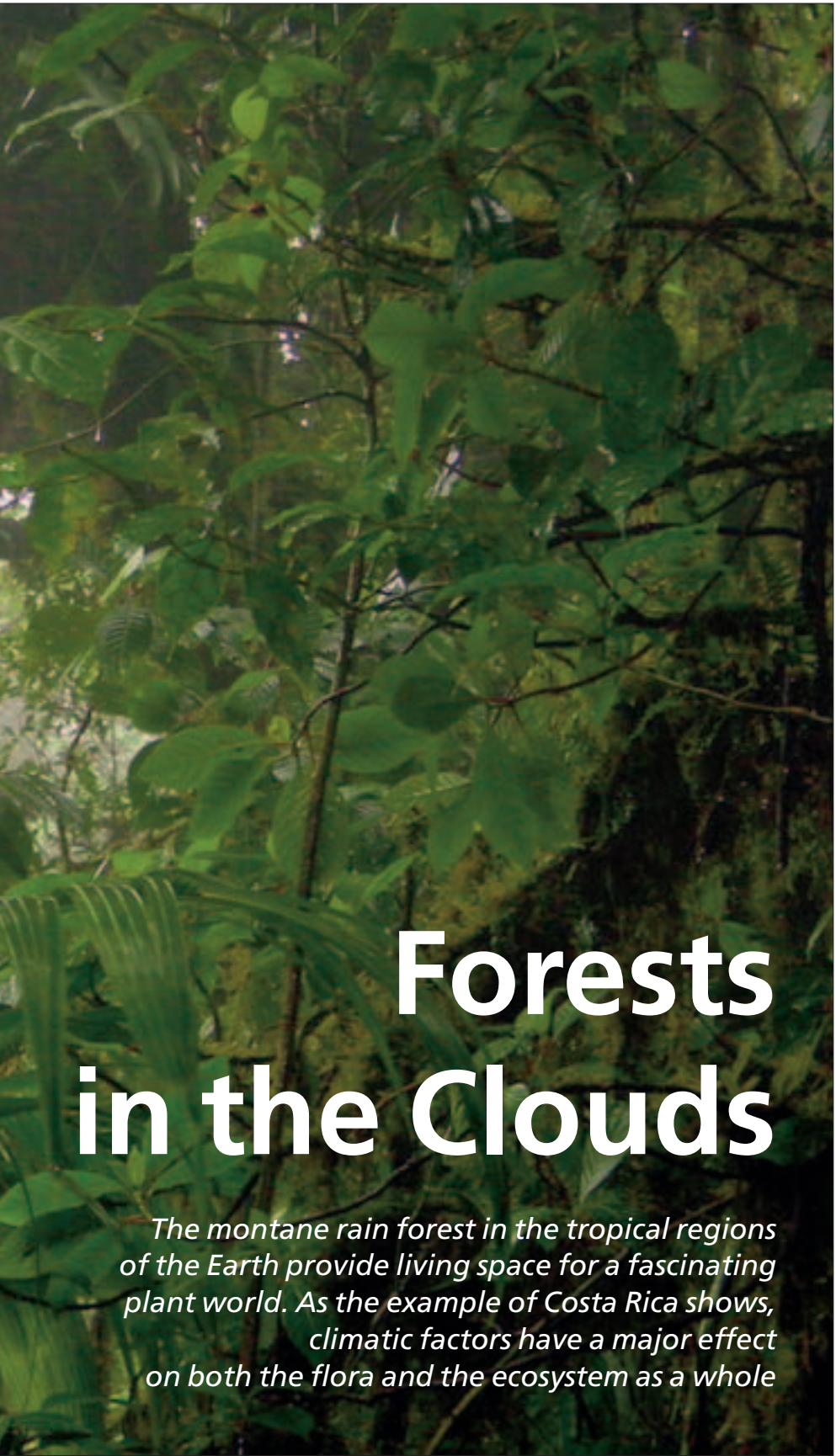
# Service and Performance

*The DFG promotes "all branches of science and the humanities". This means that its Head Office is obliged to adhere to the rules of fair competition between the disciplines and to select the projects it funds on the basis of quality*

Christoph Schneider was the Head of the Scientific Affairs Department at the DFG Head Office for many years.



On the floor of the cloud forest:  
The closely crowded and crooked trees  
are covered with mosses.  
Small picture: The bromeliad is an  
epiphyte which lives in the canopy far  
above the forest floor. It stores water in  
its rosette-shaped leaves.



# Forests in the Clouds

*The montane rain forest in the tropical regions of the Earth provide living space for a fascinating plant world. As the example of Costa Rica shows, climatic factors have a major effect on both the flora and the ecosystem as a whole*

Tropical cloud forests are found in the cordilleras of Central and South America, in Eastern and Central Africa, in Indonesia, Malaysia, the Philippines and Papua New Guinea and in the Caribbean. They occur in latitudes of between 23 degrees north and 25 degrees south in a narrow altitudinal band where the vegetation is regularly covered by dense clouds. This altitude can vary from a few hundred metres above sea level to almost 4,000. At present, tropical cloud forests make up less than one percent of the globe's total forested area, and, compared to tropical lowland rain forests, exhibit smaller tree stature and lower species diversity. In contrast, endemic species, i.e., those found only in specific, geographically-restricted areas, occur noticeably more frequently in cloud



forests. Such forests typically feature tree ferns in the lower to middle vegetation layers, while the trees are crowned with an abundance of epiphytes. The special climatic conditions mean that these epiphytes are not dependent on forest soils for their water supply. They also exhibit the greatest species diversity in the cloud forest zone and include primarily orchids, bromeliads, ferns and mosses. The mean temperatures of 8 to 20 degrees centigrade represent a mild-to-cool climate, with a fluctuating annual rainfall of between 500 and 6,000 millimetres; in extreme cases it may be as much as 10,000 millimetres per year (the annual rainfall in Germany is approximately 800 millimetres per year). An important peculiarity of the water household in these re-



gions is the additional precipitation generated by the so-called “stripping” of clouds and mist by the vegetation. In numerous tropical regions, particularly those influenced by a wet-dry climate, the local people rely upon this water for drinking, hydro-electricity or agricultural purposes.

The global status of tropical montane rain forests is under alarming pressure from the expanding population, poverty and uncontrolled land use. During the 1980s, the annual rate of deforestation reached 2.5 million hectares. In Columbia, a country which contains one of the largest areas of cloud forest in Central and South America, just 10 to 20 percent of the original forest remains. Global climate change, alteration of the regional climate after extensive deforestation and the loss and division of biotopes threaten many of the characteristic species living in cloud forests. The golden toad, for example, which was uniquely indigenous to Costa Rica, has suddenly disappeared from the Monteverde Reserve – along with a further 24 amphibian species. It is remarkable that there are sustainable utilisation strategies for tropical montane rain forests. These include so-called “agro-forestry” systems, in which timber and agricultural products are simultaneously produced in the same area. In some regions, ecotourism, with its indirect potential for benefits plays a significant role. Knowledge of the general ecological, economical and social conditions is essential in order to be able to take advantage of the diverse opportunities offered by such ecosystems.

In view of this, the primary objective, using Costa Rica as an example, was to study the relationships between the general ecological conditions and structures, including the biodiversity of various forest

Above: A fairytale thicket. The cloud forest is also known as an elfin or dwarf forest. The trees covered in mosses are adapted to an extremely wet climate. Below: The canopy of giant trees – here, a 30-metre high strangler fig – can be reached only with the aid of ropes.



Collapsed forest giant. Not only in Costa Rica's Monteverde Reserve is the cloud forest biotope becoming increasingly smaller. At present, tropical cloud forests make up less than one percent of the world's forests.

formations in Monteverde. This private reserve, which is managed by the Centro Científico Tropical in San José, is located in northwest Costa Rica, on both sides of the continental watershed of Central America at an altitude of between 900 and 1,800 metres. Together with adjacent protected areas, it forms a continuous forested area of almost 40,000 hectares.

The central mountain ridge of the Tilarán Cordillera forms the continental watershed between the Atlantic and the Pacific Oceans. There are huge climatic differences and a variety of different types of forest in this region. In this respect, the Monteverde Reserve also makes a suitable natural laboratory in which to study the influence of climate changes on the ecosystem. The Pacific side of the Cordillera is more exposed to the dry season from January to May, whereas the wetter Atlantic side is influenced by the northeast trade winds and is thus swathed in clouds for most of the year. The climatic conditions were recorded by seven measuring stations installed along a three-kilometre stretch which traverses the mountain ridge. The structure and composition of the forests in the vicinity of the climate stations was also studied.

From March 2003 to February 2004, the rainfall on the western slopes was 3,700 millimetres, which was "only" 60 percent of that measured on the eastern side of the ridge at the same altitude (1,200 metres). The ridge zone itself has a harsh climate. The mean wind speed and the level of additional precipitation stripped from the clouds are considerably higher than those at lower altitudes. Here, the cloud precipitation of 3,600 millimetres was approximately 130 times higher than that measured on the leeward side of the Cordillera, while





the daily and seasonal fluctuations of temperature and humidity increase with decreasing altitude. Measuring the precipitation within the cloud forests confirmed these findings. Generally, higher precipitation was registered on the forest floor in locations exposed to wind and clouds than above the canopy. This unusual phenomenon on the Atlantic side indicates the generation of additional quantities of water due to cloud stripping. On the Pacific side, noticeably less rain was registered under the canopy than on open land because a large proportion of the precipitation clings to the tree crowns and evaporates.

The epiphytes are good indicators of these climatic differences. The number and diversity of these plants is very high in the entire study area; their biomass (plants

and humus) exceeds 30 tons per hectare in certain areas. Representative sampling on trees revealed that the biomass analysed was several tons higher per hectare in the humid, wind-exposed locations than on the dryer Pacific side. Approximately half the number of epiphytic species was found in the dryer areas. In the vicinity of the ridge, up to 69 different species of

vascular plants per tree were counted. Epiphytic mosses reacted particularly sensitively to a drop in humidity.

The growth of the trees exhibited an inverse tendency. The forests on the steep, exposed slopes and the marshy plateaus in the ridge zone are very dense, with the trees attaining heights of just 5 to 15 metres. In contrast, in protected, lower-

View from the mountain ridge (above):

The northeast trade winds bring a continuous mass of clouds. From great heights, the lush vegetation resembles a green carpet, with differences being visible only when viewed close to.

Right: The luxuriant epiphytes show off their beauty in the canopy of the tropical montane rain forests. In spite of the harsh conditions in this stormy biotope, their diversity of species is considerable.



# Life at Lofty Heights

*Studies of moths in Borneo provide new clues to understanding the diversity of tropical species and in assessing the consequences of deforestation*



lying locations, the trees are more than 30 metres tall and the number of tree species also increases. On the Pacific side, up to 33 tree species – more than half the number of indigenous tree species in the whole of Germany – were found in an area measuring just 500 square metres. There is also a distinctive change in the types of species prevalent at high altitudes on the wet-dry Pacific side.

A weekly check of a three kilometre-long strip of forest covering 15 hectares over a period of almost two years revealed impressive forest dynamics. Under the continuous influence of the northeast trade winds and the high precipitation rates, regular “disturbances” have a major influence on the development of the cloud forest. These events include the collapse of individual trees, the gradual erosion of the tree canopy and the loss of whole areas of forest due to landslides. The areas most affected are waterlogged, wind-exposed locations and steep slopes. Extrapolating the available results shows that a forest generation in this area would completely renew itself in less than 200 years.

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Achim Häger  
Universität Göttingen*

**T**he destruction of virgin tropical rain forests is proceeding very rapidly. Secondary forests, as ecosystems which have been influenced to a greater or lesser degree by mankind through natural regeneration or reforestation as a “replacement virgin forest”, therefore play an increasingly important role in nature conservation strategies in tropical regions. Investigations into the influence of varying levels of human intervention on organisms in tropical habitats have hitherto been chiefly limited to plants or vertebrates, with relatively little attention being paid to the effects on the more diverse insect kingdom or on other invertebrates.

Mount Kinabalu in northern Borneo, the highest mountain between the Himalayas and the mountains of New Guinea, is a biodiversity hotspot. It is a region housing a particularly rich diversity of species, and is home to a high proportion of creatures unique to this area. Whereas most groups of animals in tropical montane regions exhibit considerably less species diversity as the altitude increases, the highest number of species in many moth families are found not in lowland forests, but in the lower montane rain forest zone at an altitude of approximately 1,000 to 1,500 metres. A research team from the University of Bayreuth studied this area to discover how the local tropical moths – as representatives of the particularly diverse group of herbivorous insects – react to changes in their environment. The studies performed on these moths made use of a methodological advantage: because the

moths can be lured by UV light sources, standardised surveys could also be carried out in habitats that were difficult to access. Within tropical forests, the treetops are regarded as the stratum of vegetation with the highest number of species because the greatest proportion of the photosynthesis is carried out here. In contrast, in the forests of northern Borneo, several particularly diverse groups of moths, such as *Geometridae* and *Pyraloidae*, have comparable or even higher species diversity close to the ground. The reasons for this are the inedibility of the leaves of many canopy trees and the higher number of natural predators, such as ants and birds, which make life in the treetops difficult for herbivorous butterflies.

On the other hand, those moths which are heavily dependent on flower nectar for their main source of food are found in higher numbers and exhibit greater species diversity in the treetops where the supply of flowers is at its greatest. *Sphingidae* (hawk moths), especially, display a particularly marked preference for living at lofty heights because they are very fast and long-lived and rely on the continuous supply of flower nectar. Six times as many *Sphingidae* were observed in the treetops as close to the ground. Observations show that the availability of certain food resources in the different areas of vegetation plays a decisive role in the vertical distribution of insects in rain forests.

The economic and demographic conditions in most tropical countries mean that human-influenced habitats, such as secondary forest and



agroecosystems, are having an increasing effect on the landscape. At the same time, near-natural habitats are being forced to retreat to ever-diminishing protected "islands". It is therefore essential for modern nature conservation concepts to place more importance on secondary forests or agricultural areas as buffer zones and to provide links between protected areas. The potential of such man-made habitats to serve as habitat for herbivorous insects was studied by the research team on the basis of the diversity of *Pyraloidea* moths. More than 850 *Pyraloidea* species were found thus far in Mount Kinabalu National Park with an area of 730 square kilometres – more than are found over an area of 10.5 million square kilometres in Europe. These figures illustrate the tremendous diversity of moth species in tropical latitudes. Studies carried out on the outskirts of the National Park also showed a remarkable similarity to the species diversity in forests with differing levels of disturbance. This diversity, however, had noticeably decreased at locations just a kilometre from the closed forest. This shows that areas of small-scale cultivation close to the forest greatly profit from the continuous immigration of "forest species". It is, however, difficult to estimate which species are actually able to find sufficiently adequate living conditions in the disturbed

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enduring population. Nevertheless, the strong correlation between the occurrence of common moth species in the various types of forest and in the extremely disturbed open land close to the forest does indeed provide a first indication. These species must be finding suitable conditions for permanent colonisation in the more intensely disturbed habitats as well – not least because the *Pyraloidea* populations in the habitats disturbed by mankind do not differ greatly in frequency from those in the forest.

The diversity of moths in secondary tropical forests is only slightly lower than that in primary forests, although the composition of the communities has indeed shifted. This leads us to the conclusion that many moth species are directly dependent





Left: A Pyraloid moth from Mount Kinabalu. Centre: Areas of ancient forest provide an ideal habitat for moths of the genus *Cydalima*. Right: The hawk moth *Daphnusa ocellaris* lives in the rain forests of Southeast Asia, which also include the montane forests of Mount Kinabalu (below) on the island of Borneo.

neither on a closed tree canopy nor on the survival of mature trees. Instead, the decisive factor for many tropical moths appears to be the richest possible vegetation on the forest floor. This means that the same situation could arise in Borneo as in Central Europe, in which the conversion of primary forests into near-natural secondary forests resulted in only a moderate loss of species diversity. There are, for example, far fewer endangered or protected butterfly species to be found in deciduous forests in Germany than in open locations, although nearly all Central Europe's present-day deciduous forests are reforested areas.

Man-made forest habitats can therefore play an important role in the conservation of a variety of tropical insects. Nevertheless, the highest priority must be given to establishing the largest possible proportion of the remaining near-natural virgin forests as protected areas. Greater efforts to sustain and manage existing protected areas are also necessary. Not only are these protected areas essential sources for the colonisation of newly-created man-made habitats, but many organisms also react very sensitively to changes in the forest structure. Particular attention must be paid to the remaining lowland forests. In Borneo, most of those outside nature reserves have been almost completely destroyed over the last few decades. Even though the widest range of moth species does not usually occur in lowland areas, these regions nevertheless provide a haven for a unique section of the species which can no longer find a suitable habitat in the cooler, more inaccessible mountain forests.

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# Mandeville's Journey into the Big, Wide World

*Jean de Mandeville and his report of a fantastic journey around the world were once as well-known as Marco Polo. The distribution of the French manuscript versions of this medieval "bestseller" can now be reconstructed*

Who hasn't heard of the Venetian trader, envoy and storyteller Marco Polo? In 1271 the young merchant set off on a trading voyage to China with his father and an uncle, then entered the service of the Mongolian ruler Kublai-Khan and did not return to his home town for another 24 years.

This is the accepted version of the story, and, while there are those who doubt that Marco Polo ever set foot on Chinese soil, his popularity has not suffered as a result. How different, then, is the fate of another 14th-century traveller, Jean de Mandeville, who today is entirely unknown to the general public. According to his account, the knight left his English hometown of St Albans in 1322, travelled through North Africa to the Holy Land, and then crossed the Middle East to China, finally reaching the court of the Great Khan. In 1357, after further travels, his health forced him to retire to an unknown location to record his memoirs in French. In the late Middle Ages, his travelogue, commonly known as the *Voyages* or the *livre de Mandeville*, was extremely popular, as more than 300 surviving manuscripts in ten European languages testify. By comparison, around 130 copies of Marco Polo's book were handed down in seven languages.

That his reputation has today paled into insignificance may have something to do with the fact we are almost certain that Jean de Mandeville did not undertake his journey himself. So far, it has not even

been possible to connect him with a historical figure. Instead, it is far more likely that he is the – probably fictitious – first-person narrator created by an erudite author who drew on a variety of ancient and medieval texts for inspiration, including reports by travellers and pilgrims, other literary, historical and religious texts, as well as scientific encyclopaedias. This enabled him to create a travelogue based on what seemed to be personal experience, in which he reported on all the then known countries of the world, their inhabitants, customs and traditions, languages and religions. Educational literature of this type was obviously popular with readers in the late Middle Ages, as has been shown by studies of the written tradition in the German-speaking world.

But how was it received by the Southern European public? The *livre's* transmission and reception history has been reconstructed using 28 French manuscripts. All the writings examined belong to what is known as the Continental French version of the Mandeville text, date almost exclusively from the late 14th and 15th century, and were created mainly in Paris and in eastern France, in what was once the Burgundy sphere of influence.

This group of writings also includes the oldest dated Parisian copy. In 1371, Gervaise Chrétien, the first court physician to the French King Charles V, commissioned a copy from a well-known Paris scribe in order to present his King with the *livre de Mandeville*,

perhaps as a New Year's gift. According to the transmission history, the *livre* was already known in the Northern French and Flemish-speaking areas, which gives credence to the theory that the text originated in this region. Not only is there a lack of conclusive evidence for Jean de Mandeville's existence, but unfortunately the original text has also been lost.

Seven more of the surviving manuscripts were created in Charles V's environment. Minute comparison of the individual manuscripts, using the process known as collation, has thrown up striking textual similarities between them. There are also striking similarities in the way the manuscripts are decorated. Unlike the French King's copy, however, the names of the writers, patrons and owners of these precious books are unknown. The elaborately-coloured decorative elements, like miniatures, borders and capital letters, extravagantly overlaid in gold, the entries in the catalogues of book collections from the late Middle Ages, and the evidence of ownership in other Continental French manuscripts, indicate

This beautifully illustrated manuscript of the *livre de Mandeville* was created in 1371 for the French King Charles V.

The four clover-leaf-shaped scenes show the knight Mandeville writing his work (top left), the manuscript being presented to the King (top right), and (below) two images from what is known as the "dragon legend".



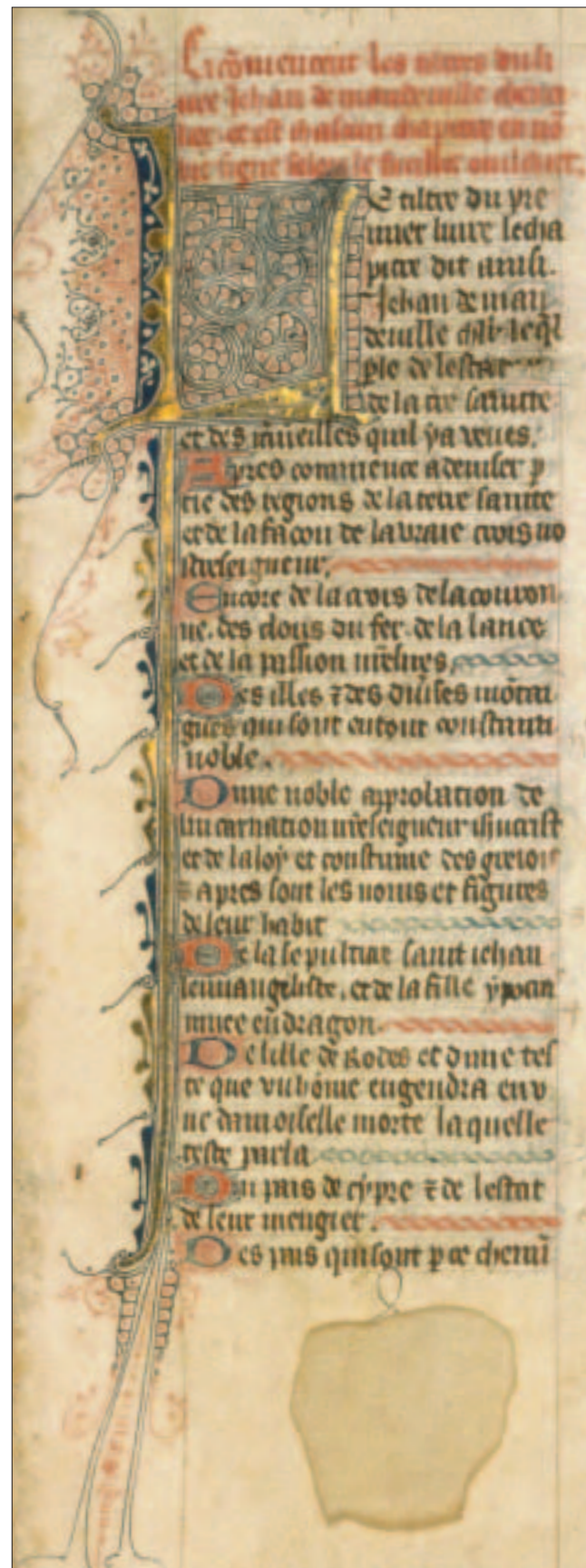
**S**omme il soit auant. *Et comence le liure Jehan de*  
*que la terre doulce mer. Mandeville chevalier*  
*est assaouir la terre sainte. le quel parle de l'estat*  
*la terre de promission. entre de la terre sainte a des*  
*toutes autres soit la plus excellent merueille*  
*et la plus digne et digne a souverain de toutes que il y a*  
*autres terres. Et soit tenoit saintefice et consacree tres*  
*du piecieux corps et du piecieux sanc nuel ihu crist ou il li*  
*plaisoit soy en ymbier en la vierge mane et d'ice humaine*  
*pendre et nourrir. Et la dite tenoit garder et enuironer*  
*de ses tenoies roies. Et la route il menoit nuade faire et par*

that the *livre de Mandeville* was circulated among the French-speaking world's upper aristocracy. Indeed, the French King's library, which was housed on several floors of a tower in the Louvre, contained three copies of the *livre de Mandeville* until 1424. Charles V's brothers also had Mandeville copies; in 1388, a copy was created for Valentina Visconti, Charles V's daughter in law, which is today preserved in the Biblioteca Estense in Modena. Valentina's son, the poet Duke Charles of Orléans, also owned a Mandeville. The *livre* is also found in aristocratic book collections in the areas ruled by the Dukes of Burgundy.

The reading habits of the French and Burgundian nobility also influ-

enced those living far beyond the borders of their respective domains: in 1380, for example, the later King of Aragon, John I, (who ruled from 1387 onwards), requested a *livre de Mandeville* from the French royal family. Short-

Below: The dedication scene of a manuscript created around 1460 shows the *livre de Mandeville* being presented by a kneeling figure. Decorative elements, such as miniatures, ornate borders and capital letters give each manuscript a unique appearance.







Left: An ornately decorated manuscript of the *livre de Mandeville*. It has been dated to the second half of the 14th century and was created in Paris. This manuscript, too, is based on the Continental French version of the Mandeville text. Above: A colourful miniature from a particularly elaborate 14th-century manuscript.

ly afterwards, Aragonese, Catalan and Castilian translations of the text were created. In Italy, the Dukes of Milan are presumed to have been responsible for the best-seller's distribution, as an Italian translation of the text was known to have been in circulation there since at least 1400.

From the Southern Tyrol, the *livre de Mandeville* began its journey to the southern German-speaking world. Since the end of the 14th century the text was also known in Dutch.

The distribution of the Mandeville text was extremely rapid. In addition to the manuscripts mentioned, all of which can be traced back to the Continental French version, the text was available in the 15th century in a second German translation, as well as in English, Irish, Latin, Czech and Danish. The translations and the nu-

merous Mandeville manuscripts in historic book collections and libraries tell us much about the degree of renown and popularity enjoyed by the *livre de Mandeville* during the 14th and 15th century. There is no lack of explanations for the "Mandeville phenomenon": the blending of a classic tour of the holy land with travels through the Orient and the combination of real and fictional narrative appealed to a wide audience. The author of the *livre* also knew how to make his vast array of material more appealing by disguising it as a travelogue, enabling him to bring his writings to an unlearned audience. Lovers of mythical tales

are as well-served here as those interested in the genealogy of the Egyptian sultans, in Jerusalem's sacred sites, in the shape of the Earth, or in life at the court of

the Mongolian leader. There is no doubt that the *livre de Mandeville* catered to a variety of different tastes. This enabled it to become a bestseller – one which seems to put Marco Polo's (today) much better-known travelogue in the shade.

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### The travelogue *livre de Mandeville* catered to a variety of tastes and thus became a medieval bestseller

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Dr. Susanne Röhl  
Universität Paderborn 15



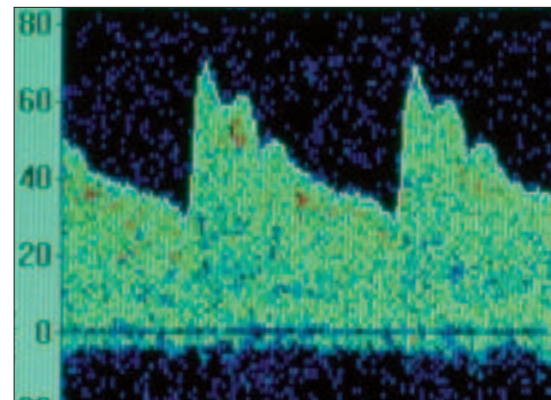
# Blood Pressure and Daily Life

*Does chronically low blood pressure impair the brain's performance? Psychological performance tests and modern measurement techniques provide a novel answer*

Individuals who consult a doctor complaining of symptoms such as dizziness, tiredness, difficulty concentrating or a general reduction in performance levels are often diagnosed with "low blood pressure" (hypotension). More often than not, they are told that this condition is harmless. The majority of doctors are of the opinion that hypotension is not an actual disease, despite the often subjectively negative symptoms experienced by 16 those affected. Nevertheless, the

symptoms frequently result in doctor's appointments and lost working hours, which mean that hypotension cannot be ignored from a health economics perspective. To what extent these symptoms, especially those affecting mental performance, actually are empirically measurable and whether they are based on a detectable regulatory disorder of brain function has so far remained open to question for basic research in psychology. The World Health Organization (WHO) defines

hypotension as a state where the systolic blood pressure is less than 100 mmHg. Approximately three percent of the population – predominantly young women – is affected by this condition. Compared with high blood pressure (hypertension) whose risk potential for cardiovascular diseases is undisputed, hypotension certainly can be viewed as being harmless. Because of the lower pressure load on the blood vessels, those affected even have an above-average life expectancy. Furthermore, a physical cause for hypotension cannot usually be found. However, it frequently occurs in in-



In this psychological concentration test all the letters „d“ that are enclosed by two lines must be marked as rapidly as possible. A new study shows that subjects with low blood pressure make more mistakes than subjects with normal blood pressure values.

dividuals of low body weight, those who engage in little physical activity and those who consume insufficient fluids.

In the light of this, individuals with low blood pressure were first subjected to psychological performance tests that contained tasks involving memory, mental calculation and concentration. In fact, it was found that their performance in nearly all of the tests was significantly worse than that of subjects with normal blood pressure. The greatest difficulties were encountered in those tasks involving attentiveness and concentration. Naturally, the extent of these performance reductions are not comparable to cognitive “deficits” that occur in brain injuries or neurological diseases. Nevertheless, they are large enough to result in impairment in daily life such as in certain occupational activities or in motor vehicle traffic.

A second step examined whether reduced blood supply to the brain is present in hypotension and whether this could be the cause of these performance reductions. The metabolism of nerve cells in the brain requires a constant supply of oxygen and glucose. If the cerebral perfusion is insufficient, the available oxygen is consumed rapidly and more or less serious functional deficits occur. For this reason, the

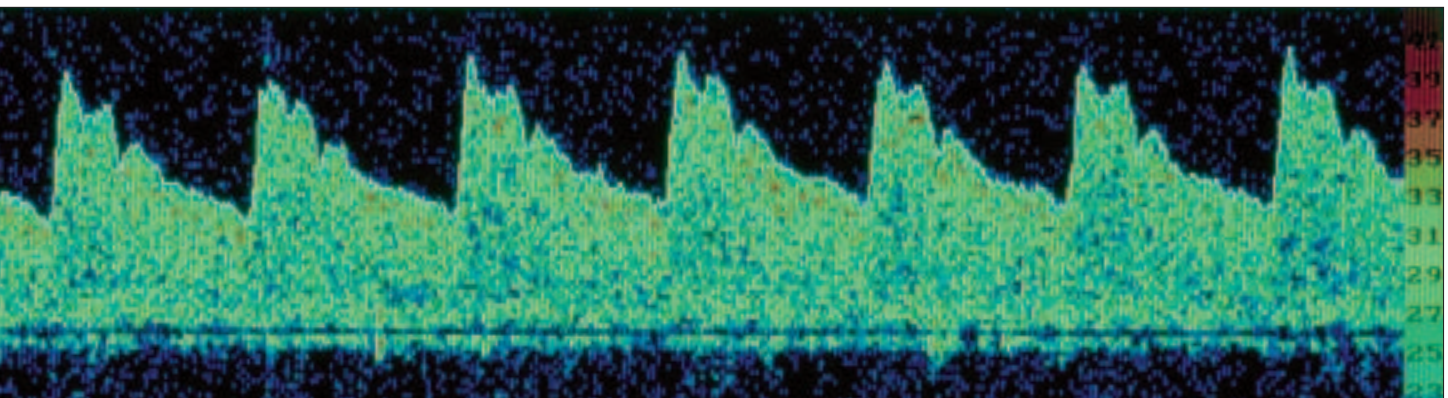


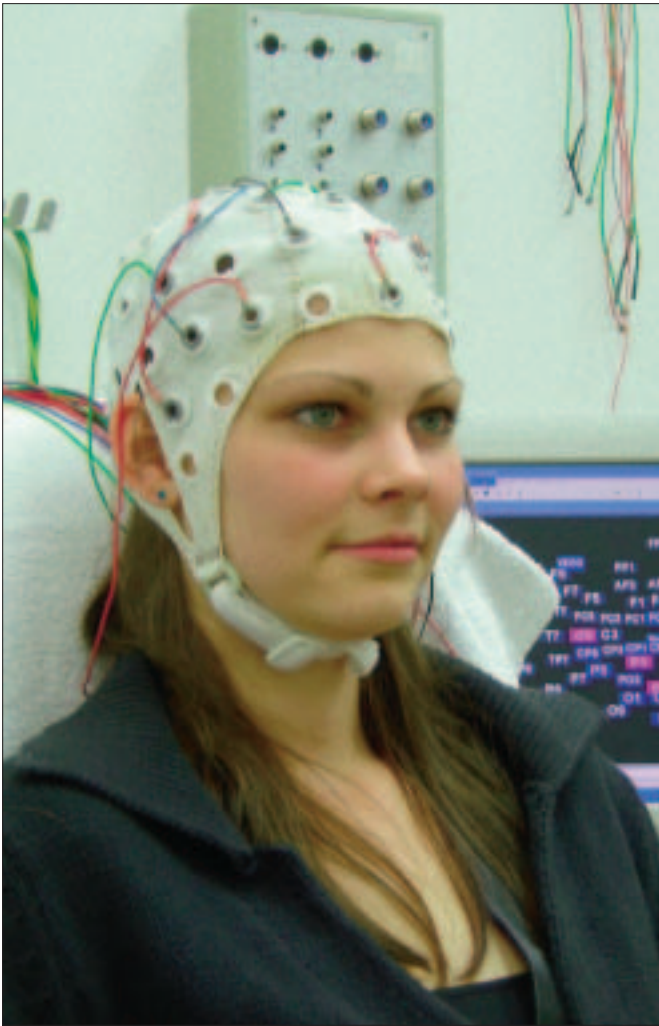
brain is better protected than any other human organ against potentially inadequate blood supply. A mechanism called “cerebral autoregulation” ensures that if the blood pressure falls the cerebral arteries immediately dilate to enable increased blood flow. According to the prevalent medical doctrine, this mechanism also should prevent hypoperfusion of the brain in chronically low blood pressure. The question which therefore arises is how a decrease in mental performance can result due to hypotension.

The technique of “transcranial Doppler sonography” was used to

determine whether the perfusion of the brain is actually diminished in low blood pressure. This ultrasound technique enables the measurement of the velocity of the blood flow in the cerebral arteries. In our case the blood flow in the “middle

Above: An ultrasound examination helps to measure the velocity of the blood flowing through a vessel. A probe is first used to locate the arteries in the brain. On the screen (below) the signals can be displayed as a graph. The blood flow changes with the rhythm of the heart beat.





Brain currents can be recorded using electroencephalography (EEG). The electrodes are placed on the scalp and in this manner measure the electrical activity of the human brain.

cerebral arteries" of both brain hemispheres was measured. These arteries are responsible for the blood supply to large regions of the brain in which several important centers for concentration and memory functions are located. Hypotensive individuals when compared with normotensive control subjects did in fact exhibit a significantly slower blood flow in these arteries. Cerebral autoregulation is apparently not sufficient to compensate for the low blood pressure. Therefore, the nerve cells receive less blood, which means that the nerve cells' "working conditions" deteriorate.

In light of the reduced cognitive performance in hypotension, it was important to test the cerebral perfusion not only at rest, but also under conditions of mental stress. The experiments demonstrated a surprising flexibility of the regulation of blood flow. Attention, thought and memory processes were accompanied by an immediate increase in cerebral perfusion. In this way the increased oxygen and nutrient requirements in the active regions of the brain can be met. With this continuous adjustment of

the blood supply to the brain activity, the circulatory system creates ideal working conditions for the nerve cells.

To clarify whether this ability to adapt is possibly limited in hypotension, the flow velocities in both middle cerebral arteries were measured again. This time the subjects were engaged in tasks on a computer requiring concentration. As had been expected, perfusion increased while the tasks were being performed. However, the extent of this increase was comparatively low in hypotensive subjects. Their value was on average 40 percent below that of the control group with normal blood pressure.

Interestingly, performance in the cognitive tasks was best in those subjects who exhibited the greatest increase in cerebral blood flow. This emphasizes that optimal mental

performance actually depends on the continuous adaptation of the blood flow to the brain's activity. This adaptation is only possible to a limited extent in hypotension.

The fact that the brain does not achieve its maximum performance capacity in hypotension was also shown in studies that were performed using electroencephalography (EEG). This technique enables the measurement of electrical voltages (potentials) that arise while the nerve cells are working. In simple concentration and reaction tasks the EEG shows a typical, short-term potential negative shift. In individuals with low blood pressure this potential shift turned out to be relatively weak. From these results it is possible to deduce a low electrical activity of the nerve cell groups involved in concentration activities, which is probably due to the unfavourable perfusion situation. Moreover, at rest the EEG exhibited a comparatively high proportion of so-called alpha waves. These occur especially when a person is very relaxed or sleepy. This is consistent with the tiredness in day-to-day life which is frequently reported by hypotensive individuals.

**T**hese research results show that the brain in individuals with low blood pressure must perform its work under more difficult conditions and is therefore unable to exploit its full performance capacity. However, a question that still remains unanswered concerns the role played by the brain itself in the creation of hypotension. By means of neural pathways to the heart and the blood vessels as well as through hormones, the circulatory centres of the brain participate significantly in the regulation of blood pressure. If a malfunction exists in these regulatory centres, it is possible that the brain is not only the victim of an unfavourable physiological situation, but also contributes to the more difficult working conditions it is subjected to.

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# The Science of “Fingerprinting” Bees

*The ABIS system allows the rapid and accurate identification of bee species. This process is based on automatic image analysis of the bee’s wings and enables the development of new, computer-aided methods to identify the bee species*

**B**iological systematics has been gaining in international significance since the Convention on Biological Diversity (CBD) held in Rio in 1992. In biology, the term “systematics” denotes the description of individual animal and plant species and their classification within an evolutionary tree that describes their evolutionary history. A specialised domain within systematics is biodiversity research, which investigates species diversity of a specific region. Cataloguing the dwindling number of species on the Earth for conservation purposes and securing the economic utilisation of animal and plant species in agriculture, chemistry and pharmacology has become a race against time. Owing to the urgency of these tasks, recording, processing and archiving species inventories without the aid

of computers is no longer possible. This has led to a new field of research: biodiversity informatics.

A key issue in conserving natural landscapes and securing crop yields is the identification of the species that pollinate these plants. Due to the large number of species and their very narrow food specialisation, bees are some of the most important pollinators of our wild plants and crops.

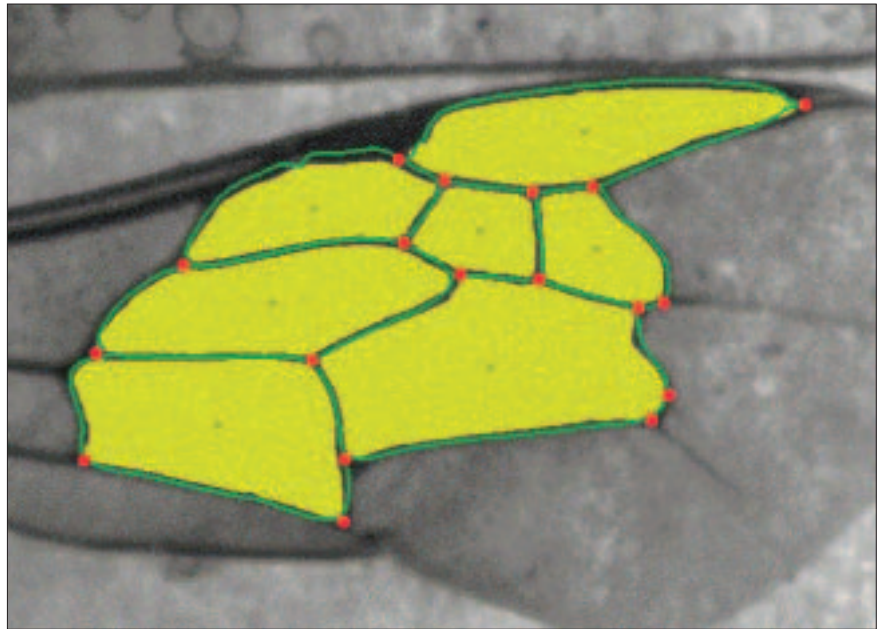
The Automated Bee Identification System, or “ABIS” for short, was developed as part of an interdisciplinary research project involving zoologists and computer scientists and enables the rapid and reliable identification of bee species. ABIS can also be used to indicate the properties of natural landscapes and their state of preservation because, on account of their specialisation, bees

can be used to identify very characteristic features of their habitat, such as types of vegetation and soil. The fact that ABIS is mobile and can be used to identify live specimens in the field also opens up new opportunities for carrying out monitoring studies to identify and monitor the number of animals living in a specific area over a specific period of time. The advantages of ABIS include the relatively low amount of equipment required compared to biochemical and molecular genetics methods and the possibility of mobile field

A mounted wing: The bee is anaesthetised before it is mounted in a holding clip. The wing can now be photographed for identification of the species. This is carried out with the Automated Bee Identification System, ABIS, a system that reliably identifies bee species.



After photography and analysis of the wing image using the ABIS system, the characteristic wing features can be seen: The green lines represent the veins, the red dots the vein junctions and the yellow areas the skin cells. Adjacent picture: The species is determined using a family-specific specimen wing.



investigations, as well as the identification of live bees.

What, though, is the most efficient approach to identify bee species automatically? Taxonomists identify species on the basis of visible differences between various morphological characteristics, such as shapes and colours of the body, head, antennae, legs and wings. This time-consuming process is not viable for automatic species identification. Instead, an automated, computer-aided identification of the species should be based on just a few, easily perceptible physical characteristics.

The bees' wings were chosen for this. The bee family belongs to the *Hymenoptera* order within the insect class. Bees have almost transparent, membranous wings that, on closer inspection, exhibit a distinctive network of veins. Can this network of veins be used as a "fingerprint" for the accurate identification of a species? Identification rates of

up to 97 percent have been obtained with the ABIS system, providing impressive confirmation of the suitability of using this feature as a means of identification.

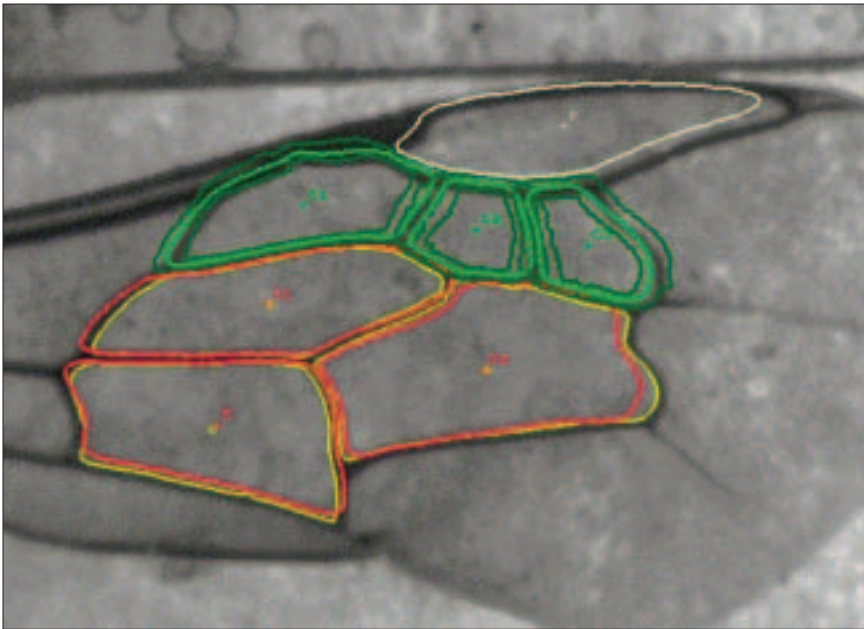
How does the ABIS system work? The starting point is an image of the bee's wings taken with an ordinary digital camera mounted on a microscope – a standard instrument used by taxonomists in species identification. The bee's wings are fixed in a transparent clip consisting of a glass prism and a glass slide, and are then

lit from behind by white light-emitting diodes. This does not injure or damage the bee's wings, thus enabling ABIS to be used to examine valuable scientific collections and to identify species of live bees. During the identification of live specimens, the bees are stunned by cooling them with ice-water in a commercially available cold box or they can be anaesthetised with carbon dioxide. Fixation and imaging processes take less than a minute. The light reveals the well-defined structure of

the wings, with the non-transparent veins forming a dark network of lines enclosing bright sections – the wing's transparent skin cells. Three categories of characteristic wing features are studied: veins,

ABIS is mobile and can thus be used in the field at any time. Above right: Having had its wing photographed, the liberated photographic model prepares for take-off.





vein junctions and transparent skin cells. So-called morphometric features are derived from these characteristics, and they are used to describe the shape of a wing by means of numerical values. Examples of these values include distances between vein junctions, area ratios of skin cells and length ratios of veins.

These morphometric characteristics of all the veins, vein junctions and skin cells of a wing thus form a comprehensive series of numbers, the so-called feature vector. The species is identified on the basis of a principle known as "supervised classification", which requires that an experienced taxonomist trains the ABIS system in a so-called training step. ABIS "learns" each species to be identified using a number of previously identified wing images. This means that ABIS learns a function which assigns feature vectors to a trained species.

Indeed, the identification of the veins, vein junctions and skin cells in the wing image and the assignment of the feature vectors to a single species of bee are such demanding processes that standard methods of image processing and classification are insufficient. Weak contrast levels in the image, soiling and pollen deposits on the wings and other forms of contamination necessitate a two-step image processing procedure. Experience has shown

that robust identification of a certain subset of skin cells and the veins delimiting them is possible, and initial image processing and classification is therefore based solely on these wing characteristics. This is sufficient to identify the genus. In the second step, ABIS loads a genus-specific "wing template" from its knowledge base. The wing template was derived in the training step from all previously identified wing images of this genus.

This wing template predetermines the structure and approximate locations where ABIS will find the remaining elements in the subsequent image processing. In other words: the system "knows" the number of veins, cells and nodes that must be found in which neighbouring constellation. While these relationships and approximate geometries are the same for all species of a genus, the precise geometric shape of these predictions is based on the individual wing image and thus ultimately specifies the characteristic feature vector required for the identification of the bee species.

In addition, simple, linear classification methods cannot be success-

fully employed for the very difficult identification of the species on the basis of the feature vectors generated for each wing image. Instead, a new non-linear variant of the established linear discriminant analysis method was developed. Not only is this variant method capable of

resolving very complex classification tasks, but it is also extremely useful for visualising the results of the identification process.

ABIS has been successfully

used in Germany, Brazil and in the USA, and identification rates of almost 100 percent have been achieved. However, just like people, the system's success depends on its learning process: the more comprehensive and meaningful the training material, the better the results of the subsequent species identification from new wing images.

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### The ABIS system "knows", on the basis of a specimen wing, how many veins, cells and nodes to look for

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# A Knitted Lightweight High-performance Rotor

*Powerful rotors capable of withstanding the highest loads are becoming increasingly required – not just by industrial and mechanical engineering applications. High-strength textiles can assist in the construction of featherweight high-performance rotors*

**M**any modern electronic machines require high-performance rotors. These are the turning (rotating) parts of a machine, for example, in an electric motor, a biocentrifuge or a pump. Such components are becoming increasingly important in the fields of bio-, genetic and nanotechnology, for example, to carry out separating processes in a more biocompatible manner and at higher temperatures. Likewise, the chemical industry, mechanical engineering plants and automotive production require lighter rotors which can perform to increasingly more demanding specifications: extreme centrifugal forces and high temperatures, chemical resistance and wear.

Most conventional materials are no longer able to satisfy present-day demands in an optimum manner and researchers are therefore seeking suitable methods of tailoring new materials – in some cases, quite literally. A research team at the Technische Universität Dresden, for example, is researching “textile reinforcements for high-performance rotors in complex applications”. Researchers there have strengthened textile fibres and combined them with other materials to enable the final material to withstand the highest loads.

Experts from the fields of lightweight engineering, plastics, textile and clothing engineering as well as solid-state mechanics and acoustics have worked together to develop textile-reinforced “plastic composites” and have already tested the stress tolerance of these materials in a new generation of high-perfor-

mance rotors. This interdisciplinary research aims to select suitable combinations of materials, to design textile-reinforced plastic products and to carry out various calculations, simulations and measurements. The strength of the materials and components are also to be tested and new production techniques developed.

A key factor for the success of this work was the selection of the appropriate materials. A prerequisite was the optimum alignment of the fibres so that they are able to withstand the physical forces to which they are subjected. The research team attained this objective using what is known as variable-axis alignment, in which the fibres within the components follow the forces acting on them rather than being aligned in straight lines. The textile-reinforced plastic composite made the new product 55 percent lighter than comparable metal rotors.

The material mixtures suitable for this are known as “commingling hybrid yarns”. Carbon fibres and polymer fibres are uniformly mixed and processed into a yarn. This textile material must then be “knitted” into a fabric, known as a preform, in such a way as to enable it to meet the physical performance criteria required of a rotor without deform too much or tearing. The indi-

vidual materials in the plastic composite all have different tasks, with the carbon fibres providing stiffness and the high-tech PEEK polymer making the finished component resistant to chemicals and ensuring that the component is sterile, does not cause allergic or toxic reactions and can withstand high temperatures.

The Dresden research team produces its own yarns. They now have a total of 40 different mate-





rials, which are processed into textile samples and thoroughly tested. Scientists at the TU Dresden have modified classical textile processes, such as spinning, weaving and knitting, and have developed a new robot-assisted stitching technique which works both two-dimensionally and three-dimensionally. This enables even parts with complex geometries to be combined.

The initially weak lightweight component is strengthened by baking it in an autoclave, a special type of oven. This melts the plastic components of the yarn at temperatures of 400 °C. At the same time, the preform is pressed into a mould which will, after cooling and solidification, produce the final component. Initially, the researchers produced only individual rotor components, but perfected the process using special moulds and clamping systems and can now produce the rotor "in one go". Metallic inserts are "baked in" at the same time. Another essential aspect of the research work was the investigation of the stresses occurring be-



Textile fabrics made of carbon fibres and thermoplasts form the basis of the new rotor. Above: The elastic preform is clamped and baked in an autoclave, a special oven, to produce the final high-performance rotor.

tween the individual layers in the polymer composite. The new results helped greatly in clarifying the gradual fracturing processes occurring in the composites and in employing suitable measures to counteract them. This enabled the research team to develop processes which give the component a high level of strength, including a special sewing process with an oblique seam which enables additional reinforcement of the textile product in highly stressed areas.

Before being tested in practice for the first time, the rotor was put through its paces. Even as a three-dimensional computer model, it had to pass a great many tests. The researchers used a special cal-

culatation technique to simulate various application situations, enabling them to study the conditions which might lead to failure of the component. Their predictions were then confirmed by experiments.

The rotors themselves were also tested to the limits of their endurance on the test rig, with deformation levels being analysed using sensors and measuring devices integrated into the rotor components. A novel method of measuring deformation inside the component, as well as on the surface, was developed. This method involved mounting a strain gauge on the component and integrating sensors into the textile reinforcement. A special fracture-indicating material (such as metallic glass, for example), whose fracture strength was slightly less than that of the component, was also incorporated into the material. The failure of this diagnostic material indicated that the component was close to failure. The use of these intelligent materials enabled optimum monitoring of the rotor under operating conditions.

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Turmoil in the heavens: In the Orion constellation about 2000 young stars form the "Trapezium cluster". Shrouded in gas and dust, it is only visible at infrared wavelengths.

# The Turbulent Birth of a Star

*The birth of a star is a dramatic process, about which there are many unanswered questions for astrophysicists. Researchers are now using computer simulations to shed light on the mechanisms which cause the gas in the Milky Way to form a star such as our own sun*

Stars are the easiest celestial bodies for us to observe, simply because of the fact that they are luminous. This makes them the most important sources of information for astronomers. The physical processes taking place within stars – particularly in the case of our own sun – and during star formation are not only decisive for the fate of the earth. They also provide information on the physical processes which control the origin and evolution of the universe as a whole. But it is the “birth” of stars which is of particular interest. Since it is impossible to directly observe the process of star formation, on the one hand because it takes several million years and on the other because stars are built up in almost impenetrable clouds of gas and dust, modern astrophysicists use computer simulations to help them understand this process.

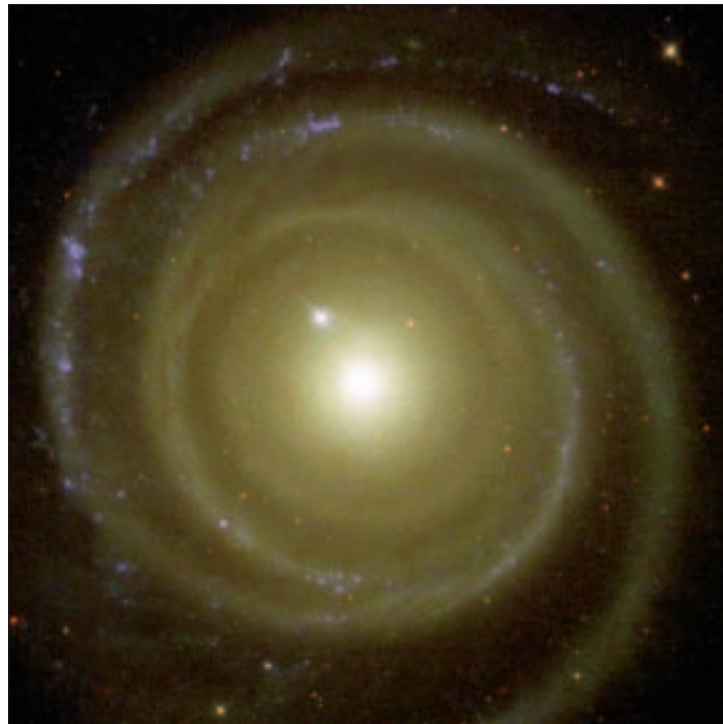
If you look into the night sky on a clear night, you’ll see darker, shaded regions along the band of the Milky Way. They are clouds composed of interstellar gas and dust, which absorb the light emitted by more distant stars. For about half a century it has been known that these dark clouds are the “nurseries” where young stars are born. The clouds are made up of molecular hydrogen gas and dust and are therefore referred to as molecular clouds. They are formed primarily in

the spiral arms of our galaxy. This is where material gathers in “holdups” in the Milky Way. The gas clouds can reach diameters of up to 100 light years and their mass can be anything up to several million times that of our sun, although the temperature within the clouds is only about ten degrees above absolute zero. Within the clouds the molecular gas is very unevenly distributed, extremely turbulent and can be

typical lifetime of such as molecular cloud, however, is a mere ten million years, which is very short on the cosmic timescale. So the process of star formation needs to take place “fast” in these clouds.

The conditions required for this to occur are one of the puzzles which the researchers are attempting to solve using computer simulations. In view of the turbulence and inhomogeneity within the clouds, it is necessary for the model to make assumptions in order to simplify matters, while still yielding the right re-

A spiral galaxy in the Centaurus constellation. Gas and dust provide the necessary ingredients for the formation of new stars in the arms of the spiral.



sults. Stars are formed in areas of high density in the cloud cores if the gravity towards the centre of the cloud is greater than any other opposing outward force, such as thermal pressure, turbulence, or magnetic fields. This occurs if the mass of the cloud exceeds a critical mass, known as the Jeans mass, named after the British physicist Sir James Jeans (1877–1946). The system then collapses under its own weight. The density and temperature of the gas

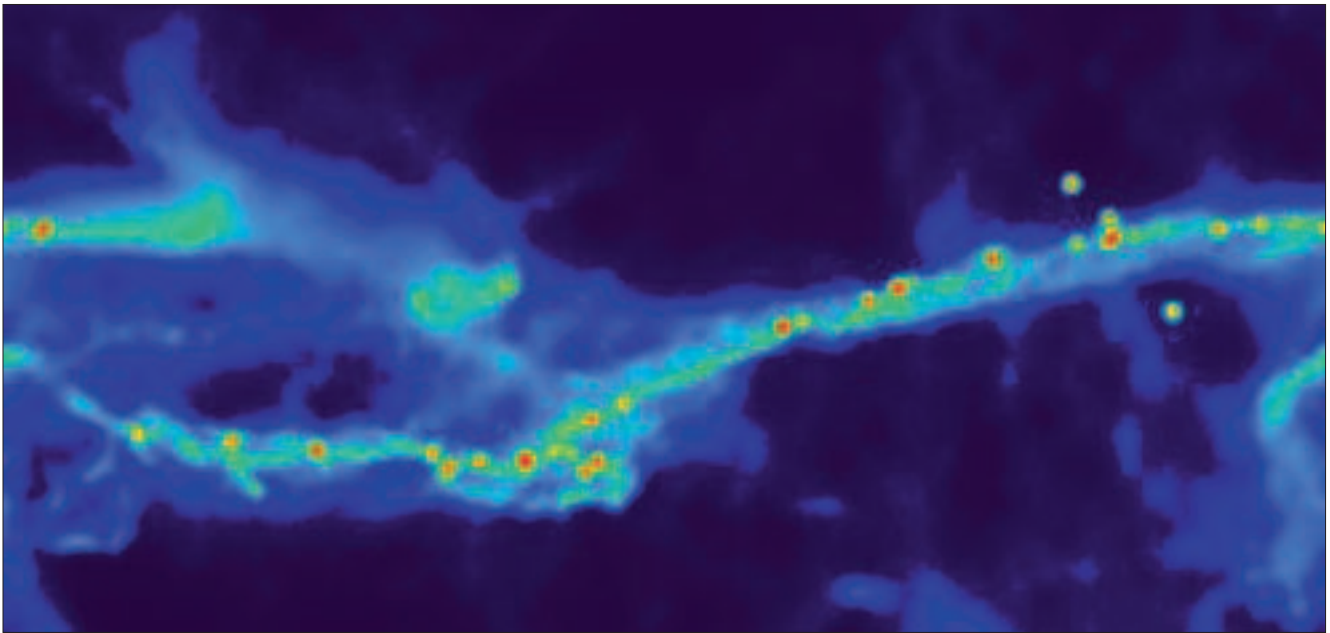
increase until a new star is born. For decades the theory of star formation was dominated by the idea that the process of star formation was primarily the result of competition between gravity and cosmic magnetic fields. According to this model, a strong magnetic field stabilises the molecular cloud and only once sufficient interstellar material has passed through the field does it begin to contract. More recent observations have shown, however, that the field strengths measured are insufficient to stabilise the molecular cloud as a whole. The modern theory of star formation therefore views the supersonic turbulence, observed in all such clouds, as the most important physical process which controls star formation. On

large scales, the kinetic energy of this turbulence more or less corresponds to the gravitational energy and exceeds the magnetic energy present within the cloud. This means that supersonic turbulence is able to counterbalance the gravitational forces and stabilise the cloud against contraction. On small scales, however, star formation can be triggered by turbulent compression. Turbulence plays a dual role.

Converging currents within a turbulent cloud result in the formation of localised clumping of high density, where compression can result in structures which exceed the

Jeans mass. This contraction changes the structure of the cloud. The distribution of density within the cloud during this process is characterised by elongated filaments and blobs containing protostellar cores. These are the direct precursors of actual stars. The computer model also simulates the formation of these protostars.

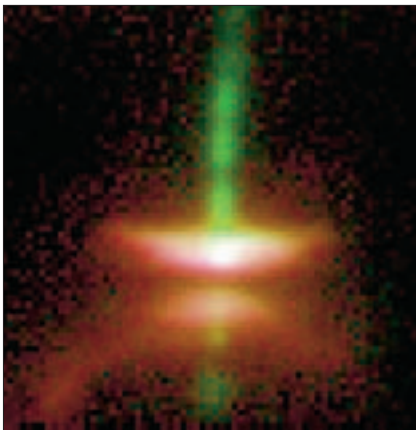
These objects collapse as a result of their own weight, allowing a young star to be formed in the cen-



tre, which attracts gas by gravity and rapidly gains mass. Due to the rotation of the gas it initially forms a disc called an "accretion disc". The material contained in this accretion disc gradually "rains" towards the centre and eventually reaches the actual star. This disc may subsequently give rise to a planetary system.

Once the reservoir of gas has been exhausted the dynamic stage of star formation ends. This process of "star birth" takes several million

A star is born. Gravity collects matter, forming a disc approximately 60 million kilometres in diameter. In its core a star, the presence of which can only be inferred from the light it scatters, gradually grows.



years. It is then followed by the significantly slower quasi-static contraction of the protostar. During this stage, temperature and pressure within the protostar continue to increase until it eventually reaches about ten megakelvins, at which point hydrogen begins to fuse into helium. This onset of nuclear fusion acts as a source of energy, setting up a hydrostatic equilibrium. The star has reached maturity and begins its "main sequence", where it exists in a stable state. One of the most important conditions to consider for accurate simulation of star formation is the fact that stars do not form alone. A single molecular cloud typically gives birth to a cluster of several hundred or a few thousand stars, which interact with each other and compete for the same gas reservoir. Star formation is thus a highly dynamic and chaotic process. A complete theoretical description of this process is therefore only possible from a statistical point of view. In general, however, all young star clusters have very similar properties. For instance, the distribution of stellar mass is almost the same in all clusters and the highest-mass stars are almost always to be found at the centre of the cluster. A more recent approach is thus to simulate the formation of entire star clusters rather than single, isolated stars, as they form in collapsing gas clouds, which

Using a simulation it is possible to model the development process within galactic molecular clouds. The precursors of stars form in regions of high density within these clouds. These so-called protostellar cores are shown as red points in this image.

is a much better approximation to reality.

Using a computer simulation it is possible to study various characteristics such as mass, angular momentum and motion as well as individual protostars within the cluster at any given time and to compare the modelled data with observations. It has been demonstrated that, in spite of the need to simplify or ignore certain physical processes, the numerical calculations do yield a realistic model. Many characteristics of modern simulations, such as the formation of protostars, the time scales and the mass distribution within young stars, correspond well with observations. These calculations thus confirm the modern theory of star formation, which is based on the interaction between supersonic turbulence and gravity.

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## The Deutsche Forschungsgemeinschaft

The 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 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.

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.

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## Illustrations

Häger (pp. cover, 4/5, 6 a., 7, 8/9); Querbach (pp. 2, back); Walotek (pp. 5 r., 6 b., 8 b.); Christian H. Schulze (pp. 10-11); Bibliothèque nationale de France, Naf 4515, Bl. 1r (p. 13); Bibliothèques d'Amiens Métropole, Les 95 E, Bl. 1r (p. 14 b.); Tours Bibliothèques Municipales, Nr. 947, Bl. 67r (pp. 14/15); Biblioteca Apostolica Vaticana, Reg. Lat. 750, Bl. 1r (p. 15 a.); Duschek (pp. 16-18); Steinhage (pp. 19-21); TU Dresden (pp. 22-23); Caughrean/Rayner (pp. 24/25); Hubble Heritage Team (p. 26); Astrophysikalisches Institut Potsdam (p. 27 a.); Burrows/NASA (p. 27 b.).

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



**E**n route to success: The young reader of the DFG magazine "forschung", the German counterpart to „german research“, accompanied her parents to this year's Leibniz Prize ceremony at the Berlin-Brandenburg Academy of Sciences and Humanities.