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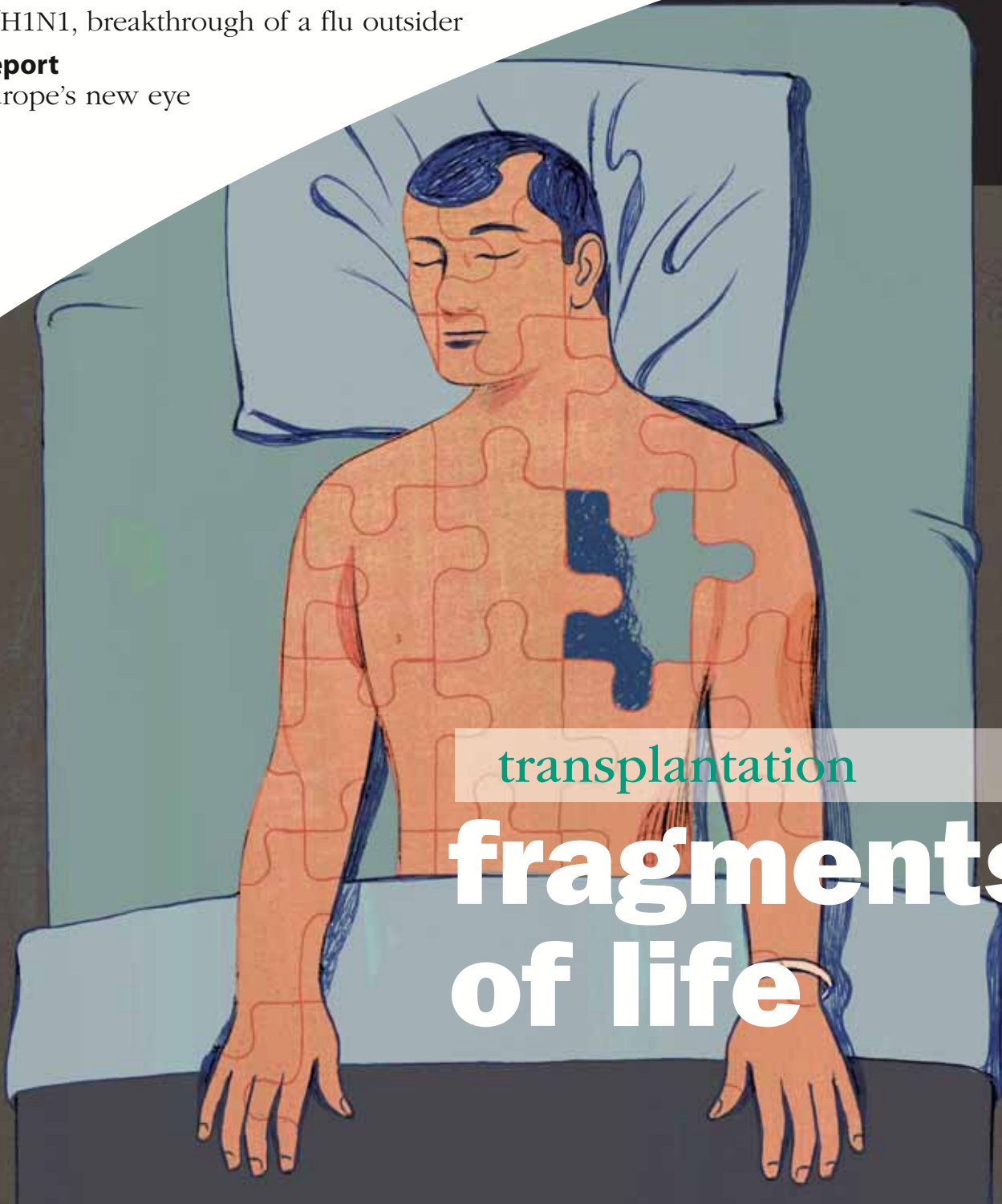
★ **Pandemic**

A/H1N1, breakthrough of a flu outsider

★ **Report**

Europe's new eye

ISSN 1830-7361



transplantation

fragments of life

research*eu is the European Union's research magazine, written by independent professional journalists, which aims to broaden the democratic debate between science and society. It presents and analyses projects, results and initiatives through which women and men are making a contribution towards reinforcing and uniting scientific and technological excellence in Europe. Published in English, French, German and Spanish with ten issues per year, research*eu is edited by the Communication Unit of the European Commission's Directorate-General for Research.

Death on screen

Some sociologists believe that we are living in a society of fear, and recent events certainly seem to bear them out. We have lost count of the number of virtual crises and incidents hyped by the media. Health alerts, natural disasters and technical failures all fuel fear – the cause or origin of all this media hype. We experienced it yet again this summer when a series of air crashes happened over just a few weeks. Should we be afraid of flying? The answer is no – or at least only a little afraid (as there is always the risk of an accident, however small). The problem with fear lies in the way it is perceived.

Technical accidents such as air crashes certainly grab our attention, starting with the media. But after the initial fright stoked up by the media, time and distance allow us to gain some perspective. Every day 60 000 people worldwide die from cardiovascular disease, nearly 10 000 children perish from malnutrition, and 100 Europeans are killed on the roads. Compared with an air crash, though, such figures seem to be of no account. When the only things deemed to exist in our communication society are those portrayed by the media, then the only deaths deemed to exist are those that the media choose to portray.

Such technical failures seem to be the price we pay for our technological marvels. A sort of entrance fee to 'ever-more' land, which sums up our civilisation's technological development: ever faster, ever more accurate, and ever more powerful. Ever more complex too, in terms of technology and technological monitoring. All in all, technological progress can look forward to a bright media future!



Michel Claessens
Editor in chief

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ZEITGEIST

Head in the clouds of Titan

Titan, Saturn's biggest satellite – and the only satellite in the solar system with a dense atmosphere – has revealed its cloud cover. Its atmosphere is the site of a very active meteorology with very marked seasonal cycles due to the sharp inclination of the satellite's rotational axis. Lying ten times further from the Sun than Earth, Titan takes 29 years to orbit our star and each season lasts about seven years. Cloud formation in Titan's atmosphere is not the result of the condensation of water but of methane and ethane. Launched in 1997, the international mission Cassini-Huygens has the task of studying the planet Saturn and its environment. The study of its satellite Titan is one of the mission's major aims. Observations carried out with the VIMS (Visible and Infrared Mapping Spectrometer) scientific instrument between July 2004 and December 2007 made it possible to produce the first map of Titan's clouds on

the basis of more than 200 clouds recorded during this period. The spatial distribution of the clouds revealed by this study, published in *Nature*, gives precise indications of Titan's atmosphere and in particular of the mechanisms that govern its cloud cover. The clouds are distributed in the two polar regions and across a latitudinal band around 40°S, this confirming the dominant role of air circulation in cloud distribution, as the satellite's climate models predict. The evolution of cloud cover through the seasons is understood less well, however. So there is still work to do for the Cassini-Huygens mission that 'interplanetary meteorologists' hope to extend until 2017.

www.esa.int/esaMI/Cassini-Huygens/

To the sound of Greek antiquity

For the first time in centuries, the sound of the epigonion, a musical instrument of Greek antiquity, can

again be heard. Italian experts working with the *ASTRA (Ancient instruments Sound/Timbre Reconstruction Application)* project have succeeded in reviving this instrument that is closely related to the modern-day harp by combining art and technology. In re-creating the sound of the epigonion they took as their basis data obtained from archaeological discoveries, historical drawings and literature. The information describing the materials of which the instrument is made and the way in which it is used were then transcribed into 'computer language' using the physical modelling technique. This involves using a series of equations and algorithms that

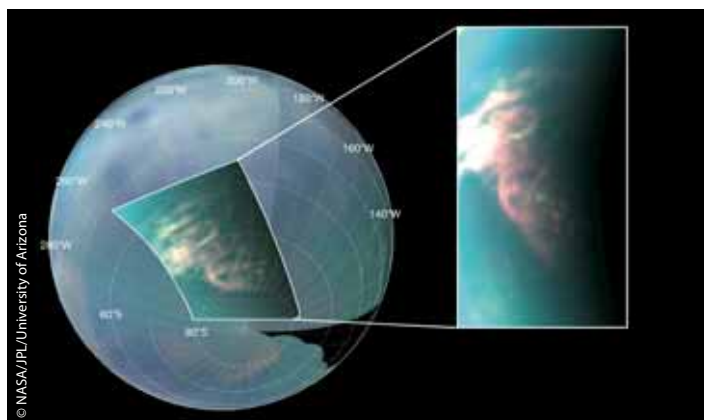
share knowledge and data on the epigonion. It is easy to understand why *ASTRA* had recourse to such networks when one considers that reproducing a sound of around one minute requires about half an hour of data processing.

www.astraproject.org

The return of the blue whale

Forsaken by the blue whales decades ago, the waters off

Cloud imaged by the VIMS on 26 March 2007 when the Cassini flew over Titan (cloud activity over the South Pole can still be observed, when it was expected to have disappeared).



Francesco De Mattia playing the epigonion at the Musica@Fisica concert organised by the Dante network (www.dante.net), held in Catania (Sicily) in June 2009.

make it possible to model the instrument's 'behaviour' in a mechanical system. This achievement was made possible thanks to the GÉANT and EUMEDCONNECT research networks and the Grid infrastructures managed by the *EGEE (Enabling Grids for E-science)* infrastructure project that served not only to link up powerful computers but also to



the coast of Alaska (US) and the Canadian province of British Columbia are seeing the timid reappearance of the large cetacean. Since 1966, when the ban was introduced on hunting that had brought the species to the brink of extinction, these large mammals have been making a gradual recovery. While scientists estimate that the blue whale population was 350 000 before the whalers began their onslaught, there are now believed to be between 8 000 and 14 000 blue

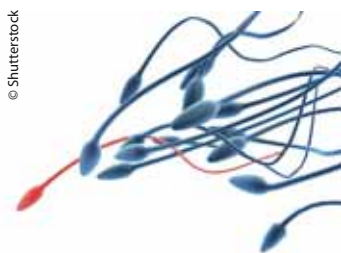
whales inhabiting the world's oceans.

It was in 2004 that scientists making a population census of humpback whales in the Gulf of Alaska noticed three blue whales. One or two blue whales have since been observed every year off the coast of the Canadian province and in the Gulf of Alaska.

Researchers with the US National Oceanic and Atmospheric Administration (NOAA) stress in the journal *Marine Mammal Science* that such findings could mean that a population of blue whales



© Shutterstock



annual congress of the European Society of Human Reproduction and Embryology, held in Amsterdam, involved 18 men whose sperm quality was below the average.

After being 'prescribed' an ejaculation a day for a week, the researchers measured the DNA deterioration of the spermatozooids as well as their mobility, two parameters that saw a marked improvement after the treatment. The authors attribute the improvement to a reduced stay of male gametes in the testicular ducts where they are exposed to the damaging effect of oxidising molecules.

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www.eshre.com

Injecting into the heart of cells

Twenty times thinner than a human hair, the nanoneedle measuring 50 nanometres in diameter developed by researchers at the University of Illinois (US) permits injections into a single cell. Coated with a fine layer of gold and attached to a glass pipette, this needle easily penetrates the cell membrane and makes it possible to deposit one or more molecules inside the cell together with the quantum dots used for the medical imaging of cells, replacing the usual colouring agents.

This new nanotechnological instrument as described in *Nano Letters* enables scientists not only to control, monitor and record the process for delivering active molecules to a cell interior, but also to use this needle as an electrochemical probe and optical biosensor. This development should permit a more precise monitoring of the fine interaction between proteins and DNA or RNA molecules inside cells.

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www.news.illinois.edu

An anti-rejection and anti-ageing molecule

Already valued for its effectiveness in preventing rejection in the case of organ transplants, rapamycin could be even more prized for making it possible to extend the life of mammals. This is what was recently revealed by a team of US researchers and published in *Nature*. Scientists administered this molecule with antifungal and antibiotic properties as a foodstuff to mice aged 20 months, which is the equivalent of 60 years for

a man. A comparison of their life span with those of mice of the same age fed normally showed that treatment with rapamycin increased the average life span of males by 9% and of females by 13%.

Rapamycin inhibits the TOR (target of rapamycin) protein kinase that plays a fundamental role in cell growth and proliferation. First discovered in yeast, this protein is also found in mammals (mTOR) and its inhibition had already extended the lives of invertebrates. While a second study, which is in progress, already confirms the effect of rapamycin on the life span of mice, the authors nevertheless advise caution regarding the potential use of this molecule to slow the ageing process given the significant immunosuppressor effects it engenders. This discovery could, however, make it possible to develop compounds similar to rapamycin, but without side effects.

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www.jax.org

in the eastern North Pacific is in the process of re-establishing a traditional migratory flow.

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www.newscientist.com

Daily sperm practice

An ejaculation a day improves sperm quality and therefore the chances of conception. The Australian study that reached this conclusion, presented at the last



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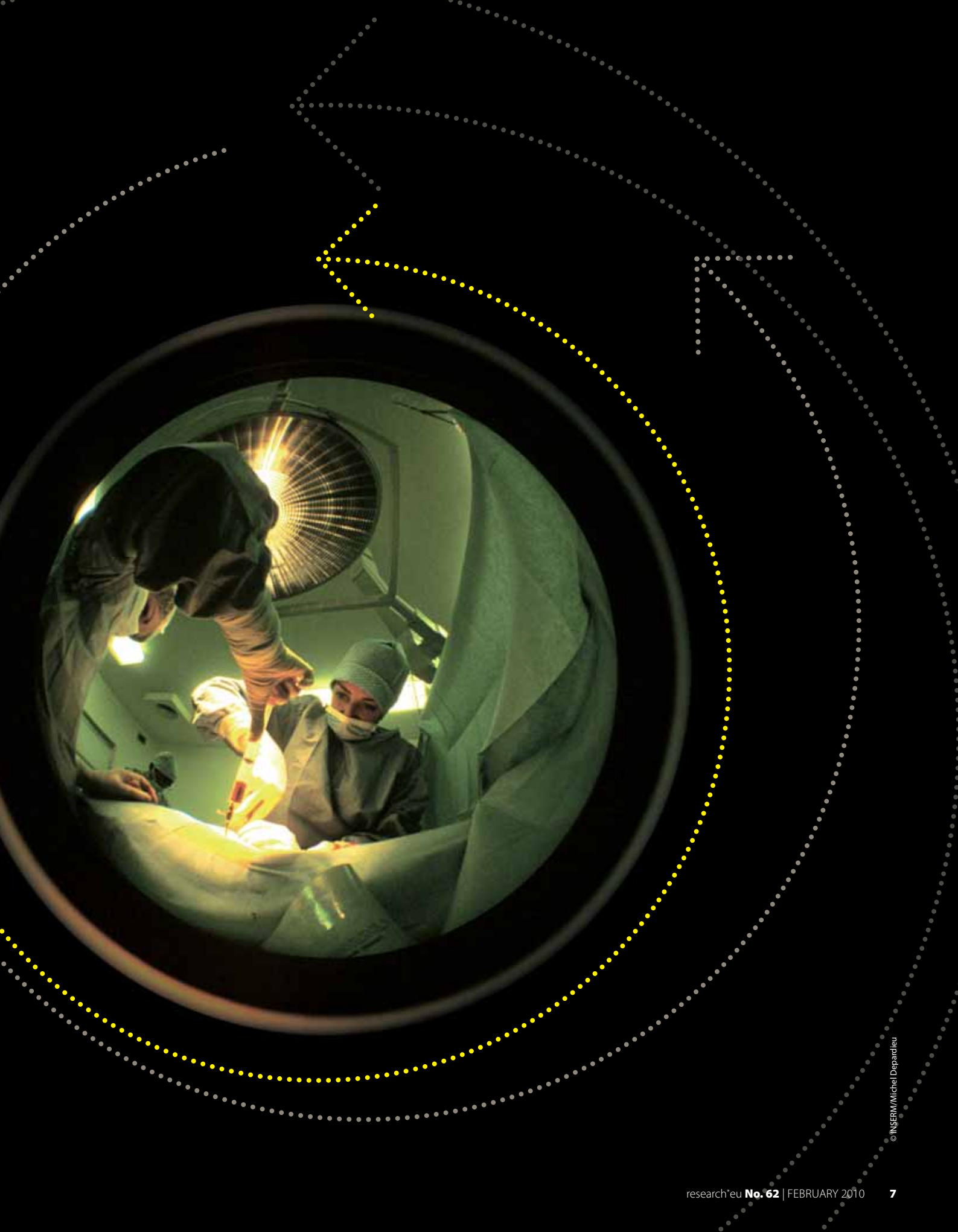
SPECIAL REPORT

TRANSPLANTATION

Fragments of life

In 1902, the French surgeon Alexis Carrel had the strange idea of removing a kidney from a dog to graft it onto its neck. A century after the success of this first autograft, another type of transplantation, the allograft – between two individuals of the same species –, is now current practice, including in man. It nevertheless remains a serious and risky operation as the threat of reaction can never be ruled out, despite immunosuppressor treatment.

This type of operation faces the problem of organ shortages, despite campaigns to increase awareness and even if more and more Europeans say they are in favour of organ donation. This is an urgent matter as a shameful trafficking and a no less shameful poverty are giving rise to growing transplantation tourism. Within the next 20 or 30 years all of this could be no more than a bad memory as we may be able to create the necessary organs. Research on bionic prostheses, for example, has attained a level unimaginable just a decade ago, thanks to the biotechnologies. One day, perhaps, we will also cross the species barrier to 'borrow' from animals the hearts and kidneys we are lacking. Here too, even if clinical trials are still a long way off, research has made some extraordinary advances and the technical obstacles seem to be overcome as quickly as they arise. However there is the risk that these advances will cause us to forget the only barrier that we most certainly do not want to cross: that of ethics.



Body parts

The trade in body parts is booming. Growing numbers of the poor are allowing themselves to be mutilated to supply international trafficking operated by a transplant mafia. Meanwhile, unscrupulous tour operators and surgeons are engaging in a new kind of tourism. Although we are now seeing a response in the form of investigative networks, ethical codes and international positions, it is very much at the early stages.

M*an aged 29, in perfect health, is selling one of his kidneys for EUR 150 000.* This message, published on the free website habitamos.com and condemned by the Spanish consumer association Facua, was reported by various European media. The services charged with looking into this case by the Spanish Health Ministry and police conducting the investigation identified around 30 similar proposals on 13 websites. In most cases it is kidneys, lungs and bone marrow that are advertised for sale, by Spanish nationals as well as immigrants from Latin America, with prices ranging from 15 000 to a million euros. Such practices are contrary to the legislation of an EU Member State in which organs are not regarded as merchandise and their prevalence is all the more surprising as Spain has a high level of donors. But what can the law do in the face of poverty?

A special kind of tourism

Although such adverts are the result of individual initiative, organised crime is quick to seize upon them. They know the ins and outs of the complex path, with its shady surgeons and illicit transporters, by which the life of the 'rich man' can be saved or improved by amputating that of the 'poor man'. Thanks to this special kind of operator, transplant tourism is

booming. In most cases the surgeons are known in medical circles. The circuits are indirect: a Brazilian may have an organ removed in South Africa for a transplant patient in Israel, for example. In Pakistan, two-thirds of kidney transplant patients in 2006 were foreigners. Kidneys are in fact the 'star product' (although we have two, only one is needed for the body to function) and the going rate varies according to the country (from EUR 470 in South Africa to EUR 20 200 in the United States, and EUR 1 800 in Moldavia and EUR 6 800 in Turkey)⁽¹⁾.

The WHO (World Health Organization) estimates that 10% of organs transplanted worldwide are the result of unethical commercialisation or practices. In 2004, it called on its member states 'to take measures to protect the poorest and vulnerable groups from transplant tourism and the sale of tissues and organs, including attention to the wider problem of international trafficking in human tissues and organs.' Known since the 1990s, these practices have grown considerably with the increase in poverty but also due to progress in treatment that has reduced the likelihood of the body rejecting the transplanted organ or tissue.

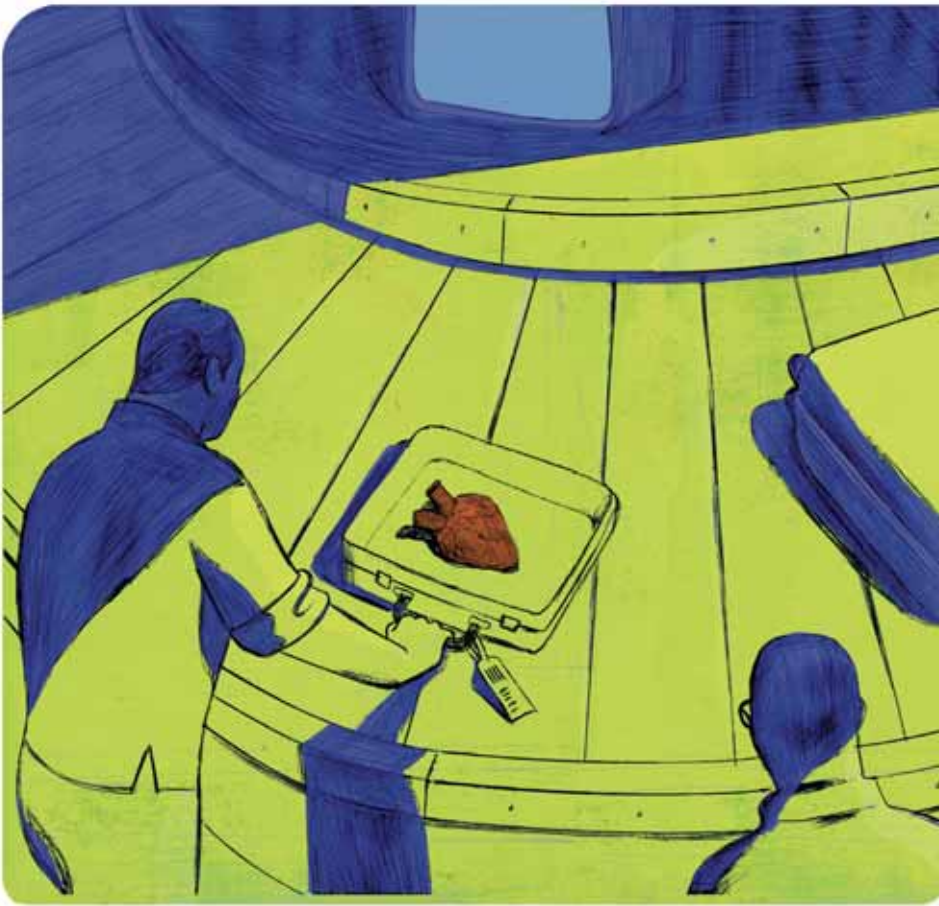
The good resolutions of 2008...

Some major stances were adopted in 2008. On 22 April the European Parliament approved the Adamou report. The resolution stresses

that the donation of organs must remain 'strictly without commercial intent'. The Commission and Member States were invited to take measures to avoid trafficking in body organs – regarded as a form of trafficking in human beings that violates fundamental rights and abuses vulnerable persons – as well as 'transplant tourism'. There was also the declared intention to increase the availability of organs through legal channels. A European donor card was also seen as a possibility.

A month later, the Declaration of Istanbul, drawn up on the initiative of The Transplantation Society (TTS) and the International Society of Nephrology, was signed by 150 representatives from 78 countries (see box) including doctors, scientists, government representatives, social scientists and ethicists. This text clarifies concepts connected to trade in organs and suggests to governments ways of combating such practices. The aims are to encourage the removal of organs from deceased persons, to protect living donors from commercial malpractices and to give them a quality of care equal to that of the recipients. 'We are therefore beginning progressively to accept the idea at international level that human organs are not spare parts, that nobody can put a price on an organ destined to save a life,' remarked Dr Luc Noël, coordinator of the WHO's Clinical Procedures Department.

Such a position does not have unanimous support. At the Constant de Rebecque Institute, a decidedly liberal Swiss research centre, Jan Krepelka – a member of the scientific team – takes the view that 'a monetary price set arbitrarily at zero (...) is not in any way more moral than any other value' and asks whether or not free trade in organs should be authorised 'so as to finally allow supply to come into line with demand, and avoid unnecessary deaths.' He believes that 'banning the sale of organs simply aggravates the problems that are sometimes used as an excuse, such as the unacceptable removal of organs from living persons without their consent: there is much greater risk of seeing a proliferation of trafficking in stolen organs when the legal and consenting supply is limited by laws.' He adds that 'the role of intermediaries, who are criticised particularly in the present black market, would decrease with the reduced risk and the increased competition brought with a legal market.'⁽²⁾



The Europeans and organ donation

The results of a survey on organ donations and transplants, ordered by the European Commission's Directorate-General for Health and Consumers (SANCO), were published in the Eurobarometer series in May 2007. It is certainly a controversial subject: 41 % of the Europeans interviewed had already discussed the subject with family members, usually resulting in a positive view. A majority of those interviewed (56 %) say they would be prepared to donate their organs after their death and 54 % would agree for organs to be taken from deceased family members. These positive opinions are more common among those with a high level of education and/or high socioprofessional level.

More generally, the idea of having a 'donor card' stating that the holder is ready to donate an organ is viewed positively by the vast majority of Europeans (81 %). Currently rare, except for in the Netherlands where 12 % of citizens carry one, such a document, preceded by an awareness campaign, could therefore have a major impact on the acceptance of organ donation.

Downloadable report: http://ec.europa.eu/public_opinion/archives/ebs/ebs_272d_en.pdf

... and the individualism of the legislation

The legislation is currently as varied as the opinions. According to a report published by the French newspaper *La Croix*, Iran officially pays donors (EUR 3 000, equivalent to a year and a half of the minimum wage) for what is described as a 'religious donation', provided the recipient is not a foreigner. In the Philippines, transplant tourism is flourishing, with specialists proposing fixed sums (organ, operation) ranging from EUR 45 000 to EUR 100 000. In China, Deputy Health Minister Huang Jiefu admitted, in 2005, that most of the 12 000 organs transplanted in the country were taken from people sentenced to death. This situation is now controlled by a law, passed in 2007, which bans the commercialisation of organs and stipulates that donors must consent, as well as the promise to set up a national network of organ donations.

Israel has banned insurance companies from reimbursing the costs of 'medical tourism'.

The countries that are coping best are those where a sufficient number of donors are available. In Cyprus, for example, the rate of donations between living persons is high, while Spain is almost self-sufficient in organs due to removing them from deceased persons. France has seen organ transplants double since 2000 and every year the list of those awaiting transplants grows by around 4%. In 2007 more than 275 000 Europeans were living with a transplanted organ and thousands were awaiting a transplant.

Christine Rugemer

(1) Figures presented at a WHO meeting in 2006.
(2) www.institutconstant.ch/paper.php?id=37

i Declaration of Istanbul

www.agence-biomedecine.fr/presse/declaration-d-istanbul-sur-le-trafic-d-organes-et-le-tourisme-de-transplantation-1.html

Adamou report

www.francoisecastex.org/v2/actualites/articles/DOC94/01.04.08%20Rapport%20Adamou.pdf

The Transplantation Society

www.transplantation-soc.org/policy.php

Organs Watch

<http://sunsite.berkeley.edu/biotech/organswatch/>

The *pas de deux* of immune tolerance

Too many transplants fail because the transplanted organ is rejected by the recipient's immune system. We are beginning to define the underlying molecular mechanisms that cause this. The challenge now is to change these mechanisms to induce a tolerance that will make it possible to dispense with heavy immunosuppressor treatment.



© INSERM/Michel Depardieu

Characterisation of HLA cells by immunoblot. Colouring of the 'electrophoretic' strips using monoclonal antibodies marked with peroxidase.

There are around 250 000 people living in Europe today with a transplanted kidney, liver, lung or heart. To avoid their immune system rejecting the organ, which it recognises as a foreign body, they have to follow a permanent and heavy course of immunosuppressor treatment that is not only expensive (EUR 15 000 a year) but also likely to produce many side effects, including renal toxicity, increased susceptibility to infection and increased risk of cancer. Controlling this immune rejection response is therefore crucial for improving transplant effectiveness.

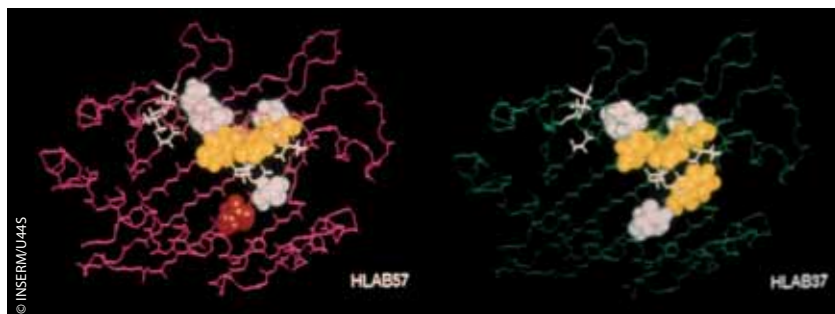
The rapid increase in organ transplants from the 1960s was only possible thanks to the discovery of the HLA (Human Leukocyte Antigen) system. This group of proteins present on our cell surfaces enables lymphocytes (a kind of white corpuscle) to distinguish between what 'belongs' and 'does not belong' to the body and constitute, in a sense, our biochemical ID. It was the identification, in man, of six major HLA families that permitted the first organ transplants between unrelated individuals, just as, in the 1920s, the description of blood groups had opened the door to blood transfusions.

But progressively, as transplants became widespread, it became clear that HLA matching was a necessary but insufficient condition for the transplantation to be successful in the long term. The acute rejection of the transplant during the days or weeks following the operation is today controlled effectively by medicines, while chronic rejection, which appears after a number of years, remains a problem. After 15 years, half of all kidney transplants are no longer functional. The only solution then is to envisage a second transplant, with all the inherent risks.

The memory of lymphocytes

'We are at present unable to predict whether or not a patient's immune system will tolerate the transplant, or will develop a hypersensitivity response leading to chronic rejection. We also do not know whether or not a transplant patient can be allowed to cease his immunosuppressor treatment,' explains Michel Goldman of the Institute of Medical Immunology in Charleroi (BE). One of the reasons for this difficulty is that our immune system has a prodigious memory. Any foreign substance or body (bacteria, virus, parasite) with which it has at any time been in contact is susceptible to leave a trace that takes the form of antibodies or T lymphocytes (so named because they are produced in the thymus) that are able to recognise the foreign cell and break it down. These defence responses to what 'does not belong' are in principle very specific... but not totally. All it takes is for a molecular motif on the transplanted tissue surface to bear a certain resemblance to a foreign body that the immune system learned to recognise in the past for a so-called heterologous response to be produced. The T lymphocytes then attack the transplanted organ or tissue that degenerates as fibrosis sets in and progressively loses its biological function.

This heterologous response is particularly difficult to study as animal models are unable to mimic it totally. In mice we can administer various chemical treatments to induce a very strong, although never total, tolerance of the immune system to foreign organs or tissue. But when applied to man the same treatment proves much less effective. 'The environment in which we are living is much less regulated than that of laboratory animals,' explains Hans-Dieter Volk of the Institute of Medical



Modelling of human HLA class 1 cells.

The HLA B57 cells are represented as well as certain anchoring regions that permit the association with the antigenic peptide.

Immunology at Berlin's Charity University Hospital. 'This means we have many more memory T lymphocytes and therefore a much greater risk of a heterologous immune response in the event of a transplant.'

An education in tolerance

The studies on mice nevertheless served to shed light on two ways forward, which the *Reprogramming the Immune System for the Establishment of Tolerance (RISET)* programme has started to explore by carrying out pilot tests on man. The aim is to develop selective immunosuppressor treatment that neutralises the T lymphocytes responsible for the transplant rejection only and not the entire immune system, as present medicines do. Progress in biotechnologies has made it possible to produce molecules that intervene in the activation of T lymphocytes and transform them into regulating cells that inhibit responses that are pernicious for the transplanted organ.

Another way forward is to accompany the transplant with an infusion of donor cells that can then educate the recipient's immune system to recognise the transplant as 'belonging' to the body. Although results on animals have been encouraging, such cell treatment approaches remain heavy solutions that can only be administered at a limited number of high-tech centres. There is also the problem of the absence of standardised industrial production of these precious medicinal cells.

Emergency markers

While waiting for these innovative therapies to be perfected, the most urgent task is to define biomarkers able to predict rejection. Under the Sixth Framework Programme, the *RISET* and *AlloStem* projects served to define

around 10 of these markers. Some, such as the presence of anti-HLA antibodies or cytokine dosage (molecules that permit communication between the cells of an immune system) are pre-transplantation markers. Their presence in the recipient indicates a major rejection risk. Others, such as certain ARN messengers characteristic of T lymphocyte activation, are post-transplantation markers. They indicate that a rejection response is starting up or, on the contrary, that the recipient has developed a hyper-responsiveness to the donor's antigens. At present these can be measured in the recipient's biological fluids and, in the future, possibly by molecular imaging of the transplant. At some point, monitoring these levels could guide the immunosuppressor treatment administered by the medical team.

However, each transplantation centre has developed its own biomarkers and its own tests, making it very difficult to compare results and sometimes even to reproduce them. 'No biomarker of rejection or of the risk of rejection today has a consensus,' observes Michel Goldman. 'We must take inspiration from what has been done in cancer research to arrive at a standardisation of detection tests.' The *Transplant Research Integration in Europe (TRIE)* project that he coordinates has thus set itself the goal to define the best rejection biomarkers by working closely together with the industry and regulating authorities. The rewards would be a reduction in immunosuppressor treatment and an improvement in the long-term success rate of transplants, for the great benefit of the many transplant patients living in Europe and for the tens of thousands of persons awaiting a transplant. ●

Mikhail Stein

Leukaemia and bone marrow transplants

The treatment of certain types of leukaemia and cancer involves the transplanting of hematopoietic stem cells, the cells that form the different categories of blood cells. The stem cells are taken from a donor's bone marrow or a bank of umbilical cord cells. The therapeutic effect is due to the fact that the T lymphocytes in the transplanted material attack and destroy the cancer cells. But in certain cases this reaction runs out of control and the transplanted cells also attack the mucosa of the recipient's cells, the latter being unable to put up any defence due to the immunosuppressor treatment required by the transplant. This is what is known as graft versus host disease. It is thus a response that is symmetrical to that which leads to the rejection of a transplanted liver or kidney: it is no longer the host's immune system but the immune system of the transplant that is activated. That said, the biochemical mechanisms involved in these two phenomena are largely identical.

i Reprogramming the Immune System for the Establishment of Tolerance

www.risetfp6.org

Transplant Research Integration in Europe

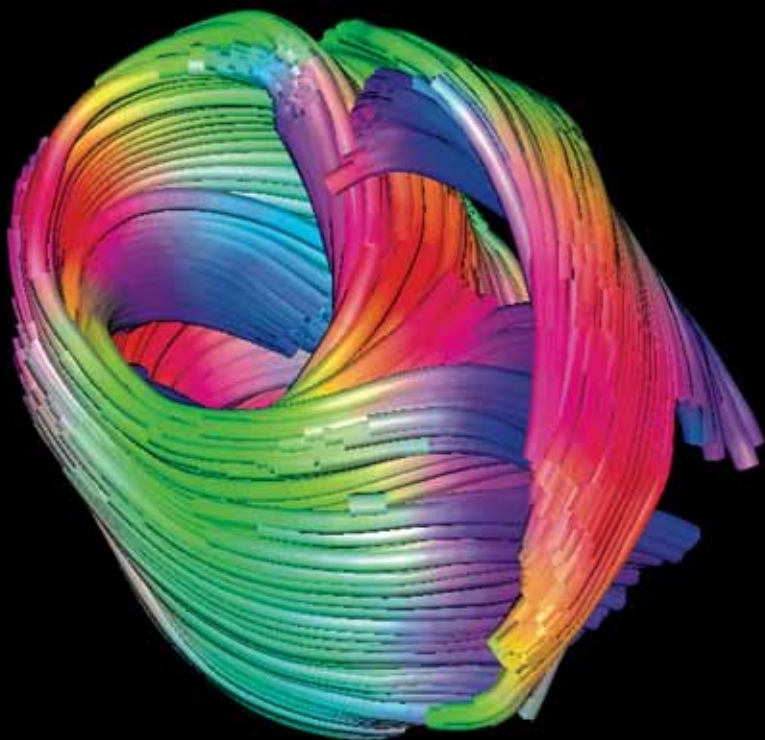
www.transplantation-research.eu

AlloStem

www.allostem.org

Xenotransplantation: overcoming the obstacles

Can animal organs be used to make up for the shortage of organs? The biotechnologies have permitted dramatic progress in transplanting pig hearts and kidneys to monkeys, but it is still too soon to envisage any attempts on man. In the meantime, it is the ethical implications that could be usefully explored.



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A decade ago, the medical world had little faith in xenotransplantation, or the inter-species transplantation of organs. Few believed this technology had a future given the seemingly insurmountable immunity barriers and the fear of transmitting animal viruses to man. But progress in the biotechnologies has since brought some dramatic results. 'On the road leading to clinical xenotransplantation,' announced the headline in the June 2009 edition of the scientific journal *Transplant Immunology*. But it looks like a long road, with many obstacles along the way.

Of pigs and men

The most evident benefit of xenotransplantation is to help make up for the shortage of organs, although nobody sees this as the panacea and there remains considerable scope for progress in spreading the word on organ donation and improving the effectiveness of traditional transplants. Yet xenotransplantation has some unexpected virtues also. Medically, it permits better transplant planning and can provide organs of better quality than those currently taken from accident victims or suicides who fall into an irreversible coma. Then there is the ethical advantage of transplant patients being spared the psychological stress of living in the knowledge that they owe their own survival to the death of another human being.

◀ The key researchers for pork xenotransplants.

Observation by IRM reveals the functioning of a pig's heart, which could be useful for humans. By measuring the movement of microscopic water molecules in cardiac muscle fibre, this technique can reconstruct the organisation of these fibres (multicoloured spaghetti). Their orientation is a good indicator of integrity and functionality of the heart. The image can also show the rotation of fibre in the space between the pericardium (outer part of the myocardium) and endocardium (inner part).

Even among animal rights campaigners there are few who would oppose the use of pig organs to relieve human suffering. But why the pig, as it is indeed on this animal that current xenotransplantation research is concentrating exclusively. First, pig and human organs are of a comparable size. Cardiac surgeons already use pig valves as spare parts for the human heart (these operations not being regarded as xenotransplants as the valve is regarded as inert rather than living tissue). It is also because the gestation is short (115 days) and litters frequent, thereby ensuring a supply of large quantities of organs. Finally, the pig is easy to rear in sanitary conditions that reduce to a minimum the transmission of pathogens. When a sow is close to giving birth she is placed in a sterile bubble, the piglets are born by caesarean, subsequently transferred to a kind of incubator where they are fed on sterilised milk and then raised, after weaning, in a confined pigsty.

More than six months survival

It is from pigs reared in these very strict hygiene conditions that the organs were taken for use, in recent years, in the many transplant experiments involving the great apes. The most dramatic results were obtained with the transplantation of islets of Langerhans (the pancreatic cells that produce insulin) to diabetic monkeys. Encapsulated in a special material to limit the risk of immune rejection, these transplants enabled diabetic monkeys to regulate their glycaemia for more than six months, without even receiving an immunosuppressor. 'These results are of the greatest importance as they are the first demonstration of the long-term survival in a primate of a xenotransplant that fulfils a vital biological role,' explains Emanuele Cozzi of the Department of Medicine and Surgery at the University of Padua (IT), coordinator of the European programme *Xenome*, the principal European effort in the field of xenotransplantation. Dramatic progress has also been achieved with heart xenotransplants (2 to 6 months) and kidney xenotransplants (3 months) to monkeys. A decade ago the survival records here were no more than a few weeks. On the other hand, lung and liver xenotransplants continue to be rejected after a few days, for reasons that we do not yet fully understand.

The transgenic pig

The first obstacle is what is known as the hyperacute rejection of the transplanted organ, in which clots form that block off the blood supply to the transplanted organ. The recipient then dies within a few minutes or a few hours at the most. Genetic engineering has enabled researchers to partly overcome this obstacle that was regarded as insurmountable a decade ago. A study of the mechanism involved in hyperacute rejection has shown that the cause lies in incompatibilities between the proteins involved in the chemical reactions of the immune defence mechanism (complement cascade) and in blood clotting. The very presence of pig forms of these proteins in the primate's body triggers these reactions and leads to the almost immediate rejection of the organ. The solution was therefore to genetically modify the pigs to remove these genes from their genome, or otherwise to replace them with genes producing 'humanised' forms of these proteins. It is this approach that the European *Xenome* project plans to pursue to overcome another obstacle, that of acute rejection. This occurs during the weeks following the transplant and is due to the antibodies of the recipient's immune system attacking the transplanted organ. *Xenome* has set itself the goal of obtaining a 'super transgenic' pig whose genome will have been modelled so that the animal's organs possess the anti-inflammatory, anti-coagulant and immunosuppressive properties that will facilitate its acceptance by the recipient.

In addition to these gene additions, the future super transgenic pig will also possess fewer DNA sequences, namely those of the PERV (porcine endogenous retro-virus), a pig virus that has the formidable property of being able to infect, in vitro, human cells. In the midst of the BSE crisis and fears of pathologies crossing the species barrier, the discovery of this retrovirus in 1997 very nearly put an end to xenotransplantation research. This virus is in fact present in the genome of nearly all pig varieties and no extent of hygiene precautions can eliminate it. With hindsight, it seems that the threat is less worrying than was initially believed. No human contamination by the PERV has ever been identified, despite very advanced research. But this does not mean that the virus may not surface under certain

conditions. At the time of the A/H1N1 flu virus pandemic, which in part originated in pigs, no precaution can be too much: the sequences that are essential to PERV reproduction will therefore be eliminated in the super transgenic pig on which the *Xenome* project is working.

The ethical before the technical

When this animal – which those involved in the project like to describe as 'Europe's contribution to xenotransplantation research' – becomes available, will it then be time to start the clinical trials? Emanuele Cozzi is very cautious. 'Research in recent years has concentrated mainly on the effectiveness of xenotransplantation and other fundamental questions must be studied before moving on to clinical trials: physiology and safety, but also ethics and the regulatory aspects of xenotransplantations.' Even if the problem of immune rejection is resolved there is nothing to indicate that pig organs will be able to replace human organs. The blood cholesterol level of pigs is lower than that of man, for example. In the case of a pig heart transplant, the high cholesterol levels in man could block the arteries. Also, organs such as the liver, kidneys, lungs and pancreas are all subject to hormonal control and it is not known whether animal organs can be regulated by human hormones.

Even if these physiological problems could be fully resolved, an in-depth ethical reflection would be needed before xenotransplantation could become current practice. What would be the criteria, for example, in deciding whether a transplant patient will receive a human organ or a pig organ? As Emanuele Cozzi concludes, 'until these questions are resolved in a satisfactory manner, I believe, and I am not alone, that it is not yet the time to begin clinical trials.' ●

Mikhail Stein



Xenome

www.xenome.eu

The sensorial awakening of the bionic hand

Are artificial organs the solution to the shortage of transplant organs? In an age when the living and the man-made are coming together, the excitement is palpable. But what about cooperation between biological and electronic processes? The search for a new generation of bionic hand provides elements of a response.



Tests on using the prosthesis prototype SmartHand at the Department of Electrical Measurements, Lund University (SE).

Replacing a limb whose physiological function (walking, gripping, etc.) is activated by a conscious decision brings an additional challenge, that of manipulating the artificial limb as intuitively as possible. The brain issues the command and, despite the amputation, the cerebral nerve impulses continue to be transmitted to the remaining muscles. Muscles that, at least in the imagination, control the lost limb. In the latest generation prosthesis, electrodes fitted in the joint record the muscular electrical activity of the stump. These signals, known as electromyograms (EMGs), control the movement of an artificial hand, for example.

Did you say bionic?

'The existing systems are in reality very primitive,' explains Fredrik Sebelius, an electronics expert at Lund University (SE) and coordinator of the *SmartHand* project. Funded to the amount of EUR 1.8 million under the Sixth Framework Programme, by the end of 2009 the project will be ready with a prototype

of the next generation of artificial hands. 'Present systems,' continues the researcher, 'have two electrodes, each placed on a different muscle. The strongest signal prevails and it can take as long as six months to succeed in controlling the only two movements possible, namely opening and closing the hand.'

The first imperative is to design a prosthesis that adapts to the user. 'The problem stems from the natural instability of the muscular signals,' explains Fredrik Sebelius. 'These vary from one individual to the next, with the degree of muscular training, and even from day to day depending on what you have drunk or eaten.' The aim is to improve the EMG processing and widen the range of possible movements. 'We have placed 16 electrodes on the forearm. On this basis, our method teaches the system to recognise the different combinations of EMG received.' Incorporating a genuinely intelligent system, the solution involves a shape recognition algorithm based on artificial neuron networks. The system learns while the user executes a series of imposed movements: bending the fingers the one after the other, then all together, with the fingers spread wide, the thumb pointing outward, etc. 'After carrying out this series of exercises the system is calibrated. Two hours is now enough for a user to master an initial set of movements.'

A sensory map of the lost hand

A functional hand is essential, but a hand is not just a perfected gripping tool. It is an inherent part of our identity, of our relationship with the world and with others. A hand is irreplaceable: at the clinical level alone transplantation still presents too many risks and disadvantages. Göran Lundborg, a hand surgeon at the Malmö University Hospital (SE) and member of the *SmartHand* project, highlights something of a paradox: 'The amputee would like to have an artificial hand but one which he experiences as an inherent part of his own body.'

In principle, it is possible to induce a sensitivity in the artificial hand by connecting a sensor located on the prosthesis to an electrode implanted directly into the somato-sensory cortex or into the peripheral nervous system. But the specific nature of the relationship between a lost hand and the brain allows us to envisage another possibility. 'The amputation

of a hand causes considerable functional reorganisations of the sensorial cortex,' explains Göran Lundborg. 'One of the consequences of these reorganisations is the formation of a sensory map of the lost hand on the surface of the stump.' Stimulation of a precise location on this map is felt by the amputee at the same place on his lost hand (see box). Is this then the way of giving the amputee the sensation of having an artificial hand that is very much his own? It is too soon to say. The first stage is to re-create the sensation of force exerted on the object gripped.

A false hand that feels real

'Existing artificial skins were quickly discarded,' Fredrik Sebelius. 'Too many integrated sensors and that means wires with the constant risk of them breaking in a flexible structure.' While awaiting more practical skins, researchers have come up with a clever trick. This involves measuring the tension of a cable that, inside each finger, is linked to a motor. This cable causes the joints to bend mechanically on each finger used in gripping an object. 'As soon as one of the fingers makes contact with an object we have a signal,' explains Fredrik Sebelius.

This signal is relayed to the user using an experimental device that commands five activators each positioned in contact with the 'fingers' of the stump's sensory map. The user feels a pressure from 1 to 10 depending on the tension measured and is able to identify which of the fingers is at the origin of these sensations. This device is currently at the clinical evaluation stage. 'We have demonstrated that the stimuli activate the corresponding areas of the brain, triggering genuine sensations from the artificial hand,' announces Göran Lundborg.

It is difficult at this stage to assess the cost of such equipment, but it will be high. This raises the question of who will pay. The patient, assisted to a greater or lesser extent by his private insurance policy or the national public health system? 'If the patient regains his autonomy in day-to-day life and is less dependent on medical and social assistance, the outlay could prove profitable in the long term for society,' believes Freygardur Thorsteinsson, an engineer with the industrialist Össur (IS), a partner in the project. Hence the attempts to identify those patients who would benefit most.

The art of playing a good trick on the brain

You are seated at a table, with a rubber hand placed in front of you and your own hand concealed from view behind a screen. Simultaneously and at precisely the same spot, a brush strokes the hand placed in front of you as well as your own, which is hidden from view. You soon experience a strange illusion, the sensation of the brush strokes coming from the rubber hand that suddenly feels as if it is your own hand. What is happening? The brain has resolved the contradiction that it perceived between the visual and tactile information.

Carried out for the first time in 1998, this experiment known as the rubber hand illusion has just been repeated with 18 volunteer hand amputees at the Department of Neurosciences at the Karolinska Institutet (SE) (1) 'For the first time an amputee has the feeling that an artificial hand is part of his own body,' announces Göran Lundborg, a hand surgeon at Malmö University Hospital (SE). But how is this possible when the hand is not there? Because on the surface of the stump the lost hand is present in the form of sensations. Inducing tactile sensations in an artificial hand is therefore as simple as playing a trick on the brain.

'We will be charging a university or an independent research body with the socio-economic analysis of the long-term cost effectiveness of our high-tech prostheses,' he says. So what will finally decide the future for artificial organs? Urgency in the face of organ shortages, medical and scientific progress or economic considerations? Ultimately, it will be down to societal choices.

Sandrine Dewez

(1) H. Ehrsson, B. Rosén, A. Stockselius, C. Ragnö, P. Köhler & G. Lundborg, 'Upper limb amputees can be induced to experience a rubber hand as their own', *Brain* (2008) 131, 3443-3452, brain.oxfordjournals.org/cgi/content/full/131/12/3443



SmartHand

7 partners – 6 countries (DK-IE-IL-IS-IT-SE)

www.elmat.lth.se/~smarhand

EUROPEAN NEWS

Renewable and profitable?

While there is no doubt that renewable energies help combat climate change and to reduce dependency on fossil fuels, their economic interest is far from clear. Now, thanks to the Employ-RES study carried out jointly by six European institutes at the Commission's request, we have facts and figures on the impact of renewable energies on jobs and growth.



If Europe meets the target it has set itself, namely renewable energies representing 20% of final consumption by 2020, the sector will then generate, gross, 2.8 million new jobs and 1.1% added growth in the Community GDP. But if we look at the net figures, taking into account the increase in energy prices and the reduction in investments in the traditional energy sector, the ultimate result would be the creation of 410 000 jobs for an added growth of 0.24% of GDP. Although more modest, these figures seem to be the best we can hope for. The study concludes that action would be more rewarding

economically than inaction. Forecasts show that if we do not step up the effort, present policies – which would permit no more than 14% energy savings by 2020 – would provide less in terms of jobs and growth, whatever the model of analysis and scenario envisaged.

<http://ec.europa.eu/energy/renewables/>

BIOTRACER 1 – Salmonella 0

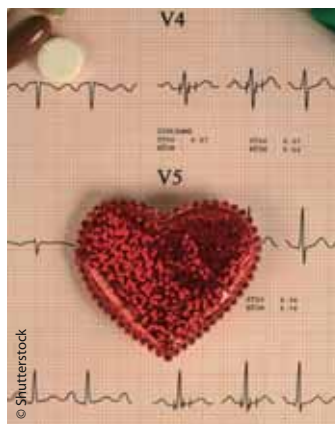
The principal culprit in gastroenteritis has lost a major battle. A team of researchers from the BIOTRACER network has developed a process for quantifying salmonella in pork. To date, all such attempts had come up against the same obstacle. As the bacteria are generally present in low quantities in food, the samples are first of all enriched to facilitate detection. But this process renders quantification difficult.

The new method is still based on an enrichment phase, followed by an amplification of the bacterial DNA by PCR (polymerase chain reaction) in real time, but this initial phase has been reduced. Researchers observed that there



is a precise correlation between the quantity of salmonella contained in the basic sample and the PCR signal, provided the enrichment period is limited to the exponential growth phase of the salmonella. By permitting the simultaneous analysis of several samples, this process opens the door to compiling a new quantitative database, one that is necessary in the field of risk analysis and controlling critical points, an area hitherto impossible.

www.biotracer.org



A new lease of life for the heart

Stem cells obtained from bone marrow and adipose tissue could improve the cardiac function after a heart attack, according to studies carried out by scientists at the Centre for Applied Medical Research and Navarre University Hospital (ES). Cardiac arrest is one of the most common complaints in the world. When a person suffers such an attack the damaged muscular tissue dies and the residual scar tissue does not retract. As a result, the myocardium is unable to regenerate, with serious consequences for the workings of the

heart, possibly ultimately leading to cardiac insufficiency. Experiments carried out on rats showed that stem cells obtained from bone marrow were able to repair the damaged tissue while the adipose cells were transformed to form blood vessels and cardiac cells. What is more, the results obtained were maintained over a long period, stressed Manuel Mazo, who headed the study.

www.basqueresearch.com/index.asp?hizk=l

The other Sichuan disaster

It seems that a huge volcanic eruption in south-west China virtually wiped out all marine life 260 million years ago, according to a study headed by the paleontologist Paul Wignall of Leeds University (UK) and published in the journal *Science*.

Mount Emei, located in present-day Sichuan Province, is believed to have spewed almost half a million cubic metres of lava. The lava flowed down the mountainside and into deep sea waters triggering a massive explosion that emitted vast quantities of sulphur dioxide into the stratosphere, leading to the formation, around the earth, of thick layers of cloud that cooled the atmosphere and culminated in torrential acid rain.

The researchers were able to identify the precise moment of the eruption, as the lava formed a very distinct layer of igneous rock between two layers of sedimentary rock that contain all the marine fossils that can be easily dated. The link between a volcanic eruption and mass extinction is often difficult to establish as it is generally based on the CO₂



According to a **Chinese proverb**, 'going on the road to Sichuan is as hard as going to heaven'.

produced as a result of the eruption. Yet the effects of the build-up of this gas in the atmosphere are progressive and therefore more difficult to identify.

www.see.leeds.ac.uk/research/essi/

Goodbye to the Kraft process

The timber processing industry could be on the verge of a small revolution. Researchers at Queen's University Belfast (IR) and University of Alabama (US) have developed a dissolving technique that is cheaper, more effective and, above



all, more ecological than the Kraft process that has been used since the 19th century. The miracle recipe swaps traditional chemicals for ionic liquids. These are in the form of organic salts with a relatively low fusion point. Not only are these products less toxic and biodegradable, but they are also able to dissolve wood shavings at lower temperatures and pressure. By adding water and acetone, researchers also managed to partially separate the two components of the dissolved wood, namely cellulose and lignin, both of which are at the basis of many derivatives. Cellulose can be used to produce biofuel, textiles and of course paper. Lignin makes it possible to synthesise chemical products that are usually derived from oil. According to Robin Rogers, co-director of research with Héctor Rodríguez, the discovery of this new process marks major progress in developing the bio-refinery concept. 'This could open the door to developing a genuinely sustainable chemical industry, one based on renewable resources,' he declared.

www.rsc.org

River pollution

A team from Cemagref in Lyon (FR) has identified a pertinent indicator of the level of pollution in rivers: the biofilm. A complex combination of bacteria, algae and fungi, the biofilm forms a viscous layer on immersed supports, such as the stones on a river bed.

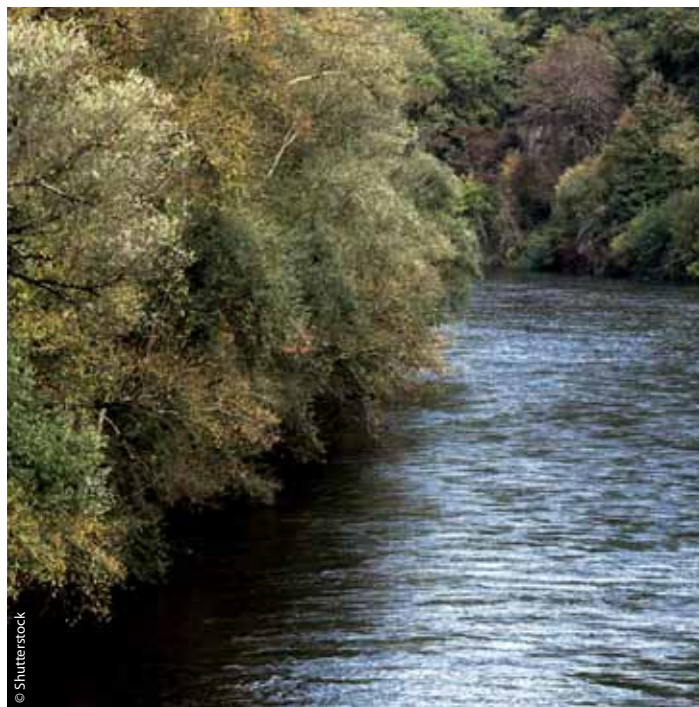
The biofilms are able to break down the pesticides that contaminate aquatic environments and modify their structure, diversity and functioning. Toxic substances, for example, can change the photosynthetic, respiratory or enzymatic activity of aquatic ecosystems, either definitively or temporarily. It is in this way that biofilms can serve as an early warning signal of pollution. It remains to characterise and distinguish the responses of biofilms to pollutants from those induced by environmental factors (current speed, physico-chemical composition, etc.). It is research of this kind that should help respond

to the need set out in the Water Framework Directive to improve the ecological quality of European rivers by 2015.

www.cemagref.fr

The water carrier

Researchers at Göteborg University (SE) have succeeded in unravelling a major mystery in the fight against cancer. They have managed to determine the three-dimensional structure of yeast cell aquaporins. An aquaporin is a small membrane protein on which many hopes have been pinned, as it regulates the flow of water inside cells. This is vital to controlling cell shape and size. These flows of water could play a crucial role in several types of cancer, research on mice having shown that inhibiting this function made it possible to reduce significantly tumour propagation and growth.



The Swedish researchers revealed the protein structure with the aid of X-ray crystallography. The high resolution of the images permitted detailed observation of the protein's amino-terminal extremities, a sort of long tail whose function was hitherto unknown. Their research indicates that these act as a valve, opening and closing depending on the quantities of water the cell needs to absorb or reject. The channel formed by the aquaporins is regulated mechanically and by phosphorylation (addition of phosphates). Research Director Karin Lindkvist believes these discoveries will allow a human aquaporin inhibitor to be developed that, in the longer term, could lead to the creation of medicines able to slow tumour growth. The results of this study were published in the June 2009 edition of the journal *PloS Biology*.

www.science.gu.se

The stealth of the chlamydia

Sweden has contributed to its cost to the better detection of chlamydia, the parasites that are the source of many sexually transmitted diseases. In 2006 a new strain of this bacteria spread like wildfire through the country, eluding the principal diagnostic tests. Swedish doctors believed that infection rates were falling when in fact the very opposite was the case. This new strain of chlamydia, along with five others, was the subject of a recent study by the British Sanger Institute and Southampton University (UK). It seems that the genetic sequence of the bacterial plasmid (the DNA molecule that exists outside the chromosome) on which the tests



© Shutterstock
Cardiogram of a foetus.

were based had quite simply disappeared from the Swedish strain.

The researchers therefore set about determining another genetic sequence for the purposes of identifying the parasite. After painstaking analysis they opted for the region that showed the least variation between strains but is still situated in the plasmid. According to Helena Seth-Smith, who headed the study, this is a timely warning as this kind of development could also be true of other infectious bacteria.

www.sanger.ac.uk

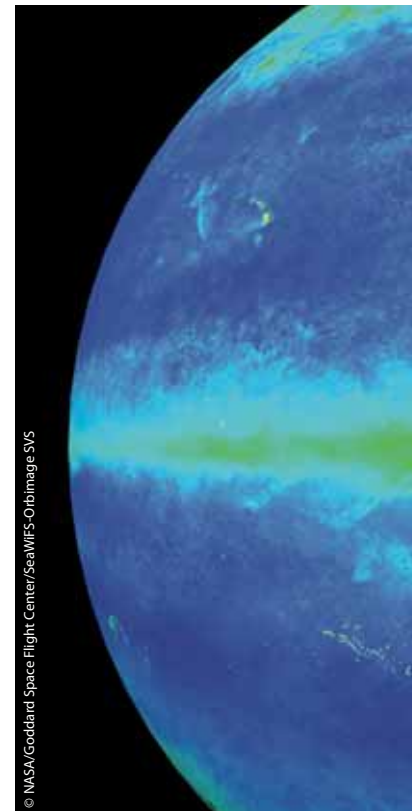
The mother, the child...

A good example of interdisciplinarity was published recently by the prestigious National Academy of Sciences in the United States. It was in the form of cooperation

between the Potsdam (DE) Institute of Research on Climate Change and the Chair of Radiology and Microtherapy at the University of Witten/Herdecke (DE). The scientists discovered that the heartbeats of the mother and foetus could be synchronised. The feeling often reported by mothers of being able to feel whether or not their baby is doing well could be linked to this interaction.

The study was carried out on six women at between 30 and 40 weeks of pregnancy and the heartbeats were measured with the aid of a magnetocardiograph. It seems that the cardiac rhythms are different but linked by certain ratios. It also seems that an increase in the mother's respiratory rhythm favours the phenomenon. These hidden interactions were revealed thanks to an algorithm that generates what are known as 'twin surrogates' which could be translated as 'fictitious twins'. These are independent copies of the underlying system that

Surface plankton bloom after El Niño crossed the Pacific.



© NASA/Goddard Space Flight Center/SeaWiFS-Orbimage/SVS

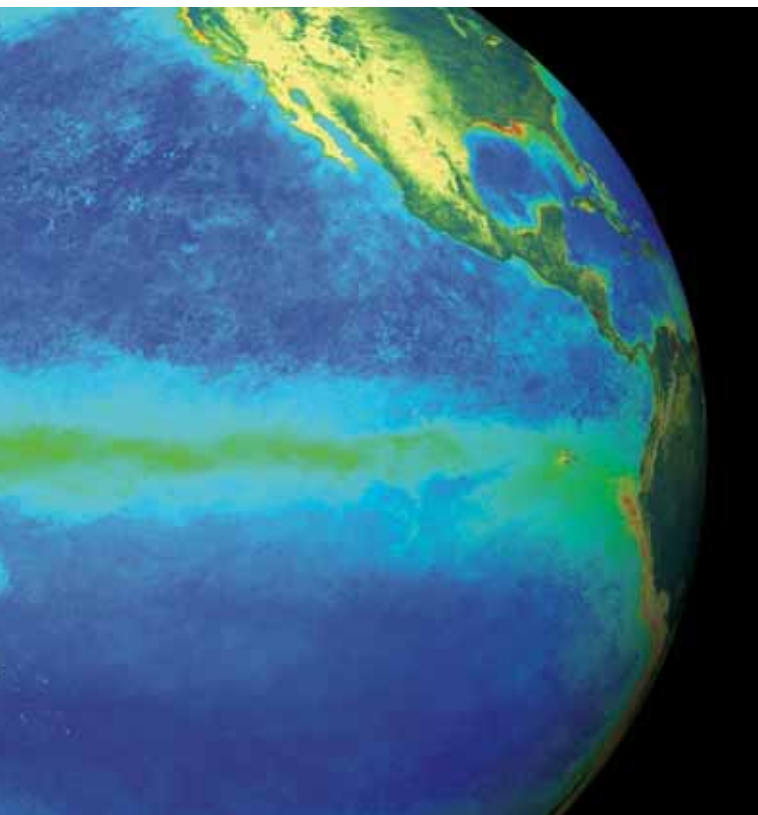
serve to identify statistically the periods of synchronisation. The mathematical approach could facilitate the detection of complications earlier in a pregnancy. More generally, it opens up new prospects for research on interactions between independent but strongly linked physiological systems.

... and the Earth

So what does all this have to do with climate, the object of attentions at Potsdam? The algorithm developed by the mathematicians also makes it possible to understand other synchronisation phenomena, which could be described as the 'perception' by a given dynamic system of the existence of another system. Synchronisation defines the way in which these two systems

respond to the influence of the other as well as external influences. This could be applied to complex climate models, such as teleconnection, or the correlation between two climate phenomena separated by great distances. The most known teleconnection unites the El Niño current off the coast of Peru with the Indian monsoon caused by southern oscillation, that is the cycles of variation in atmospheric pressure in the South Pacific. The algorithm could also serve research on the loss of biodiversity caused by man, making it possible, for example, to identify why and to what extent the fragmentation of an ecosystem by roads or plantations affects the diversity of species.

 www.pik-potsdam.de



RESEARCH UNDER THE MICROSCOPE



Do industrial researchers have souls?

In his work *The Scientific Life: a Moral History of a Late Modern Vocation*, historian and sociologist of science Steven Shapin questions two widely accepted ideas. The first is that modern scientific research, as presented by Max Weber and Robert K. Merton, is a collective enterprise based on standards of interaction between researchers, exempt from any moral concern and in which individuals do not count. The second is that deep-seated differences exist between research undertaken in the academic environment and research carried out in business enterprises which are motivated by the search for profit. Shapin takes the opposite position, maintaining first that in modern research, just as much as in classical research, individuals and their personal psychological qualities, starting with their own charisma, play a vital role, as do moral roles such as integrity and the desire for knowledge; second that these qualities and values influence just as much research undertaken in an industrial environment as that undertaken in universities. Shapin supports these affirmations with historical considerations and theoretical reflections, as well as an analysis of the results of a survey he himself undertook among a certain number of researchers. Shaping received ideas is always useful, and Steven Shapin has frequently shown himself a perspicacious observer of science. But this time, the general opinion is that he has gone too far, with a desire to think out of the box leading him to exchange one form of naivety and prejudice for another. Clearly, the statements of industrial researchers cannot be considered as strictly objective. As everyone who has ever looked at pharmaceuticals research knows, the fact that research activities are carried out in a context dominated by considerations of profitability has profound consequences on the way they are undertaken. To maintain otherwise is to defend a paradoxical thesis for the pleasure of doing so.

Michel André



Research on every front

In 2004 Janez Potočnik was one of the principal architects of Slovenia's EU membership. For the past five years he has been the Commissioner in charge of science and research. As such he has coordinated the European Research Area, advancing it continuously on every front. He looks back on progress to date.

Your mandate as Research Commissioner is ending at a time of unprecedented economic and financial crisis. How do you see this new situation?

First of all, I feel it is essential to stress to what extent we are facing global realities that are undergoing profound change. We are living in a fast changing world that is increasingly interconnected and interdependent and in which many new actors are appearing. At the same time, we are facing global challenges, linked not only to the present economic and financial crisis but also to questions such as climate change, future energy resources, the water problem, world food imbalances,

the appearance of new pandemics, increased population movements and so on.

I am convinced that the 21st century will be dominated by two key issues. On one hand *sustainability*, understood not only in the environmental sense but in economic and social terms also. The crisis illustrates the need for a sustainable world economy and finance. The term must also be applied to social systems. The second issue is *global governance*, because these common challenges require a common approach. Hence the need, for the international community, to build a genuine global governance within which the European Union can and must play a major role.

Is not the expression 'knowledge economy or society' a concept that is in danger of being abstract to the ears of most people?

But the knowledge economy is the one we are already living in. Science and its relationship to society relate to every political issue, such as health, the battle for the environment, education, jobs, food security, energy and transport. We are emerging from a period when power and leadership depended on material resources and entering a knowledge economy.

Innovation, research and education are the three factors that cause the economy and society to evolve towards this new paradigm

of knowledge. This requires us to change our way of thinking and our approach.

The European Research Area, the ERA, has been the concrete expression of a new EU strategy on science and technology policy for nearly a decade now. What is your assessment today of this ambition, one supported actively throughout your mandate?

Europe has always been and remains a continent rich in scientific and technological excellence, but the landscape is marked by a deep-rooted compartmentalisation of research systems. For almost three decades the EU has supported close cooperation between European research actors through its framework programmes that have been allocated ever bigger budgets. Launched in 2000, the aim of building a genuine European Research Area now incorporates these programmes within a much broader vision. The ERA is defined first and foremost as an area within which research actors and ideas circulate freely, without borders, as a single market. After having created an EU based on four freedoms of movement – of goods, of persons, of services and of capital – it is now time to acquire a fifth, that of the free movement of knowledge.

In this context, the Seventh Framework Programme introduces a new and vital element in creating the European Research Council, the ERC. This is an entity offering the European and global scientific world substantial financial support to explore and exploit the most advanced research fields emerging from the development of contemporary science. It supports men and women or fundamental research teams, selected for the excellence and the pertinence of the investigations they propose, and the arbiters of which are themselves recognised and experienced scientists appointed by their peers.

The aim is to create a kind of Champions' League of researchers at European level, akin to the Champions' League in the world of football. That is precisely the role that falls to the ERC: to attract to Europe the best researchers whose fundamental research bears the seeds of top level scientific research. What best researchers? Wherever they can be found, at European universities and research centres of course, but also European brains that have gone elsewhere as well as foreign researchers who choose to work in a European framework.

I am convinced that the existence of the ERC will bring profound changes to the reality of the European research landscape and change the way it is perceived. Europe will be regarded as more attractive by researchers and will therefore be more competitive on the world stage.

The ERC was set up two years ago. Has it now progressed beyond the pilot stage?

We launched it in 2007 with a budget of EUR 7.5 billion from the Seventh Framework Programme for the period 2007-2013, but with no pre-established structure. The ERC therefore operated with what is known as a 'dedicated implementation structure' before becoming an autonomous executive agency on 15 July, 2009. We therefore 'learned by doing'. The first calls for proposals, launched in 2007, drew more than 11 000 very worthy candidacies. So it is certainly succeeding in attracting interest. Further proof of this lies in the very strong reputation this body enjoys in scientific communities elsewhere in the world, especially in North America.

For a long time now the scientific and technological indicators place Europe in third position at world level, outpaced by the United States and Japan, especially in terms of investments made in research. Yet compared with its competitors, it is the low level of investments by EU businesses that is seen as its principal handicap.

Most research expenditure is indeed financed by the public sector while the aim of the Lisbon strategy is to allocate an average of 3% of Europe's GDP to research, a third of which comes from public funds and two-thirds from private funds. We are not there yet. This brings me to the second innovation of the Seventh Framework Programme: the creation of public-private partnerships, the *Joint Technological Initiatives*, or *JTIs*. In this way the Commission is aiming to encourage industry to invest in high-tech research sectors that are vital to our competitiveness but for which market demand is an insufficient incentive for businesses.

In cooperation with the private sector we have identified these strategic sectors and built joint companies to manage these research programmes. Five *JTIs* have been launched to date, in the fields of innovative medicines, clean aeronautics, fuel cells and hydrogen,


embedded computing systems and nano-electronics. As part of the European economic recovery plan, three new public-private partnerships have now been launched to support research in 'clean' technologies in fields of strategic importance in economic and environmental terms: the automobile industry, construction and manufactured goods. I believe that this new approach comes at just the right time amid the current crisis. They are tools for recovery through research and for research.

Apart from the synergies between the public and private spheres, what is the situation regarding a better orchestration of the 27 public research policies that each Member State is itself pursuing?

This desire to coordinate national research policies is an essential part of creating the European Research Area. Why? Quite simply because we are facing very major common challenges that call for a common response that involves research. The Commission has therefore placed on the table of the Council of Member States a number of proposals on issues – as diverse as they are fundamental – such as the mobility of researchers, the creation of new European research infrastructures, the strengthening of international scientific cooperation and the joint programming of national research agendas. On all these points there is now a genuine desire to press ahead.

In terms of joint programming for example, 20 Member States have started work on drawing up such an agenda for research on Alzheimer's and neurodegenerative diseases that are a major health issue in Europe. It is for the Member States to define those fields in which they want to work together. The Commission plays a coordinating role in this, that of co-pilot and not captain. ●

Interview by Didier Buysse.

 *research*eu* special issue, November 2009: 'European research: where are we now?'

To act or not to act?

Threats of epidemics, the security issues or ethical problems that come with new technologies, damage to the environment or upheavals in the global economy... such issues, of direct concern to each and every one of us, place politicians and scientists in the firing line. Citizens are growing tired of the monopoly held by policymakers and experts, and are wanting more and more to understand what is happening around them and to have a say in it.

In the space of just two or three decades, the place held by science and technology within the political functioning of society has undergone a radical change, both in size and nature. We are witnessing *an interacting twofold movement*, consisting on the one hand of what science can offer and on the other of society's demand for answers dreamed up and guaranteed by science. Science is continually breaking new ground. In GMOs, nanotechnologies, genetic diseases or all-pervasive communications, it is developing a manna of knowledge with enormous promise (wiping out epidemics, curing genetic diseases, raising life expectancy, etc.). But its effects can also be highly negative, not least the destruction of the environment and climate change. In addition, a number of scientific discoveries are starting to challenge ethical frontiers.

Jekyll and Hyde researchers

Faced with questions requiring knowledge they do not possess, policymakers in the public – or private – sectors have no other choice than to turn to 'wise men' to underwrite the merits of their decisions. But when researchers leave their laboratories to give advice and guidance, they are changing functions and moving into the field of expertise. This doubling up is not without a certain amount of ambiguity.

Of course scientists are required to base their advice on objective facts. The link

between pleural cancer and exposure to asbestos is amply demonstrated – even if it took a long time for this truth to express itself. Such a straightforward cause and effect scenario is, however, not the usual case in any scientific expertise. The boundary between the objectivity of the data and the subjectivity of the responses derived from them remains to a great extent blurred and uncertain.

This movement of contemporary science is paradoxical: the more knowledge breaks new ground, the more it gains in complexity, and the more diversified the issues inherent in this very complexity become. 20th century quantum physics established the unique concept of 'the uncertainty principle' – that the very observation of a phenomenon generates uncertainty *as to how to measure it*. This concept can be extended to virtually every area, with science being both a judge of and a party to the advances it makes possible. And the accumulation of knowledge is constantly challenging established certainties, with a large portion of discoveries drawing their inspiration from a perpetual questioning of established concepts...

A sceptical society

Beyond this, the ambiguity of any scientific expertise is rooted in a bipolarisation between experts and policymakers. This intimate relationship has long ignored a third party: society as a whole. The traditional and comfortable assumption of the inherently beneficial nature

of science is no longer accepted as true. 'There is concern in society that scientific advances have become double-edged; and there is also a fear that science-based technology is running out of control,' says Oxford (UK) University's Jerry Ravetz (1). 'Instead of the pure curiosity of the discoverer, the direction of this sort of science is to a great extent motivated by power and profit, with eventual societal benefit mediated through those primary goals. Also, this new sort of science is not immune to manipulation and abuse, be it the neglect of unpopular lines of research, the suppression of unwelcome results, the pressuring of regulatory authorities, or the victimisation of critics'.

From Chernobyl to Kyoto

A number of high-focus developments and events have marked the path of this questioning of 'technological innocence'. In the '70s, when several European countries were building nuclear power stations, the emergence of a structured protest against nuclear energy can be seen as a 'pioneering' manifestation of a refusal of this option and as a test bed for a much wider environmental movement. One decade later, the results of this opposition led several states, first and foremost Germany, to abandon, or at least put on ice, nuclear energy, with the 1986 Chernobyl disaster playing a major role in swaying opinion...

But it was in the early '90s that a 'third state' started to appear in society, intervening in a much more systematic way in the cosy relationship between scientists and policymakers. Environmental and consumer protection issues became the driving force behind the formation of a growing number of NGOs. Surfing on this wave and opting for spectacular media operations, GreenPeace became (and remains) a thorn in the side of the scientific and political establishment, playing a major role in shaking the foundations of trust – even if the group only represents the tip of a particularly large iceberg.

With the question of human influence on climate change gaining increased focus, scientists were the first to take this societal malaise seriously, using the 1992 Rio de Janeiro Summit and the 1997 Kyoto agreement to open the eyes of the political class to the fundamental reality of this problem. We are now all too well aware of the major global challenge that climate represents.

The European dimension

As an institution with a regulatory and legislative function transcending national political powers, the EU has long been a decision-making venue making repeated use of scientific expertise. This has led it to forge extensive links with a wide range of players from different cultural backgrounds and with varying scientific and professional specialisations.

In 1992, the adoption of the Maastricht Treaty paved the way for a new approach to risk – the major object of the use of outside expertise, by taking into Community law the fundamental rule of the precautionary principle. Immediately after the ‘mad cow’ crisis, in which the EU’s health decisions, with their dramatic consequences for animal farmers, were perforce dependent on the



The malaise of innovation

In 2007, DG Research commissioned a group of experts to study the impact of the concept of the knowledge society on citizens (*'Taking European Knowledge Society Seriously'*). A central question of this project was the nature of and possible answers to the malaise that civil society feels towards certain techno-scientific innovations, particularly in relation to their objectives, the social changes they bring and the underlying risks. The research was conducted very openly by groups that included not just experts, but also students of 'hard' sciences and human sciences (sociology, philosophy and law students), citizens who had expressed their interest in taking part in the study and trade unions.

The conclusions of this study centre in particular on the tendency to focus exclusively on a knowledge society motivated by a frenzied race for innovation and efficiency imposed by globalisation, which, its authors state, poses a serious problem of acceptance by society. The study explores many avenues for having civil society experience the dynamics of innovation as a collective and diversified undertaking, democratically shared by all.

http://ec.europa.eu/research/science-society/document_library/pdf_06/european-knowledge-society_en.pdf

●●● deployment of a vast range of expertise, covering both medical and veterinary issues and the commercial organisation of the beef and sheep sectors. This led, in 1997, to a complete overhaul of the EU's system of scientific committees in the areas of food safety and consumer protection, with a further step being taken in 2002 with the establishment of the European Food Safety Authority (EFSA)⁽²⁾.

In that same year, the Commission adopted guidelines for the use of outside expertise on which it constantly relies for its health, environmental and consumer protection policies, or again in socio-economic, scientific and technological fields. The questions are manifold. How and by whom are the subjects to be evaluated chosen? Who decides on the composition

of advisory panels – researchers, in particular – at a time when science is becoming increasingly complex, necessitating multidisciplinary approaches? What place is to be given to counter-expertise and to differences of opinion or advice between experts? In which form will results be published? All this depends on the qualifications, independence and objectivity of the players invited to give their opinions, and on the transparency of their work and their findings.

Moving on beyond procedural issues, the European Commission – without doubt itself confronted by the Gordian knot of the democratic deficit weighing on the institutions – has posed the question of how to have society participate in scientific and technological choices and evaluations. This has been a long journey. For years, the EU, long criticised for its 'purely economic' orientation, was preoccupied with building a great 'single market', with one of its major extensions being the introduction of the euro.

Society and knowledge

At the start of this century and reflecting a consensus 'of anxiety' felt by all Member States, priorities evolved over a wide front towards the concerns of the future. This new situation has given the current *Lisbon Strategy*, of moving beyond the concept of an *information society* – which in the '80s translated into a primarily industrial priority targeting information and communication technologies – towards a '*knowledge society*', currently under construction, with the key word 'market' being replaced by 'society'.

In European research programmes, 'science, governance, society' is becoming a major development focus, alongside social sciences and humanities. Out of this concentration of analyses and studies a true 'European laboratory' has been born, with a new formulation of this triptych beginning to develop.

Within civil society, a fundamental citizen movement is demanding to be part of the debate. This is gradually growing into a protest force that neither politicians nor scientists can afford to ignore. The demand for transparency is gaining ground. Policymakers and experts have long known their opponents: the various associations, themselves supported by reputable scientists, with whom they must

negotiate. In this regard, the Commission's advisory body EURAB⁽³⁾ has called for a greater commitment towards society from researchers: '(They) work in systems that are rational and instrumental, and have a tendency to assume that society behaves likewise. But society does not always behave rationally, and in certain sensitive areas, researchers should keep in mind that their systems operate in a public context.'

More recently, citizen debates, consensus conferences and experiments in participatory democracy have emerged in various forms, differently organised, both broad-based and focused on specific issues. Many of them relate in one way or another to science (medicine, the environment, etc.), offering democracy – if the information provided is comprehensive and covers both sides of the argument – a new hand of cards.

In this evolution, science is benefiting from a clarification of its fundamental value: independence. 'Knowledge cannot be controlled or geared by the wishes of the public authorities,' states *IPCC (Intergovernmental Panel on Climate Change)* Chairman Rajendra Pachauri. 'We must do our utmost to prevent politics from interfering with scientific results. Our duty is precisely to disseminate all scientifically established knowledge to the public. It is a duty that I heartily endorse.'

●
Didier Buysse

(1) 'Science, Governance and Society – EU Research in Social Sciences and Humanities'; J.R. Ravetz ftp://ftp.cordis.europa.eu/pub/citizens/docs/eur23169_final_en.pdf

(2) 'Improving the knowledge base for better policies'; ec.europa.eu/governance/better_regulation/expertise_en.htm

(3) European Research Advisory Board, ec.europa.eu/research/eurab/

 <http://ec.europa.eu/research/science-society>

Southern colours

Analysing the natural pigments used by artists and craftsmen in the Mediterranean basin throughout history. Reproducing them industrially for use by restorers and creative artists today. Spotlight on the MedColour European project.

Ochres that pass from bright yellow to deep orange, reds that can darken to near-black, inimitable blues... Since antiquity, the works and objects of art from the Mediterranean heritage have shared a common colour palette. These tonalities are found equally in painting, textiles and manuscripts from the Middle East to southern Europe simply because the artists and craftsmen of this part of the world used the same pigments, taken from plants, minerals,

insects and shellfish, even if our knowledge of the 'colour routes' they took over time is imperfect. 'From the 19th century onwards, synthetic colouring agents took over from traditional techniques based on natural pigments, which then fell into oblivion. If we want to restore ancient works, we need therefore to identify and analyse these pigments. Rediscovering them would enable us to avoid the clumsy restorations of the previous century, and maintain our entire Mediterranean heritage with proper respect for its specificity. This is the objective of *MedColour* and for this we are making use of the most advanced physical and chemical technologies,' explains chemist and project coordinator Ioannis Karapanagiotis.

High tech in the service of art

More than 130 works from different periods and different techniques, all of irrefutable provenance and dating, were the subject of this research. The evidence is as varied as little rugs of the Seljuk period at the Museum of Istanbul (Turkish and Islamic art), a tunic (*sakkos*) of Emperor Ioannis Tsimiskis (Iveron monastery on Mount Athos in Greece) or 13 icons from the 15th to the 17th century belonging to the Cretan school. The latter in particular are enabling us to study the evolution of the reds, to identify the organic and inorganic colours, and to see whether novel pigments were introduced after the discovery of the New World. Microscopic samples have been used to examine the structure of different layers of paint, using a combination of several sophisticated physical and chemical methods, such as Raman spectroscopy or High Performance Liquid Chromatography (HPLC) coupled to a photodiode detector⁽¹⁾.

This new knowledge makes it possible, for example, to restore works of art knowing exactly what pigments were used in a particular layer of varnish and to clean each stratum with appropriate solvents. Additionally, manufacturing wool or silk in the traditional manner will help carpet restorers to use colours that are close to the original and far more resistant to light than industrial products.

To present the concrete aspect of their approach, the *MedColour* partners organised various workshops at the Sidi Mohamed Ben Abdellah university at Fez (Morocco) in November 2008. 'We wanted first of all to inform SMEs and organisations in the craft sector of the possibility of creating new natural colouring agents, manufactured industrially, but incorporating traditional recipes,' says Rachid Benslimane, of the University of Fez. 'It was also an opportunity to disseminate to researchers and specialists the latest results of our work on new methods of diagnosis and identification of natural colouring agents in objects of art and the technologies for producing and characterising these colorants.'

The dissemination of this knowledge is another important objective of the *MedColour* partners. They are currently developing a database that will provide information on conservation strategies for the Mediterranean heritage. ●

Christine Rugemer

⁽¹⁾ Raman spectroscopy is a non-destructive method for characterising the molecular composition and structure of a material. HPLC, or high performance liquid chromatography, is an analytical separation technique based on the hydrophobicity of the molecules of a compound. A photodiode is a semiconductor component that can detect radiation from the optical field and convert it into an electrical signal.

Icon of the Cretan school conserved in the Benaki Museum (Athens) and investigated by the *MedColour* project. In-depth investigation has identified the organic and inorganic pigments of the reds of the different paint strata.



© Benaki Museum, Athens - Photo Conservation department

 www.medcolourtech.org

Tracking back from plate to net

Combating illegal fishing is critical for achieving sustainable management of the seas. But the very vastness of the big blue makes it extremely difficult to outwit fraudsters. Researchers are right now developing new tools to trace a fish's origin and determine whether it was caught legally or not.

88% of species fished in Europe cannot be optimally replenished because they are overexploited.

‘Sea fishing is free because it is impossible to exhaust the wealth of the sea,’ wrote legal expert Hugo Grotius in his book *Mare Liberum* back in 1609. Since then, things have changed dramatically. 28% of fished species are now overexploited, depleted or in the process of rehabilitation, and 52% of stocks have reached a point of maximum exploitation⁽¹⁾. In Europe, 88% of species are unable to renew optimally because exploited beyond the limits of maximum sustainable yield. For the 30% that are outside safe biological limits⁽²⁾, it may already be too late.

With restrictions on the size and number of vessels and the amount of time at sea or imposition of fishing quotas by species, the fishing industry labours under such a weight of regulations that some choose simply to disregard them. This is now a major problem that is threatening the proper management of fish stocks. Experts refer to this problem with the words ‘illegal’, ‘unreported’ and ‘unregulated fishing’ – *IUU* (see box).

Genetic barcodes

To identify the species of a particular piece of tissue, researchers examine, not the nuclear DNA, but the mitochondrial genomes. These intracellular structures (organelles) are abundant in the cells and their DNA is easier to isolate, even when the tissue has been cooked or industrially processed. And as part of their genetic sequence has a specific structure for each species, we can use this sequence as a sort of bar code for identifying them.

‘This is a formidable weapon for protecting consumers,’ says Gary Carver, professor of molecular ecology at Bangor University (UK). ‘Already several years ago, an analysis of the genetic barcodes of the content of tins marked as containing red snapper showed that 77% was in fact of another type of fish!’

Elusive illegal fishing?

'In Europe, illegal and unreported fishing rose sharply in the mid-'90s in the wake of a cut in fishing quotas which were introduced without real consultation with fishermen, who often perceive these measures as unjust,' says David Agnew, a researcher in marine biology from Imperial College London (UK), a specialist in issues relating to IUU fishing. 'Over the past two to three years, the situation has improved. New national and European measures have been introduced that better reflect the difficulties that fishermen encounter. There has also been a strong response from the processing industry to limit the trade in fraudulent catches.'

But illegal fishing continues. According to a recent study led by David Agnew, between 11 and 26 million tonnes of fish are caught each year illegally and without being reported, equivalent to between 12% to 31% of the total global sea catch⁽³⁾. To arrive at these figures, David Agnew and his team had no other choice than to carefully pick through existing national-level reports and case studies. 'The problem is right there,' he explains. 'These documents are based on a wide variety of techniques. There is no standardised methodology, which makes any general assessment approximate.'

For Gary Carver, professor of molecular ecology at Bangor University (UK), countering illegal fishing is a question of resources. 'IUU fishing continues mainly because there is no technology to determine the origin of fish. If a ship is spotted in an area that is closed to fishing, inspectors have no tools to prove that the catches aboard the vessel actually come from that part of the sea.'

Anti-fraud genetics

Since February 2008, Gary Carvalho has been coordinating *FishPopTrace*, a European project that has set out specifically to develop a set of tools to track down the geographic origin of a catch and in this way determine whether the fish was caught illegally or not. 'The main objective is to design an analysis protocol that is easy to use by inspectors and accurate enough for the results to serve as evidence in court against those responsible for IUU fishing,' he explains. 'Our research focuses on four of Europe's most caught species: cod,

hake, herring and sole. But the technique can in principle be used for all European stocks'.

The protocol the *FishPopTrace* researchers have developed breaks down into three steps. The first step is to determine the species of the tissue being analysed. Here, researchers are focusing on genetic features that act as 'barcodes'. The principle is to examine a genetic marker and compare it with information collected in a database. From this one can determine the species of the sample in question (see box).

Once the species is known, it remains to locate the origin of the specimen. For this, researchers are focusing on the single nucleotide polymorphisms (SNPs), that is minuscule variations of the nitrogenous bases of DNA. These mutants are specific to each individual fish, even within the same species.

'We are hoping to identify 1 200 SNPs for each species studied by *FishPopTrace*,' says Gary Carvalho. 'These SNPs are all specific to the populations of a given area. By setting up databases, we will end up with a set of collective signatures and be able to trace the origin of the products tested.'

Between control and listening

The latest analysis technique that *FishPopTrace* has developed can further refine the previous results. This time, the method relies, not on the DNA but on the otoliths, the bones of the inner ears of the fish. 'Just like tree rings, the shape and biochemical composition of the otoliths vary depending on the environment surrounding the specimen. Analysis of otoliths allows us not only to define the age of the fish, but also the composition of the seawater in which it has evolved,' says Gary Carvalho.

We can thus refine the geographic location established using SNPs while determining if the fish has been caught prematurely, because there are also regulations that seek to secure the renewal of populations by prohibiting the capture of undersized fish.

Launched in 2008, the *FishPopTrace* project is still in its infancy, but Gary Carvalho is confident. 'We've already identified many SNPs for each species studied. It remains to determine which are most relevant for locating the original environment of the fish. We have also launched a huge sampling campaign to create the database with which to compare the

Illegal, unreported and unregulated fishing: reference points

- **Illegal fishing:** applies to vessels that violate the rules, for example by fishing in prohibited areas.
- **Unreported fishing:** refers to boats failing to report all or part of their catches to the competent authorities.
- **Unregulated fishing:** takes place in high-seas areas not falling under the jurisdiction of any regional fishing regulatory authority.

results of the different analyses. This is a time-consuming process, but we are already well on the way and the project is not planned to end until February 2011.'

There is no doubt that this sort of research can pave the way towards more effective control of fishing fraud. 'With the development of new deterrent tools we should, however, not forget the need to involve fishermen as much as possible in any decision-making on the sustainable management of stocks,' David Agnew insists. ●

Julie Van Rossom

- (1) *The state of world fisheries and aquaculture 2008*, FAO, Rome, 2009 – www.fao.org/fishery
- (2) Green Paper: *Reform of the Common Fisheries Policy*, European Commission, 2009 – http://ec.europa.eu/fisheries/reform/consultation_en.htm
- (3) David J. Agnew & Co., *Estimating the Worldwide Extent of Illegal Fishing*, 2009 – www.plosone.org. NB: This study does not take into account unregulated fishing, which, in the author's opinion, is extremely widespread.



FishPopTrace

14 partners – 10 countries

(BE-DE-DK-ES-FR-GR-IT-NO-RU-UK)

<http://fishpoptrace.jrc.ec.europa.eu>

A/H1N1: uncovering a new type of influenza

Even if the latest influenza virus fails to spread panic, it will, all the same, have managed to disrupt health authorities worldwide. As it spreads across the world at the speed of light without proving to be particularly lethal, the new public enemy number one is not what we expected.

Let's hope that the threat will come from a predicted direction for once' mused one of our journalists recently in an article on the potential sources of viral epidemics⁽¹⁾. Even just a few months ago, the famous H5N1 virus, responsible for the avian influenza that raged since 2003, was considered the most threatening. But today things seem to have advanced somewhat, towards a viral epidemic or, more precisely, an influenza pandemic. A new subcategory of the influenza virus, the A/H1N1, has emerged without warning, compelling the World Health Organization (WHO) to raise its level of alert to the maximum phase 6 in only a few weeks, declaring a global pandemic last 11 June.

Just as this edition was going to print, WHO counted at least 622 482 confirmed cases, nearly 8 768 of which were fatal. If we compare these figures to those of the dreaded H5N1, which, in six years, infected about 450 people and killed just over half of them, these figures seem

alarming. Yet, the transition from alert phase 5 (imminent pandemic) to phase 6 (full-blown pandemic) was marked by clearly discernable doubt as to the severity of the situation. Of course, the new virus spreads from person to person and has colonised the planet in eight months, but the strength of the illness seems relatively limited. It is difficult to know how to respond to this invader!

A/H1N1 versus H5N1

How did A/H1N1 get the upper hand over H5N1? While H5N1 aroused fears of pandemic from the moment that its transmission from poultry to man was observed, no human-to-human transmission has been registered to date. 'H5N1 is a very frightening virus because the death rate, that is to say the number of deaths reported in relation to the number of cases, is 60%. But until now, it has not humanised, although it spreads with great intensity,' explains Antoine Flahault, a doctor and biostatistician, developer of *FluNet*, the Global Influenza Surveillance Network with WHO, and current director of the EHESP School of Public Health in Rennes (FR). According to the school, the new A/H1N1 virus strain has acquired the much-dreaded capacity to be easily transmitted from one human to another. It also contains genetic fragments of the swine, bird and human influenza viruses. Even so, does this make A/H1N1 a particularly formidable virus?

'It is difficult to assess the strength of a virus other than by the death rate it provokes. The death rate due to seasonal flu is quite stable, amounting to one death per 1 000 cases in developed countries,' points out Antoine Flahault. 'It seems to have the same type of strength as the A/H1N1 virus. Although the death rate is a little higher, four deaths per 1 000 cases, it is close to that of the seasonal

influenza and far from that of the influenza pandemic of 1918,' he continues. Simply speaking, even if it is very contagious, A/H1N1 is not a source of infection that we can qualify as 'serious' for the time being. Even if the risk of the virus mutating in order to resist the antiviral drugs used to treat those infected is in fact real, treatments with oseltamivir and zanamivir will have allowed us to limit the damage while we await a vaccine.

One of the fears elicited by the appearance of the new virus is a genetic recombination with the H5N1 virus, which would enable the latter to cross the barrier between the species. The product of this recombination could simultaneously inherit the contagious character of the A/H1N1 virus and the highly lethal character of H5N1. Even if no one can predict the behaviour of H5N1 under pressure from a A/H1N1 pandemic, this scenario is nevertheless unlikely, according to Antoine Flahault. 'Since H5N1 first appeared in 2003, there have been seasonal influenza viruses which have spread widely each year, including in Asia, and there has never been a recombination with H5N1 to produce a more virulent virus.'

Great Danger in the South?

Based on recent virological history, three big probable scenarios emerge. First, a scenario comparable to that of Severe Acute Respiratory Syndrome (SARS), provoked by a very powerful coronavirus. This virus, which appeared in Asia in 2002, was at the root of a global level epidemic in 2003, but oddly, it did not emerge again the following winter. In the case of A/H1N1, this scenario would translate into a non-resurgence of the virus in the autumn. Second, A/H1N1 could provoke a fairly moderate global epidemic, as observed in the case of the so-called Hong Kong influenza of 1968.

Possibly, there could be fresh outbreak of A/H1N1 influenza cases in the northern hemisphere in the autumn, but without the illness becoming more serious. Finally, there is the most catastrophic scenario, like in 1918, whereby A/H1N1 would become extremely virulent after mutating and would provoke a pandemic, causing devastating numbers of deaths.

'I would not be surprised if the scenario in the northern hemisphere proves to be moderate but of the 1918 variety in the southern hemisphere,' says Antoine Flahault. According to WHO, the impact of a pandemic on a population depends on three characteristics: the characteristics of the virus with its epidemiological and clinical manifestations, the vulnerability of the population and, finally, its capacity for action. Now, we know that these last points are far from being uniform the world over. As Louis Cruvellier wrote in the annals of the Institut Pasteur in 1919, 'If influenza condemns, it is the secondary infections which execute'. The influenza virus is, in fact, rarely the direct cause of death. It is the complications linked to secondary bacterial infections which make influenza infections fatal. We can thus assume that in countries where, on the one hand, the population includes a large number of people already afflicted by other illnesses and where, on the other, access to treatment is limited, death rates are likely to be high.

The consequences of a global pandemic of A/H1N1 could thus differ considerably depending on location. 'In Europe, we can expect a pandemic wave on a greater scale than a seasonal epidemic, with 30% to 40% of the population infected by the virus, but its severity would be very similar to seasonal influenza. The best equipped countries are those with the most robust health infrastructure,' explains Antoine Flahault. As for the countries that are least well equipped, there are major uncertainties regarding how they will overcome the pandemic wave. 'At the time of the *chikungunya* fever, 75% of the populations of Mombassa and Lamou in Kenya were infected by this virus which caused thousands of deaths. But this generated much less attention than in developed countries which have media coverage and surveillance and information

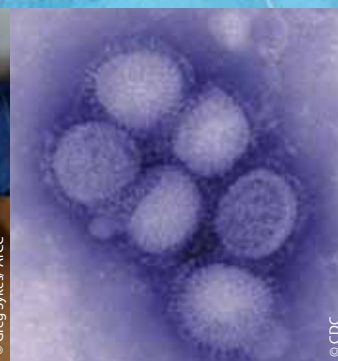


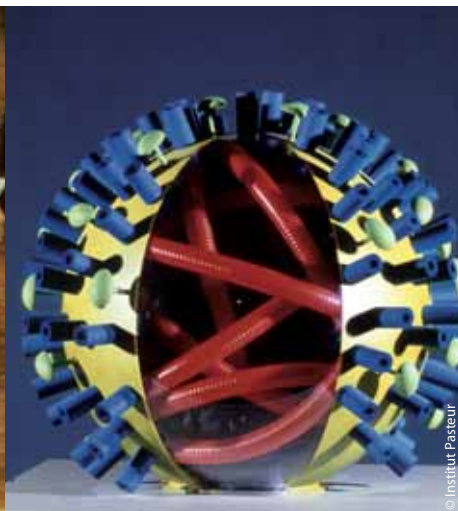
Policeman protecting himself against the A/H1N1 epidemic, Mexico, April 2009.

A test for the new A/H1N1 virus developed by the Centers for Disease Control and Prevention (CDC – Atlanta, US).



A/H1N1 influenza virus.





Culture of the influenza virus on embryonated hens' eggs.

Model of the influenza virus produced for the centenary exhibition of the Institut Pasteur. Prominent spicules are visible on the outside of the viral coat and the segments of RNA associated with the inside of the nucleocapsid.

Become actors in the fight

Since the influenza virus does not tolerate the heat well, the A/H1N1 has provided a relative respite to countries in the northern hemisphere this summer, but a second wave of contaminations started this autumn and its peak could be reached in January and February.

As a result, it is important that the populations of the northern hemisphere continue to rally round until then. 'It is through altruistic behaviour and gestures, such as washing our hands, getting ourselves vaccinated, confining ourselves if we are infected, that people protect both themselves and others,' Antoine Flahault, Director of the EHESP School of Public Health in Rennes (FR), reminds us. While the media has widely monitored the progression from epidemic to pandemic over the spring and summer of 2009, citizens who watch the news as spectators risk getting tired of repeat alerts. 'There is a delay between the release of the alert and the moment at which citizens should become actors in the fight against the A/H1N1 virus, but this should not stop people from rallying round,' warns Antoine Flahault.

●●● systems in place,' continued the biostatistician. Africa may thus experience a pandemic wave in silence...

Qualify the alert levels

Between 29 April, when the WHO pandemic alert level rose to five, and 11 June, the day it was declared a global pandemic, the UN agency appeared undecided as to the attitude it should adopt in the face of a new public enemy number one. Since the end of May, however, all the criteria corresponding to phase 6 of the alert plan coalesced. The difficulty stems from the definition of the different phases of the plan, which was established, for the most part, following the experience of the Spanish influenza of 1918, revised in 2005 to cope with a potential H5N1 pandemic and then adapted when a far more powerful, deadly influenza virus than the A/H1N1 strain emerged. 'The system envisaged by WHO is out of proportion for the current pandemic. It is as if soldiers had prepared for battle with classic arms, only to then realise that the measures taken did not really apply to the urban warfare they faced. The consequences of level 6, as envisaged in the WHO plans, are too great, at this stage, in relation to the measures appropriate to adopt,' indicates Antoine Flahault.

As the WHO alert system is solely based on the geographic reach of the epidemic and not on its level of severity, the measures suggested to the States should have been adapted to the situation. When the transition to level 6 of the alert operation took place, WHO qualified the pandemic as 'moderate', recommending that the governments of affected regions classify their countries as in a 'state of emergency' and encouraging countries that were not yet affected to finalise their preparatory plans for an 'imminent pandemic'.

From the egg to the vaccine

By May, WHO had delivered the virus strains with which to produce the vaccines to pharmaceutical laboratories. These strains were perfected, as they are each year for the seasonal influenza, by four reference laboratories in Atlanta (US), London, Melbourne (AU), and Tokyo. 'The process for a vaccine against A/H1N1 is the same as for the seasonal flu,' says Albert Garcia, doctor and epidemiologist at Sanofi Pasteur in Lyon (FR). The pharmaceutical companies prepare working seed viruses using WHO virus strains, by taking progressive steps which enable them to adapt the virus for large-scale vaccine production. 'This takes about two weeks and, once the quality controls have been carried out, the working seeds are placed in culture in fertile hen eggs. This technology can be used to obtain billions of viral particles to produce a maximum number of vaccine doses with which to confront a pandemic,' explains Albert Garcia.

The influenza viruses multiply very effectively in the embryonated hen's eggs. For decades, these have been used by pharmaceutical laboratories to produce millions of doses of the seasonal influenza vaccine each year. 'But the fierce avian influenza virus, H5N1, does not develop in the eggs since it kills them,' explains Albert Garcia. And what if the A/H1N1 virus, which contains components of the avian influenza virus, adopted this type of behaviour? 'In principle, the virus strains selected by WHO develop very well in the eggs. We have received different strain types, of which the strains, or the parts most affected by the avian flu virus, have been removed using genetic manipulation techniques. We will use those which grow best in the eggs,' continues Albert Garcia.

After an incubation period of three days, the viral particles are collected, treated and purified to ensure that they come back completely harmless. The final dose kept for the new A/H1N1 vaccine has been determined on the basis of the results of clinical trials launched in August. After these tests, the experts have also established whether or not there is a need to insert additives, either pharmacological or immunological agents that stimulate immunity and thereby strengthen the effectiveness of the vaccines. As Albert Garcia explains, the choice of these substances is vital in terms of the capacity to produce vaccines to combat A/H1N1. 'We estimate that there is global capacity to produce between 400 and 500 million doses of the influenza vaccine. Yet, in the case of a pandemic, much more must be produced. To increase this capacity, it is important to test the strategies that will produce a vaccine which provokes a sharp immune system response given a reduced number of micrograms of influenza antigen.'

Towards a universal vaccine?

Since the threat of an H5N1 avian influenza pandemic increased, research to develop a universal vaccine to protect against all types and sub-types of influenza has intensified. Though we may still have to wait a few years for such a vaccine to emerge, some research leads do seem promising. Amongst these is the development of a vaccine based on the external part (M2e) of the M2 surface protein in influenza viruses, which is taking place in the context of the *Universal Influenza Vaccine* project, which was funded by the European Commission from 2005 to 2007. 'Unlike hemagglutinin, the protein on which current influenza vaccines are based, the M2 protein is highly conserved by all strains of the influenza virus,' explains Walter Fiers, molecular biologist at the University of Ghent (BE), who discovered the potential of this protein segment. The hemagglutinin, which is also located in the viral coat, is the viral molecule recognised by the immune system. Upon contact with it, immune cells produce masses of antibodies, which will protect the organism should it be attacked by the virus again.

'The greatest task for the *Universal Influenza Vaccine* project was to make the M2e protein segment immunogenic, that is, to ensure that

it provokes an immune reaction and stimulates the organism to produce antibodies,' indicates Walter Fiers. At this stage, the effectiveness of the new vaccine has been demonstrated on mice and ferrets, and phase 1 clinical trials were successfully completed last year. 'We are currently testing whether the M2e segment of the A/H1N1 virus is recognised by the immune system. But, given that this segment is very similar to other M2e segments recognised by the organism, there is a strong chance that it would be too,' claims Walter Fiers.

With the emergence of H5N1 and now of A/H1N1, the arms race between man and the influenza virus has well and truly shifted into top gear. Up until now, viruses always had the upper hand. Will mankind soon be able to make his all-time enemy surrender? As we wait for researchers to perfect the ultimate vaccine, coordinated surveillance systems and international solidarity should enable us to cope with the first pandemic of the 21st century. ●

Audrey Binet

(1) *research*eu* No. 59, page 14, 'Should we be afraid?'



World Health Organization

www.who.int/en/
www.who.int/csr/disease/avian_influenza/phase/en/

European Center for Disease Prevention and Control

<http://ecdc.europa.eu>

Centers for Disease Control and Prevention

www.cdc.gov/h1n1flu/

Universal vaccine

6 partners – 4 countries (BE-GB-NL-SE)

http://ec.europa.eu/research/health/influenza/proj12_en.html
www.universolvaccine.org

The masks: do they protect us?

In addition to hygiene and vaccinations, masks are another way of limiting the spread of the virus. Indeed, the virus is transmitted by dispersal of particles into the air such as droplets or aerosols. There are two types of masks: anti-projection masks and respirators. As a preventive measure, the first are reserved for the sick and their family circle. They prevent the spread of the droplets produced when a person coughs or sneezes. These masks are intended for one-off use and are effective for eight hours.

As for the respirators, these are reserved for health professionals who have to work in close contact with people who have contracted the A/H1N1 virus. Being far more 'selective', these masks prevent droplets from going out, or liquid particles from coming in, when patients speak or breathe. It acts as a proper filter that protects the

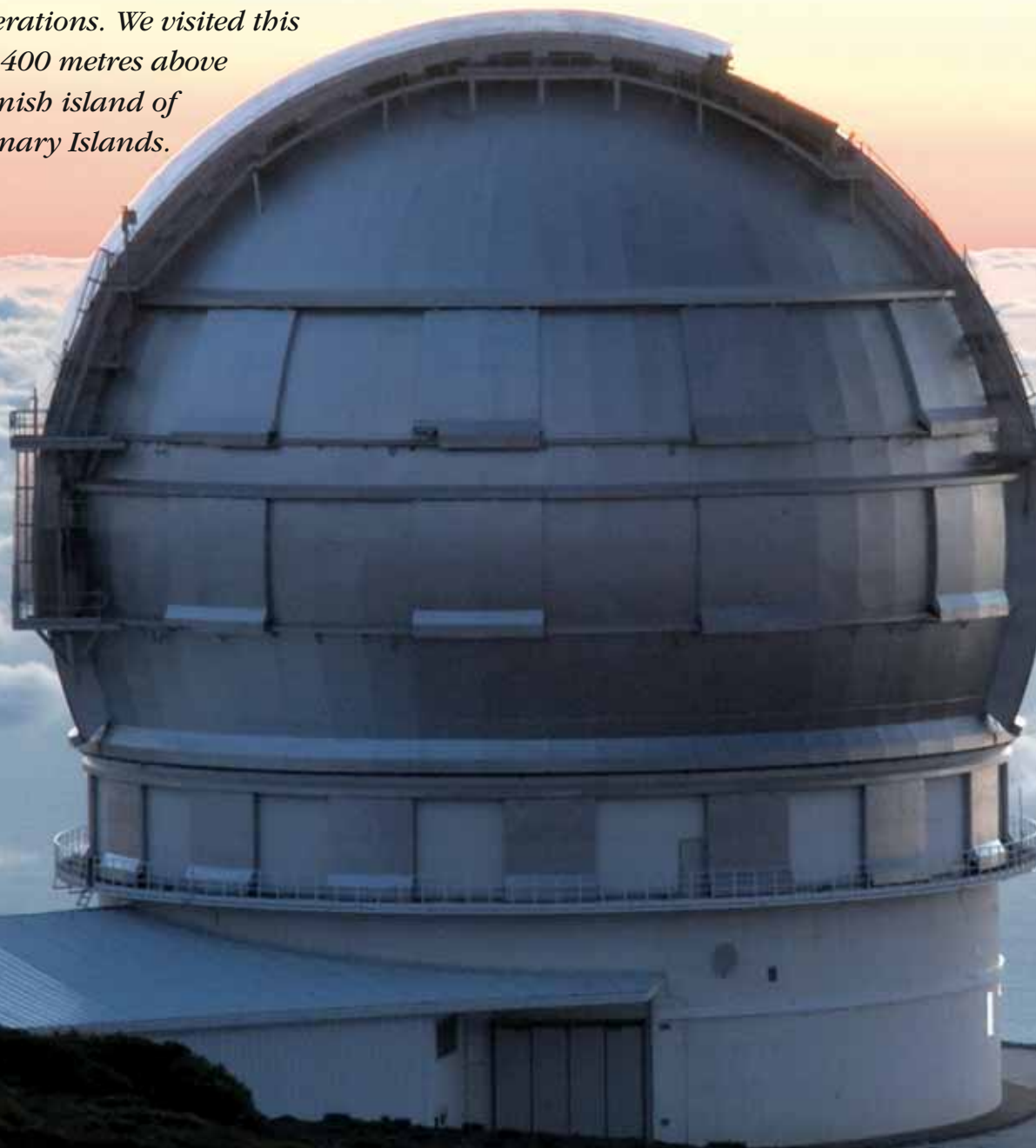
In the streets of Kobe (Japan), passersby wearing masks to protect against the A/H1N1 flu epidemic, May 2009.

wearer from inhaling infectious agents in a contaminated atmosphere. Effective as these masks may be, they are intended for single usage and must be replaced every 4 hours.

Europe's new eye

With a primary mirror 10.4 metres wide, the Great Canary Telescope (GCT) is the largest telescope in the world. Just a few months after its inauguration, its time is divided between scientific data collection and calibration operations. We visited this colossus, perched 2 400 metres above sea level on the Spanish island of La Palma in the Canary Islands.

Dome of the Great Canary Telescope (GCT) located 2 400 metres above sea level on the Spanish island of La Palma.



It is not the best idea ever to arrive at the *Roque de los Muchachos* Observatory at night. A few kilometres outside of the capital of Santa Cruz, street lighting disappears – the island of La Palma is hard-nosed as regards light pollution. Visitors have only their headlights to guide them along the 40 km of winding roads leading up to the site. Up there, you need a torch to reach the stargazers' residence. The sky truly is studded with stars. Dazzling. We almost forget them in our over-illuminated cities.

During the day, the stars give way to no less fascinating a spectacle. On this early summer day, a pretty carpet of canary yellow broom flowers covers the volcanic mountain. From now on, there will be twelve telescopes, which much resemble giant mushrooms, here in this peaceful natural landscape. Located at the highest point on La Palma, *Roque de los Muchachos* offers a breathtaking view of the *Caldera de Taburiente*, an 8-km-wide volcanic crater.

Ideal conditions

La Palma was a natural choice for René Rutten, head of operations of the Great Canary Telescope (GCT), long-term resident of *Roque de los Muchachos* and former director of the Isaac Newton Group of Telescopes, 'This is the only observatory of global stature in Europe. To avoid the air at ground-level heating up and creating atmospheric turbulence, the best sites are always located very high up, either on a mountain in the middle of the ocean, as is the case in La Palma or Hawaii, or on a mountain range very close to a coast, such as in Chile.'

The sky above La Palma and the part of Tenerife that hosts the Tiede Observatory have been protected by 'Sky Law' since 1988. Street lighting and the strength and orientation of light bulbs are strictly regulated in order to ensure that the sky above the observatories is very dark. Industrial activity and air traffic are also subject to limitations in order to reduce atmospheric pollution. Flights over La Palma, in particular, are banned without special dispensation. Finally, radio wave emissions are also restricted to prevent interference with scientific instruments.

Stable atmospheric conditions, mild weather and this unique law render this Canary Island mountain a favoured observation site, where 62 institutions from 19 different countries now converge.

Busy night and day

At eight o'clock in the morning, just as the GCT night-time team goes to bed, the daytime team is having breakfast at the residence, before getting into their cars and heading to the telescope site a few minutes away. Once there, it is impossible to look up at the impressive metallic dome, which is 45 metres high and 34 metres wide, without sunglasses. The material was chosen to reflect the light and hence to prevent the internal temperature from rising.

As of last March the telescope has been gathering scientific data, but half of its time is still dedicated to fine-tuning operations. 'For a few days now, we have been working on the transit of an extrasolar planet, which will take place the day after tomorrow,' states René Rutten enthusiastically.

Carlos Alvarez is one of eight astronomers responsible for supervising the observations requested at the GCT. 'During the day, we carry out the necessary tests and fine-tuning for the nocturnal observations.' At 4pm, when the telescope empties briefly, this smiling sportsman will run home to Santa Cruz, which will take him three and a half hours!

Plaques which trace the key construction phases of the facility hang on the walls leading to the telescope chamber. The first stone was laid in 2000 and the last seven years later. It cost EUR 104 million and was 90% funded by the Spanish government, with support from the European Regional Development Fund (ERDF). Five per cent of funding also came from Mexico and 5% from the University of Florida.

Objective: zero turbulence

In the world, there are about ten large telescopes with primary mirrors 8-10 metres in diameter. The GCT is probably the most recent example of this generation of telescope. In the years to come, very large telescopes with 30-metre mirrors will supersede them.

The larger the primary mirror, the better the quality of the images, and the further we can see into the universe. However, because of weight issues, in particular, it is very complicated to build a single-piece mirror of more than eight metres in diameter. This is why the large telescopes have segmented mirrors. The main device of the so-called 'active optics' system is the GCT's mirror, which is made up of 36 1.9-metre hexagonal segments, and mounted on motors to ensure that they are perfectly positioned in relation to one another. Together, the segments form a concave surface of 81.9 m², the equivalent of a 10.4-m-wide circular mirror.

For René Rutten, the comparison of the GCT with other large telescopes ends there, 'The GCT is much more technologically advanced because it was built long after them'. One such technological advance is 'adaptive optics,' with which telescopes will be fitted in a few years' time. This system corrects distortions caused by atmospheric conditions. As they penetrate our atmosphere, light waves, which are perfectly flat up until that point, are distorted as a result of turbulence. For this reason the stars seem somewhat blurred to us, like coins at the bottom of a pool of water.

At a rate of approximately 200 times per second, adaptive optics will determine and correct this distortion almost in real-time. The light of the European Regional Development Fund will in fact be redirected towards a small flexible mirror, 10 or so centimetres in diameter, which will move very rapidly so as to flatten the wavefront once again. In simple terms, the system will create observation conditions that rival those of space-based telescopes.

Ice palace

Under the dome, the prevailing cool quickly feels cold: all the installations are kept at temperatures close to those at night. That is around 10 degrees during the summer. 'We open the dome half an hour before sunset so that the temperature inside can adjust to that outside,' explains Carlos Alvarez. 'At night, glycolised water is used to help remove the heat generated by the electronic parts. If the temperature of the mirrors were just one degree higher in relation to the air, a drop in quality ●●●'



▼ The OSIRIS Instrument.



◀ First image produced by the GCT instrument OSIRIS. This is M51, a pair of galaxies also known as the Whirlpool galaxy, located 23 million light years from Earth. The exposure time required with this instrument was two minutes. For a similar depth, from a telescope 1m in diameter, it would take more than three hours.

In the light of an eclipse

The *Roque de los Muchachos* Observatory, which has been located on the hills of La Palma since 1985, today houses 12 telescopes and tallies several astronomical discoveries on its record of achievements – both in the literal and figurative senses. Among the most recent is a study carried out by researchers from the Astrophysics Institute of the Canary Islands (*Instituto Astrofísica de Canarias – IAC*) which, at the end of 2008, revealed the existence of naphthalene in the middle of a cloud of interstellar medium in the Perseus constellation, located 700 light years from Earth. When subjected to ultraviolet radiation and combined with water and ammonium, both of which are (relatively) abundant in the interstellar medium, this molecule is capable of producing a wide range of amino acids, which play a fundamental role in the development of life. This discovery allows us to better understand the environment in which Earth was immersed when our solar system formed, then enabling life to emerge.

More recently, in June 2009, another team of IAC researchers managed to analyse the composition of Earth's atmosphere in detail, thanks to a lunar eclipse. The results of their study were published in the magazine *Nature*. The principle is simple: sunlight crosses Earth's atmosphere, is reflected on the surface of the Moon and then directed back to Earth, where it is picked up by a telescope. This new technique allows Earth's atmosphere to be analysed as if it were a distant planet. Scientists have thus been able to determine the biological markers of our atmosphere, information that should enable us to evaluate whether other planets possess all the necessary atmospheric conditions to harbour life.

●●● 'would already be perceptible,' adds René Rutten.

At the very top, right on the axis of the primary mirror, there is a smaller secondary mirror, which is convex in shape. It deflects the light gathered towards a third mirror, which is positioned in the centre of the mosaic of

segments, serving to direct the beam towards one of the six foci stations, where the scientific instruments are installed. The GCT has only one such instrument at present. It bears the name of an Egyptian god: OSIRIS, which stands for Optical System for Imaging and Low Resolution Integrated Spectroscopy. And so,

it is in this large blue box, fed by an incalculable number of cables, that light, which has travelled for thousands of years, finishes its course. It becomes an image and, most importantly, scientific data.

From gamma-ray bursts to extrasolar planets

OSIRIS operates over a range of wavelengths, from infrared to near ultra-violet. As well as producing images, it allows for multiple-object spectroscopy, the simultaneous analysis of 30 or so celestial objects, which is not insignificant for a telescope of this size. But what really makes this instrument unique, according to the director of operations, is its tuneable filter, which can select an extremely small part of the spectrum. 'Teams from the University of Mexico used it for the first time yesterday to observe the formation of stars and the movements inside an active galaxy.'

The filter will also make it possible to determine the level of redshift of cosmic bodies. The term 'redshift' refers to the shift of a light wave towards the red end of the spectrum, caused by the observer moving relative to the source of the wave. The greater the speed of movement, the greater the redshift, the further away the object will be. 'By applying the filter to an image, we will see galaxies appearing at



Inside the GCT dome. The light, collected by the mosaic of mirrors, is directed towards the secondary mirror on the top (small cylindrical structure), which will redirect it downwards, via the black tube, where the tertiary mirror is located, which is responsible for directing the light towards the various stations on which scientific instruments are mounted.

Over time, dust collects on the primary mirror, which is why each segment is cleaned every two years in accordance with a realuminisation process. The fine layer of aluminium which covers the structure is removed and a new one is pulverised.

different wavelengths, which will enable us to measure their individual speeds.' And ultimately, we will learn more about the expansion of our universe.

Other instruments will gradually fill the different stations. CanariCam, an infrared camera with spectroscopic, polarimetric and coronagraphic capabilities, should be installed next spring. The polarimeter will mainly be used to measure the polarisation of radiation emitted by the coldest objects in the universe, such as forming stars or extrasolar planets. As for coronagraphy, this technique creates artificial eclipse around a star, so as to expose not only the star's corona, but also the objects which orbit around it.

The EMIR, a multi-object spectrograph that will work on the near-infrared range, is also planned, as is FRIDA, which has been specially designed to work with the GCT's adaptive optics. The instrument will serve to perform '3D spectroscopy' which allow for high-resolution observation of very distant objects, among other things.

Sharing precious time

The telescope's schedule reflects its financing: Spain has access to 90% of its time, while Mexico and the University of Florida each have 5%.

Requests submitted by research centres are prioritised by an independent committee in relation to their scientific interest. René Rutten then divides the proposals into different categories, according to the observation conditions they require. 'Use of the telescope is still a very complex matter. In order to be able to concentrate on the scientific operations, the first year we decided to lead the observations ourselves, with people who knew exactly what they were doing'.

At night, the astronomer on duty manages the operations alone, assisted by a technician who is responsible for operating the telescope. 'We draw from a list of possible observations in order to establish a scientific programme which corresponds to observation conditions,' explains Carlos Alvarez. Until now, teams have mainly looked for brown dwarfs (sort of missing links between the stars and the planets) and gamma-ray bursts (violent explosions linked to the formation of black holes or the merger of neutron stars). 'We have also spent quite some time on star clusters in very distant galaxies,' finishes René Rutten. 'But the GCT is a multipurpose tool which could be used for all sorts of research'.

Of course, at this point, we still do not know what will come of data circulated to the scientific community. But in the eyes of Carlos

A major gain for Europe

Ninety per cent of the Great Canary Telescope (GCT)'s time will be offered to Spain, its main financial backer, and 5% to Mexico and the University of Florida respectively. And yet, there is no doubt that the data gleaned from this telescope will travel beyond these boundaries. Within the European Research Area (ERA), 'The GCT only began producing data very recently, which is why no project directly related to its use received funds from previous and current Framework Programmes (FP) yet. Of course, certain researchers who have been allocated observation time are part of research networks funded by FP6 and FP7,' maintains Jesús Burgos, Director of the Offices for the Transfer of Research Results (Oficinas de Transferencia de los Resultados de Investigación – OTRI) of the Astrophysics Institute of the Canary Islands (IAC).

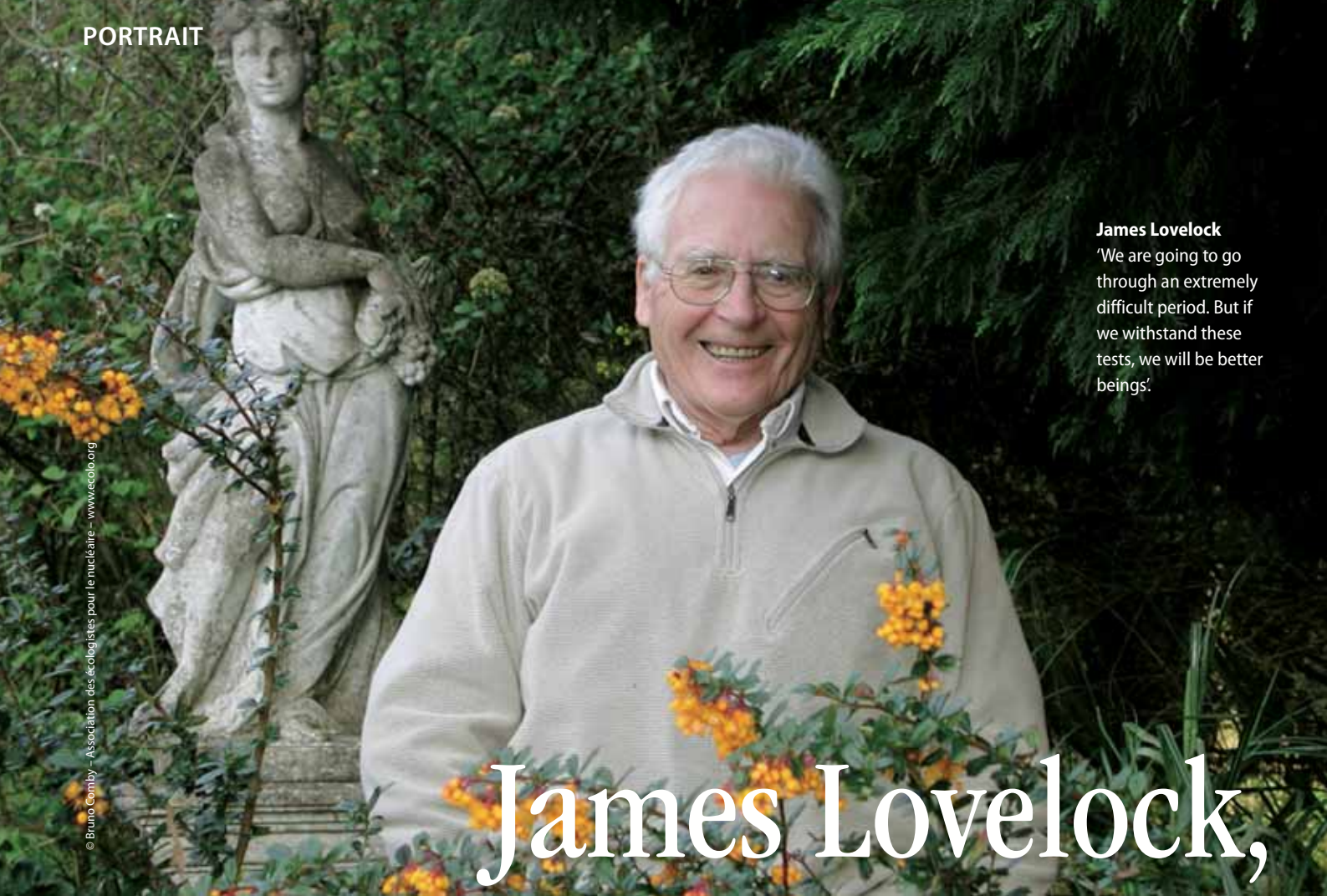
What's more, the teams that participated in the GCT's construction will be in a position to share their know-how with several European projects, including the *European Extremely Large Telescope*, the *E-ELT*, and the *European Solar Telescope (EST)* construction projects.

Alvarez, astronomers have many reasons to be satisfied. 'On the same night, you can look for an extrasolar planet, then a galaxy and, after that, a quasar located very close to the source of the universe. Our work affects numerous fields. When you carry out your own research, you concentrate on a particular field, which will make you an expert after a few years, but that's more limited. This profession is more general, which is precisely what I like about it.'

In a few minutes, the sun will set on a sea of clouds. The GCT opens its dome in quite surprising silence. Soon, data will begin to rain down on the row of screens lining the control room. The hunting season is open. ●

Audrey Binet and Laurence Buelens

 **The Great Canary Telescope**
www.gtc.iac.es/en/



James Lovelock
 'We are going to go through an extremely difficult period. But if we withstand these tests, we will be better beings.'

James Lovelock,

As a chemist, physicist, engineer, medical doctor and specialist in earth sciences, James Lovelock has more than one string to his bow and it is his highly interdisciplinary profile that makes this climate expert so valuable.

In 2001, in Amsterdam, a group of 1500 scientists involved in climate research projects formalised the notion of the earth system, a unique and self-regulated system of physical, chemical and biological components. This was an accolade to James Lovelock, whose insistence that we should understand the blue planet systemically had fallen on deaf ears for almost 20 years. For him, the earth is a vast organism, made up of

elements that react symbiotically to one another, maintaining conditions conducive to life. This symbiosis is threatened by man, whose activities push this fragile equilibrium towards another climatic era.

A man with several hats

Lovelock started his career in London at the Medical Research Council (UK) where he researched the ways in which colds are transmitted. During the Second World War, he developed new forms of fire protection and elaborated a technique with which thermal rays could be detected. After the war, he worked on the cryogenics of living tissue.

The man is an unrivalled handyman, the creator of numerous inventions, of which the most famous is the electron capture detector (ECD), a device developed in 1957, which has the capacity to detect minute traces of chemical products in the air. It was the main tool used to support the theses of Rachel Carson, the biologist who, in the 1960s, was a vocal critic of the negative impact of certain pesticides, such as DDT, on the environment. The ECD

also made it possible to evidence the proliferation of chlorofluorocarbons (CFC), compounds responsible for destroying the ozone layer.

At the beginning of the 1960s, Lovelock became involved in space exploration, an old childhood dream. NASA called upon his talents as an engineer for a mission that aimed to establish whether there was life on Mars. 'It was this period at NASA which really tipped me towards the earth sciences,' he explains. 'The instruments developed by the researchers participating in this research project were all conceived to detect a life form similar to those we know, which did not make sense to me. As my criticisms offended my biologist colleagues, the head of the mission threatened to dismiss me if I didn't perfect my own detection device.'

The engineer thus suggested that spectrographic analysis be carried out using an infrared telescope in order to determine whether gas exchanges take place in the Martian atmosphere. A chemical signature was thus detected in the atmosphere and it was possible to

establish whether it was chemically balanced, a technique widely used by astronomers today. 'The unique characteristic of this life is that it uses compounds present in the environment to produce energy and thereby throw the chemical composition of the atmosphere off balance.' This relationship between the biological, physical and chemical elements of the planet stirred Lovelock's curiosity. After his departure from NASA in 1965, he established himself as an independent researcher and began working on this issue.

From darkness to light

The fruits of his labours became the 'Gaia' theory, which was outlined in a book published in 1979, in which Lovelock makes the analogy between the earth and living organisms. Like our body, which remains at a constant temperature because our organs collaborate with one

Lovelock's disrepute. 'Gaia interested climatologists, but profoundly displeased the rest of the scientific community, particularly the biologists who, most notably, accused me of casting doubt on Darwin's theories.'

For biologists, it is impossible that any type of collaboration could be established between organisms in permanent competition with one another. Lovelock replied by developing Daisyworld, a computer model conceived to illustrate the earth's feedback mechanisms. It uses a basic biotope, black and white daisies, to regulate temperature alone. During the first simulation phase, the temperature is low and the black flowers grow rapidly, because they channel the sunlight better. This warms up the planet, which allows the white flowers to grow. At the end of the day, the two types of daisies survive and the fact that they are in competition with one another actually helps maintain

has not ceased to emphasise the harmful role of CO₂ emissions on the planet's equilibrium. Hence his favourable take on nuclear power. 'The development of renewable energy is a good thing, but there will never be enough to meet our needs.'

For Lovelock, the gradual global warming described in the last report by the Intergovernmental Panel on Climate Change (IPCC) is a staggering underestimate of the power and violence of climate change. The past disruptions of the climate and the provisional models conceived in accordance with the Gaia theory instead foresee sudden, unpredictable changes, he asserts in his latest book, published in 2009. 'Politicians asked scientists for predictions, which scientists are not, in fact, in a position to provide. Several research studies indicate that the impacts of global warming will be much more serious. Let's take the 2007 study

Or Living Earth

another, a system is maintained in homeostasis thanks to the activity of its component parts. Lovelock goes as far as to say that our planet is alive, self-regulated by complex positive and negative feedback mechanisms, involving the living as much as the non-living. 'In the 19th century our world was perceived as a relatively frozen system in which the living fought to adapt. It is only in the 20th century that scientists have gradually become aware of the role of organisms and of their interaction in the configuration of the atmosphere, the oceans and the rocks above ground. Our environment is not an inert structure, but rather a vestigial remnant of our ancestors' evolution.'

Gaia immediately aroused enthusiasm from the emerging ecological movement, which perceived Lovelock as a valuable scientific supporter. Their enthusiasm quickly curbed: the man was a fervent defender of nuclear power, which did not sit well with the green movement at the time. From the perspective of the scientific community, the theory was regarded with scepticism and the reference to Gaia, the earth goddess in Greek mythology, added to

the optimal temperature of the entire biotope. It was a perfect example of the positive and negative feedback mechanisms that form the basis of the Gaia theory.

A new planetary balance

Since 1979, Lovelock has not stopped publishing books and articles to support his theory. He has now become a respected guest at climate change conferences and a precursor to the researchers trying to understand how our environment reacts to greenhouse gas emissions. 'What was a mere crazy theory at the end of the 1970s has gradually become a respected theory. New research has emphasised the role of the ocean and marine life in regulating the climate, as well as the importance of the sulphur cycle for all life forms and for the formation of clouds... There is now no question of the existence of stabilising feedback mechanisms conditioned by physical, chemical and biological phenomena.'

The extent to which Man interferes with Gaia, a system of inextricable components, remains to be seen. Since the 1970s, Lovelock

carried out by James Hansen on rising water levels. The results foresee a 100% greater increase than the IPCC predictions. The IPCC brings together excellent researchers, but knowledge of the planet's regulatory mechanisms is currently too limited for us to hope to understand exactly what to expect.'

There is no point investing in reforestation projects, establishing CO₂ stock exchanges or promoting the use of green energy. It would be better, according to Lovelock, to immediately prepare for a terrible shock, which will cause millions of deaths and may eradicate current civilisations. Pessimistic? Not entirely. In his late 90s, the man still has faith in our capacity to adapt. 'I think that we are going to go through an extremely difficult period. But if we withstand these tests, we will be better beings. We will know our planet better and will know better how to manage it, something we are entirely incapable of doing today.'

Julie Van Rossom

New bio-indicators, based on common bird populations in Europe, can be used to assess the biological consequences of human activities: the use of fossil fuels and changes in land use.

Swallows

‘Climate change is already having a measurable impact on birds in Europe,’ a group of scientists declared in an article describing the first bio-indicator of the impact of climate change on nature in Europe⁽¹⁾. Evidence of this impact on biodiversity has accumulated in recent years: changes in the levels of profusion and distribution of plant and animal species, time-lags of certain events, such as flowering and reproduction, changes to migration patterns... Until very recently, however, there was no indicator with which to demonstrate this at the European level. In order to create this climate impact indicator (CII), researchers combined data from 1980 to 2005 on the diffusion of 122 common bird species across 20 European countries. This data is drawn from the *Pan-European Common Bird Monitoring Scheme (PECBMS)* project⁽²⁾ and includes models which predict how each of these species may respond to climate change.

A declining trend in the CII can be observed during the 1980s, probably reflecting the influence of cold winters and changes in land use, which prompted a decline in bird populations. Since the end of the 1980s, however, the indicator has not stopped rising, showing that the impact of global warming has surpassed those of other pressures, whether environmental or not. Some bird species have seen their populations increase, while others have witnessed a decline: the problem is that 75% of the species studied fall into the second category (92 of the 122 surveyed during the study). The most significant threat relates to greenhouse gas emissions, which have increased significantly since the Industrial Revolution: the use of fossil fuels and deforestation generate carbon dioxide (CO₂) emissions, which combine with other major greenhouse gases:

water vapour (H₂O), methane (CH₄) and nitrous oxide (N₂O).

Other measures taken by the PECBMS

The main goal of the *PECBMS* is to promote the use of birds as bio-indicators of nature’s general state of health, by using scientific data gleaned from large-scale monitoring schemes. Besides the CII, the *PECBMS* has helped design biodiversity indicators based on common European birds in two habitats: farm land and forests. While overall population levels fell by 10% between 1980 and 2006⁽³⁾, those of common forest birds declined by 9%, and those of common farmland birds fell by 48% during the same period. It is becoming increasingly apparent that this decline was provoked by intensive farming practices and sylviculture, which elicited a decline in crop and plant diversity, the destruction of meadows and borders, an increase in the use of pesticides and fertilisers, and drainage – all of which indirectly affects the birds via the food chain. As well as designing these indicators, the *PECBMS* also published a best practice guide to monitor the birds, which is available on the European Bird Census Council (EBCC) website.

In April 2009, the *PECBMS* received confirmation of renewed project funding for an additional three years from the Directorate-General for the Environment of the European Commission, and also continues to enjoy financial support from the Royal Society for the Protection of Birds (RSPB). Data updates are scheduled to take place on an annual basis in order to ensure that the data quality continues to improve, and that the geographic reach of the programme extends, along with the number of bird species studied. Attempts will also be made to produce indicators for other

habitats, such as marshes and habitats subject to agri-environmental policies.

From science to policy

Such findings indicate that the changes observed in nature and their impact on the birds and on ourselves must be taken seriously. At the World Summit on Sustainable Development in 2002, one of the decisions taken was to reduce the current loss of biodiversity by 2010. If Europe wants to achieve this ambitious goal of halting the decline of biodiversity loss, it must

The concept of the indicator species

An indicator serves as a substitute for a parameter that is too short-lived or too difficult to measure directly. In economics, the Dow Jones is a stock market indicator that represents trends rather than total market analysis. In biology, indicators can be used to measure specific factors, such as air quality via lichens, ground moisture via the plant species present, or even contamination from pesticides, as reflected by populations of birds of prey and, more recently, bees.

The Earth Summit, held in Rio in 1992, prompted the development of a similar indicator in the field of biodiversity. The *PECBMS* chose indicators based on birds for reasons that are both practical and scientific: birds are relatively easy to observe and are plentiful, their biology and behaviour have been extensively studied and they respond rapidly to change. These indicators use tens of common bird species to generate a comprehensive picture of the environment.

bring spring

intensify its efforts to implement nature conservation measures. The European Union and the European Environment Agency have adopted the CII and the Farmland Bird Indicator (an indicator based on farmland birds) as official measuring tools with which to assess biodiversity trends. In April 2009, the Commission also published a white paper, which set out the framework for adaptation measures, in order to reduce the European Union's vulnerability to the impact of climate change⁽⁴⁾.

Isabelle Noirot

While **climate change** may harm nearly three quarters of European birds, a few southern species, such as the European bee-eater (*Merops apiaster*) and the hoopoe (*Upupa epops*), on the other hand, may extend their territory northwards.



(1) Gregory *et al.*, 2009, www.plosone.org/article/info:doi/10.1371/journal.pone.0004678

(2) The *PECBMS* is a partnership which was established in 2002 by ornithologists and nature conservation specialists who cooperated via other organisations: BirdLife International, the European Bird Census Council (EBCC) and the Royal Society for the Protection of Birds (RSPB), with technical assistance from Statistics Netherlands. The *PECBMS* compiles population data collated from annual monitoring schemes carried out in Europe. It is financed by the European Commission and the RSPB.

(3) www.ebcc.info/index.php?ID=368

(4) ec.europa.eu/environment/climat/adaptation/

i Pan-European Common Bird Monitoring Scheme (PECBMS)

4 partners – 21 countries
(AT-BE-BG-CH-CZ-DE-DK-EE-ES-FI-
FR-HU-IE-IT-LV-NL-NO-PL-PT-SE-UK)
www.ebcc.info/pecbm.html

European Bird Census Council (EBCC)
www.ebcc.info

The Royal Society for the Protection of Birds (RSPB)
www.rspb.org.uk

BirdLife International
www.birdlife.org

A vision of the future

Do the trends observed among birds foreshadow similar trends among other species? This is an important question which still awaits a clear answer. Scientists are suggesting, however, that increased global warming could alter the way in which the entire ecosystem operates and that human activities (environmental changes and the spread of exotic species) will result in a decrease in the number of specialist species and a small increase in the number of generalist and harmful species, which thrive in a disrupted environment. The result: an environment with impaired biodiversity, at all levels. This is known as biotic homogenisation.

SCIENCE AT YOUR FINGERTIPS

Darwin celebrations

'Man in his arrogance thinks himself a great work worthy the interposition of a deity. More humble and I believe truer to consider him created from animals,' wrote Darwin. To the great displeasure of the creationists, the bicentenary of Darwin's birth (1809) has been celebrated virtually worldwide, particularly in Europe, where many discussions have been held on a ceaseless list of questions to which there are often no clear answers: How did species appear? What roles do culture and the environment play in their transformation? Is man still evolving? And lastly, what has become of God?

London's Natural History Museum (NHM) opened the *Darwin Big Idea Big Exhibition* in 2008, retracing this pioneering scientist's intellectual path to deciphering the theory of evolution. It showed various organisms and fossils collected during Darwin's voyage

aboard *HMS Beagle*, which took him from Australia to South America. Another *big idea* was the Natural History Museum's New Darwin Centre, which opened to the public on 15 September last year. This giant curved cocoon, housed inside a stunning concrete, steel and glass building, stands beside the famous 19th-century Natural History Museum. The NHM's collection of some 17 million insect specimens and 3 million plant specimens will be displayed there in an intimate yet spectacular setting. The centre will provide facilities for 200 scientists to work at any one time, as well as hosting visitors interested in science who want to find out more about the scientists' work.

The French National Museum of Natural History (MNHN) in Paris designed its famous Galerie de l'Évolution to explain how the theory of evolution became a science, through its anatomy and palaeontology collections. The adjoining garden, Jardin des Plantes, highlights Darwin's work with plants, as well as his very



© Cap Sciences/Objectif prod

personal – and passionate – approach to gardening. The botanical gardens at Meise in the Flemish region of Belgium illustrate the 'green' side of a Darwin who was passionate about plants and unravelling their mysteries, and had a special fascination with orchids, carnivorous species and the sexuality of plants. The Natural History Museum of Brussels took advantage of Darwin's bicentenary to inaugurate its new evolution gallery (containing 600 fossils and 400 naturalised animals). This exhibition, aimed chiefly at children, traces the link between the past, present and future.

The visit ends in a room dedicated to the future, where visitors are surrounded by the kind of species that might populate the Earth in years to come.

The Natural History Museum of Neuchâtel, Switzerland, is currently staging an event called *Parce Queue* (a play on the French word for tail: queue), perhaps because Darwin seemed to attach so little importance to that appendage ('The sight of a feather in a peacock's tail, whenever I gaze at it, makes me sick,' he said). While the peacock uses it for display and seduction, the tail has many other uses in other animals. For instance, it is used as a weapon by snakes and

crocodiles, a parasol by squirrels and a means of expression by cats and dogs. Despite Darwin's feelings on the subject, the event's organisers believe that the tail is a wonderful example of diversification that shows us how living creatures have evolved in close harmony with their environment. Finally, the *Evolution of Life* website (in French, English and German) takes a highly educational approach to the subject, under three different headings: 'Observe' (videos and animations tracing the history of evolution), 'Explore' (simulations) and 'Teach' (teaching kits for different levels).

.....
 ⓘ www.hominides.com/html/darwin-anniversaire/charles_darwin-2009.php
www.evolution-of-life.com

Climate in the front line

The virtual exhibition and game *Clim'City* were designed by Cap Sciences (Bordeaux) to make young people aged 12 and upwards more aware of the world in which they will have to live – and above all to reflect on the burning issue of global warming. What kind of climate can we expect in 2100? How can we



© Natural History Museum

New Darwin Centre (artist's rendition).

reduce greenhouse gas emissions now? How will humans adapt to the climatic conditions of the future? The exhibition features a range of idyllic virtual landscapes, including pleasant homes, peaceful power stations, grazing cattle, perfect blue lakes and a snow-covered ski resort. However, by clicking on them we are made aware of a more complex reality behind the idyll. More than 300 documents in English and French (texts, videos, interviews, diagrams, graphics, animations) inform us about the uncertain future of these habitats. Clim'City also takes a playful look at a dozen or so themes (climatology, politics, transport, habitat, energy, industry, agriculture, waste, health, biodiversity, food, tourism and leisure). An interactive game enables us to apply the information concealed behind the images and to try to take personal responsibility for the environment – in other words, to simulate a reduction in our own ecological footprint. The aim is for players to reduce greenhouse gas emissions by a quarter in compliance with European standards. This could turn out to be much more than a game, though, as children often prove to be excellent opinion-makers.

.....
climcity.cap-sciences.net

An artist and children

'I plan my exhibitions as installations, where children and adults can experience art in different ways: looking at it, touching it, climbing on it – in short, playing with it. My projects function almost like a theatre, with children as visitors and actors simultaneously,' explains Alexander



Bestiarium Construendum by Alexander Reichstein.

Reichstein. His *Bestiarium Construendum – Curious Creatures* exhibition, currently on show at the Heureka science centre (FI), consists of 36 large pieces of a three-dimensional jigsaw puzzle of sculpted animals, which children can dismantle and reassemble to make new creatures. Just piece together the wings from one and the head or tail from another, and there you have it – a whole new way of seeing the living world...

Russian-born Alexander Reichstein, who now lives in Finland, also likes to illustrate books for children, sometimes working jointly with them. Another of his itinerant exhibitions, *HELA LIVET FORR I TIDEN (All of Life Long Ago)*, will travel all over Finland and Sweden. The exhibition presents to children the entire cycle of human life from birth till death, in a playful and poetic way through a series of simple, half-transparent fabric 'picture houses' each illustrating a major period of human life. The houses were

decorated by Anna-Clara Tidholm, the well-known author and illustrator of children's books.

.....
www.heureka.fi/portal/englanti/exhibitions/curious_creatures/
www.halsinglandsmuseum.se/def-aktuellt.asp?lnk=aktuellt

Musée du Vivant, alias the encyclopaedia of ecology

The Musée du Vivant in Paris, France, claims to be the world's first ecology and sustainable development museum, designed to help people to 'understand the world of today'. The museum, founded by the Paris Institute of Technology for Life, Food and Environmental Sciences AgroParisTech, is a resolutely virtual medium characterised by the abundance, diversity and depth of its online documentation. Its website contains a host of

scientific archives, theses, articles, posters, photographs and films on ecology and sustainable development, compiled by AgroParisTech over the years. This material, which is often impossible to find elsewhere, is likely to be of interest to researchers, students, associations and anyone concerned by the political, cultural or economic development of ecology.

The huge archives are accompanied by a news section (news headlines, event calendar and new teaching resources), together with numerous links.

In 2006, AgroParisTech also created the Ecology and Sustainable Development Network, bringing together all the heritage conservation institutions involved in eco-matters, in particular members of the International Council of Museums (ICOM) and UNESCO. Weighty stuff indeed!

.....
www.agroparistech.fr/-Musee-du-vivant-.html

TEACHING CORNER

The sky detectives

Spain's recently inaugurated Great Canary Telescope (Gran Telescopio Canarias (GTC)) holds out the prospect of extraordinary discoveries for astrophysicists (see article page 32). The key to its future success lies not just in the impressive scale of its mirror but, more importantly, in the precision of its spectrometers, instruments that are an invaluable aid to stargazers. Just how do spectrometers unveil the mysteries of the farthest nebulae from down here on Earth?

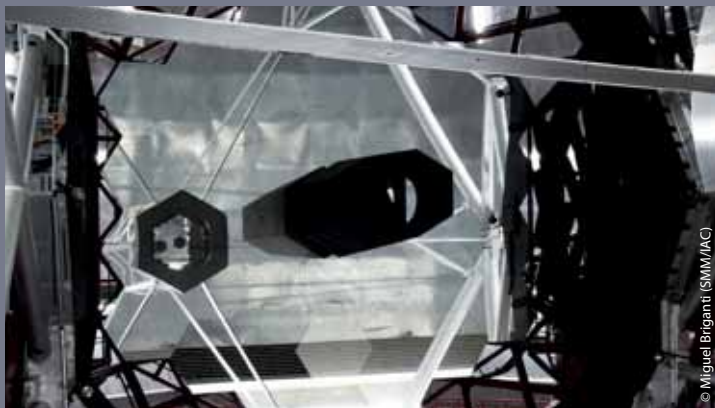
As Newton demonstrated in the 17th century, a prism breaks down the sun's rays into a continuous spectrum of colours, each corresponding to a wavelength. Each star emits its own light, which spectral analysis can decode into a wide variety of parameters, including the star's composition, speed and density.

Since the advent of quantum physics, we know that all atoms are formed of a nucleus around which electrons gravitate in predetermined energy layers. When an energy input causes an electron to jump from one energy orbit to a higher one, it emits a photon (light particle), the frequency of which depends on the energy difference between the two orbits. Because each element has its own electrical orbital characteristics, all spectral rays from a star reveal its chemical composition, even thousands of light years away.

Added to this is the Doppler effect. The sound of a racing car appears to rise in pitch as it approaches and to fall in pitch as it recedes into the distance. Similarly, the spectral rays of a star also change in relation to their relative speed. It is this systematic red shift of distant bodies (towards lower frequencies) that reveals the expansion of the universe. Finally, the denser a gas, the more collisions there are between the particles within it, resulting in a characteristic broadening of spectral rays.

With such capabilities, there can be little doubt that the four spectrometers of the European super-telescope will afford us an even better view of the skies above.

Mirrors on the Great Canary Telescope.



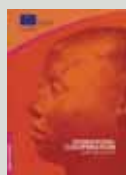
© Miguel Briganiti (SMM)/IAC



Emerging trends in socio-economic sciences and humanities in Europe

2009, 144 pp,
ISBN 978-92-79-11136-5

The METRIS (*Monitoring European trends in the Socio-economic Sciences and Humanities*) project is designed to support the European Research Area (ERA) in the social sciences and humanities field. In this report, the METRIS group of experts identifies new trends in this research field, providing major support to political decision-makers.



International Cooperation with Africa in FP6

2009, 348 pp,
ISBN 978-92-79-10408-4

In 2005 the African Union adopted a Consolidated Action Plan for Africa in the field of science and technology (S&T), an initiative that calls for firm international support. This is a catalogue of recent advances made under the specific international scientific cooperation programme (INCO) of the Sixth Framework Programme.



Europe Research on Youth

2009, 76 pp,
ISBN 978-92-79-11450-2

This publication reviews socio-economic research projects concerning young people. It makes concrete recommendations to politicians and those working with young people on the basis of results of research into young people's entry into the workplace and citizen participation.



European Research Socio-economic Sciences and Humanities

2009, 236 pp,
ISBN 978-92-79-09798-0

This catalogue of socio-economic science and humanities research projects under the Seventh Framework Programme covers the Lisbon strategy, sustainable development and regional cohesion, major social trends, Europe in the world, citizens in the EU, indicators, forecasts and infrastructure.



Moving Europe: EU research on migration and policy needs

2009, 48 pp,
ISBN 978-92-79-09698-3

Demographics, migration, integration and social cohesion are key issues for the European Union and form an integral part of the Seventh Framework Programme. This report gives a brief description of projects relating to migration and the integration of immigrants funded by the EU over the past five years.



SME FP6 Project Catalogue

2008, 590 pp,
ISBN 978-92-79-05952-0

The Sixth Framework Programme enabled innovative small and medium enterprises (SMEs) with good research ideas but no financial facilities to find qualified partners by means of cooperative research and joint research programmes. This document describes the 473 projects financed under the two programmes.

 You can consult and order more publications about the European Union from the EU Bookshop. <http://bookshop.europa.eu>

YOUNG RESEARCHERS

Fay (26), molecular biologist



Fay Christodoulou

Outside the lab, in a world full of accountants, medics and lawyers, I find it very entertaining to introduce myself as a molecular biologist. People usually do a double-take and gasp just as though they had been presented with an exotic fruit. At the EMBL (1), where I am a PhD student, being a molecular biologist is nothing fancy. Still, our lab's research (Arendt group) sounds exotic enough because we work on a 'living fossil', the marine worm *Platynereis dumerilii*, with the aim of resolving how the brain evolved into such an organ. The last ancestor of humans (and many other species) had a simpler brain and that is what interests me, because I would like to know how it all began. We believe *Platynereis*

is quite similar to this last ancestor and, by studying it, I identified how a recently discovered class of molecules (micro-RNAs) demarcated specific parts of the brain, as well as a handful of other organs early in animal evolution. As I love to tell people how fascinating my worms are and how exciting my project is, I got involved in the *SET Routes* (2) project, a European initiative to awaken young girls' interest in science. When I described my life experiences to pupils at a Greek high school, I was surprised to see how curious they were about my research. They were expecting to meet a nerd and were amazed to see that a scientist can be 'normal' and enjoy extra-curricular activities like DJ-ing, travelling, sports and photography.

The stereotype image of a scientist looks so 'uncool' in children's eyes that it may discourage them to express an interest. Ironically, the

new generation is very disappointed with many other career options yet remains unaware of prospects in the science world.

Inspiring even a few children has been so rewarding for me because I believe that a scientist's role is not only to innovate but also to communicate and hopefully enrich the brain pool of the community. That is why I chose a career in science, thanks to an excellent science communicator, my high school biology teacher in Athens. It was he who ignited my passion for evolution, which was later nurtured at the University of Sussex and blossomed under the great guidance of my PhD supervisor, Detlev Arendt.

Fay Christodoulou

(1) European Molecular Biology Laboratory, Heidelberg (DE).
(2) www.set-routes.org

OPINION

Home sweat home

That most controversial of issues – climate change – has its supporters and detractors fervently vying to prove or refute their claims.

Against such a background, it is hard to raise awareness and put across a constructive and accessible message without being accused of propaganda. We are certainly not used to 'promoting' science. In fact, this is not a question of misleading advertising but of a hypothesis (the basis of all scientific thinking) that will in all likelihood affect humankind as a whole! What is so offensive about seeking to raise people's awareness of the fate of their own

environment? And what is so idealistic about believing that opposition to change can be replaced with personal involvement, however small?

Two committed campaigners have used their reputations to convey their message to a wider audience. One is a politician who commanded the cinematic form with a film entitled *An Inconvenient Truth*. Al Gore's film preaches from the pulpit, with demonstrations and clear explanations based on the results of scientific studies.

The other is an artist who is trying to inform politicians with his film *Home*, a roadmap that places the emphasis on images, some sublime and others terrifying.

Critics may well take offence at the tone, form, sources, intentions, motives, or intuitive and preventive nature of the films and even label them as alarmist... But with all their imperfections, their two messages bring us face

to face with the reality of our planet, arousing uncomfortable feelings of guilt, disquiet, confusion and powerlessness. They also prompt us to become more involved. Isn't that a small victory, at a time when a chill has been cast over Copenhagen climate debate?

France Fillon

Assistant, European Commission.

DIARY

To keep up-to-date with research and development news, see:

<http://ec.europa.eu/research/headlines>

It's not a full moon ...

...but a network of nanotubes from a giant vesicle seen under a fluorescence microscope. The cell's various compartments are linked by fine membrane tubes to allow the targeted transport of molecules – and hence of information. To identify the key mechanisms and physical parameters involved, scientists have reconstructed an in vitro model system of membrane nanotubes pulled by molecular motors. Understanding the formation and dynamics of such systems could herald some very interesting nanoscience applications.

A selection of news

from CORDIS

<http://cordis.europa.eu/news>,

the Community Research

& Development

Information Service.

Two new windows on the Universe

Last May, the European Space Agency (ESA) launched two new missions from the Kourou space centre in Guiana using the Ariane 5 ECA launchers *Herschel* and *Planck*. These two observatories, fitted with telescopes operating independently, will soon reach their final orbit 1.5 million kilometres from Earth where they will operate for an estimated lifetime of three to four years for *Herschel* and 15 months for *Planck*, during which time they will be used to gather more detailed data on the cosmos than ever before.

The telescope on the *Herschel* observatory, with its 3.5-metre mirror and PACS (Photoconductor Array Camera and Spectrometer), SPIRE (Spectral and Photometric Imaging Receiver) and HIFI (Heterodyne Instrument for the Far Infrared) instruments, is the largest telescope ever put into space. It has unrivalled sensitivity to long waves that are inaccessible from the ground and can make astronomical observations of far infrared and sub-millimetre wavelengths, gathering unique information

on the components of the universe. The *Herschel* mission is to study the formation of galaxies and stars, the molecular chemistry of the planets, comets and the atmospheres of satellites. The *Planck* observatory has the task of measuring to the nearest thousandth of a degree the temperature fluctuations of fossil radiation, or the Cosmic Microwave Background (CMB), which is found throughout the universe and carries a direct imprint of the Big Bang.



www.sci.esa.int

Research to free up the skies

The European Union has plans to inject EUR 1.9 billion into research aimed at preventing gridlock in the skies over Europe. This research effort will be headed by the joint undertaking *SESAR (Single European Sky Air-traffic management Research)*, which is the technology arm of the *Single European Sky (SES)* initiative funded by the European Commission, EUROCONTROL (the European Organisation for the Safety of Air Navigation) and the aviation sector.

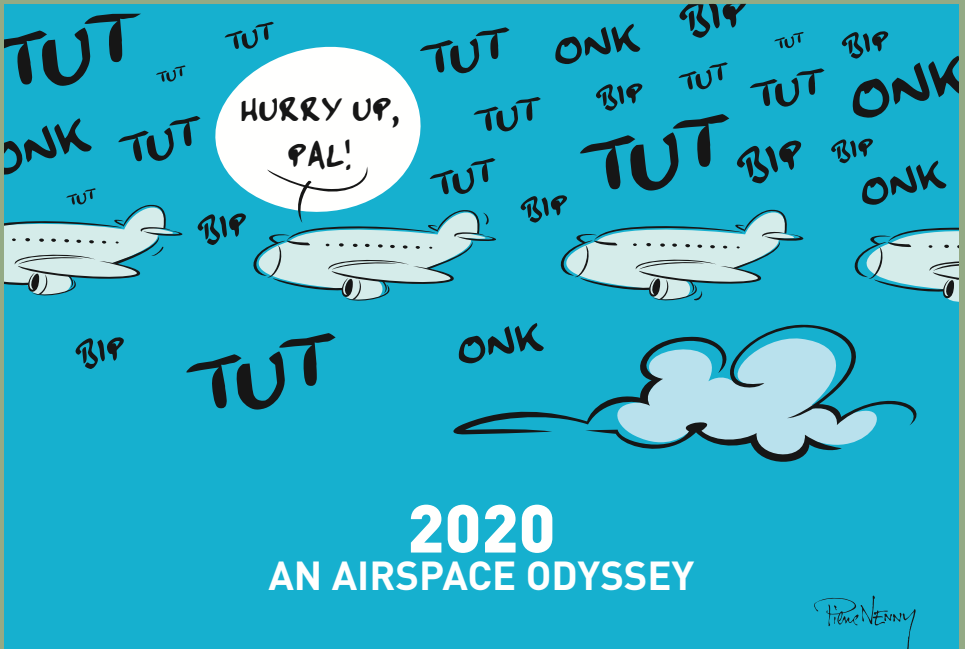
Over the next seven years the undertaking will finance 295 research projects conducted by 16 European partners specialising in air traffic management (ATM) technologies, each responsible for a specific task. SESAR will culminate in the progressive implementation of a new generation of European ATM systems integrated into a worldwide context. As Europe faces the prospect of air traffic tripling between now and 2020, the new system will focus on short- and long-term solutions

to congestion, as well as on improving air traffic safety and promoting a European air transport system more in step with sustainable development. Scheduled work packages include the development of trajectory management and route optimisation techniques, the development of an intranet for air traffic management to improve information sharing and the implementation of a 'rolling network operation' plan that adapts to the situation in real time.

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 www.sesarju.eu

IMI on course

Many are called, but few are chosen. Out of the 150 applications submitted under the *Innovative Medicines Initiative (IMI)*, 15 were finally awarded funding. The projects were selected by a committee of independent experts. Seven target a whole range of ailments: diabetes, cancer, pain, psychiatric disorders, neurodegenerative conditions, asthma and chronic obstructive pulmonary disease (COPD). Three will work on issues



relating to drug safety and effectiveness, and four focus on training.

The IMI is one of five *Joint Technology Initiatives (JTI)* launched as part of the European Commission's Seventh Framework Programme (FP7). This is a public-private partnership that involves all stakeholders in the drug chain, including the pharmaceutical industry, innovative small and medium enterprises (SME), patient groups, hospitals and government agencies responsible for issuing marketing authorisations. Together they have drawn up a strategic research agenda which was used as the basis for the call for proposals. Each research effort will be headed by a consortium of research bodies and innovative SMEs. The 15 projects will share EUR 246 million in funding, EUR 110 million of which will come from FP7 and EUR 136 million from the pharmaceutical industry. A second call for proposals is scheduled for this autumn. It will probably focus on oncology, the diagnosis of infectious diseases, chronic inflammatory diseases and knowledge management.



www.imi-europe.org

Europe's reptiles and amphibians under threat

EU-funded research conducted by the International Union for Conservation of Nature (IUCN) has revealed that nearly a quarter of Europe's amphibians and more than one fifth of its reptiles are in danger of extinction. The research formed part of the European Red Lists project, which aims to determine the conservation status of some 6 000 species of mammals, butterflies, dragonflies, amphibians, reptiles, freshwater fish, molluscs, beetles and vascular plants in Europe. The data gathered show the number of reptiles and amphibians in Europe to be shrinking and that they are at greater risk of extinction than European mammals and birds. Of the amphibian species surveyed, 85 are found only in Europe. Two species in this class of vertebrates are classed as 'critically endangered', five others as 'endangered' and 10 species of amphibians as 'vulnerable'. As for the reptiles, 151 species of which make their home in Europe and nowhere else in the world, scientists have placed on the

Red List six species that are 'critically endangered', five that are 'endangered' and 10 other species that are 'vulnerable'. The key factors that endanger the lives of amphibians and reptiles are human destruction of their natural habitat, climate change, pollution and the presence of invasive species that deprive the endemic species of resources.



www.iucnredlist.org/europe

Europeans detect the lightest exoplanet

A team of European researchers has discovered the lightest ever exoplanet (a planet beyond the solar system) in the Libra constellation by using the HARPS (High Accuracy Radial Velocity Planet Searcher) spectrograph attached to the 3.6-metre telescope belonging to the European Southern Observatory (ESO) at Chile's Silla Observatory. This extrasolar planet, christened Gliese 581 e by astronomers, has around twice the mass of Earth and is located 20.5 light years away.

Although Gliese 581 e is very likely a rocky planet according to the authors of this study, it is not in the habitable zone defined by astronomers because its location is so near its host star. The habitable zone is a region around the host star with the right conditions for water to be liquid on a planet's surface. However, the astronomers found that Gliese 581 d, the planet furthest from the host star of the Gliese 581 system, does seem to be in the habitable zone. Their latest observations indicate that this exoplanet, with a mass equivalent to seven times that of Earth, may well be an ocean planet. It could be covered with water, as well as ice, and shrouded in a deep atmosphere. The purpose of this hunt for exoplanets is to identify a planet with environmental conditions similar to those on Earth that could harbour life.



www.eso.org

OLEDs – the light of the future?

Organic light-emitting diodes (OLEDs) are semi-conductors made of layers of organic

material only a few nanometres thick that give off light when an electrical current is applied. Over time they may well replace LCD and plasma technologies. OLEDs are thin and flexible, making them ideal for the manufacture of roll-up screens. They could even be developed for conventional lighting applications, rivalling incandescent bulbs and fluorescent tubes.

The problem is that up to now, the most energy-efficient OLEDs achieved a rating of only 44 lumens (light output) per watt consumed (lm/W), far below the efficiency levels of conventional fluorescent tubes, which range from 60 lm/W to 70 lm/W. Recently, though, scientists from the Technical University of Dresden (DE), funded by the European Union under the *OLLA (Organic LEDs for ICT and Lighting Applications)* project, succeeded in creating light-emitting diodes that are just as efficient as conventional fluorescent tubes. Their results were published in *Nature*. Their breakthrough came from combining a novel, highly energy-efficient emission-layer design with improved light-outcoupling concepts. The authors believe that this discovery confirms the

revolutionary nature of OLEDs, making them ideal for conventional lighting applications.



<http://tu-dresden.de>

Model bacteria for solar cells

Green sulphur bacteria grow under extremely low light conditions. They have organelles called chlorosomes that contain thousands of bacteriochlorophyll and photosynthetic pigments, which form efficient antennas for harvesting light and synthesising organic matter through photosynthesis. Although a fair amount is known about the mechanisms at work in the light-harvesting antennas of certain photosynthetic organisms, knowledge of the structure of the chlorosomes is still rather sketchy.

In a study published in the online edition of the *Proceedings of the National Academy of Sciences (PNAS)*, an international team of researchers coordinated by the University of Leiden (NL) reveals that inside the chlorosome the bacteriochlorophyll assemble themselves into tube-like structures. Scientists have

observed the stacking of photosynthetic pigments using genetic manipulation and two sophisticated bio-imaging techniques: cryo-electron microscopy and nuclear magnetic resonance imaging. The concentric nanotube structure of chlorosomes is the basis of effective and super-fast light harvesting. The authors believe that chlorosomes are an attractive model to follow because of their simple composition and their ability to work well even in low-light conditions. This discovery could lead to the development of similar structures for solar cells that convert sunlight into chemical energy.

www.pnas.org

The happiness hormone, important but not crucial

A study published in the *Proceedings of the National Academy of Sciences* by a team of researchers working on the *FUNGENES (Functional genomics in engineered ES cells)* project provides new information on the role of serotonin, commonly known as the

'happiness hormone'. Serotonin is synthesised from an enzyme called tryptophane hydroxylase (TPH). This enzyme comes in two different forms: TPH1, which produces the serotonin that circulates outside the central nervous system, and TPH2, which is responsible for the production of serotonin within the central nervous system. The researchers deleted the gene responsible for the production of TPH2 in a group of mice. They found that these

DON'T
TOUCH
MY
HAPPINESS!



mice virtually stopped producing serotonin, confirming that TPH2 was indeed the main enzyme responsible for producing the hormone. They observed that when the rodents reached adult age, they were fertile and the females produced milk but also that they developed a number of disorders, including impaired postnatal growth, sleep alteration and breathing and cardiac problems. The mice tended to adopt more aggressive behaviour, accompanied by a tendency to eat their offspring. These observations support the assumption that aggressive behaviour is linked to low levels of serotonin. The study concludes that while TPH2-derived serotonin is involved in the regulation of behaviour and autonomic pathways, it is not essential for adult life.



www.pnas.org

Educational television stages a comeback

Although interactive learning is growing, it still does not reach a large audience. To remedy this, the European

Union is funding the *ELU (Enhanced Learning Unlimited)* project. The project aims to extend the advantages of interactive learning to a wider audience, especially in the newest Member States.

The research team has focused its efforts not on the Internet, as you might expect, but on television. To bring the undeniable teaching potential of television up to date, the research team has developed interactive digital television (iDTV) programmes.

In addition to six ready-made t-learning modules, they have created a virtual teacher and interactive quizzes. The *ELU* project also led to the creation of a software package for educators to enable them to create complex interactive courses via a visual interface. The course software and methods were tested in a 30-month study of a panel of users including MBA students and young pupils and older adults from the Czech Republic, Hungary, Latvia, Lithuania and Slovenia. According to the results of the study, t-learning would effectively complement e-learning and other methods of transmitting information.

The researchers have announced that, while a market launch of the iDTV

software is planned, educational content developers will be responsible for taking the process further.



www.elu-project.com

The anti-cancer vitamin

Although several epidemiological and clinical models had demonstrated the anti-cancer properties of vitamin D in humans, as well as the higher susceptibility to colon cancer caused by vitamin D deficiency in animal models, the exact mechanisms responsible for this have so far remained a mystery. Now a study published in the *Journal of Clinical Investigation*, led by researchers from the *NUCSYS* project ('Systems biology of nuclear receptors: A nutrigenomics approach to aging-related diseases') and the *MICROENVIMET* project ('Understanding and fighting metastasis by modulating the tumour microenvironment through interference with the protease network'), has started to unravel this mystery.

The researchers have established that the D3 form of vitamin D activates the CST5

gene in human colon cancer cell lines. The CST5 gene is responsible for making a protein called cystatin D. Research has found cystatin D to have important tumour-suppressing properties. In vitro tests have shown that cystatin D blocks the growth of human colon cancer cell lines both in the test tube and in mice. Conversely, the researchers found that artificially reducing the activity of the CST5 gene renders cells unresponsive to the anti-cancer effects of vitamin D. The exact mechanisms by which cystatin D exerts control over cancer cells remain unclear.

 www.jci.org

A legal framework for research infrastructure

The Czech presidency of the European Union ended with an important decision for building the European Research Area (ERA): it was agreed to adopt a legal framework for the establishment of European research infrastructures, which are too complex for national laws to accommodate.

For several months the negotiations, headed by the Ministers in the Competitiveness Council, had been battling over such thorny issues as how to exempt research infrastructures from indirect taxes and value added tax (VAT). The new framework now means that Member States must treat research infrastructures as international organisations for VAT purposes. 'The legal framework will significantly cut financial and administrative costs and clarify the legal environment for the functioning of European research infrastructures and at the same time enhance scientific cooperation,' stated Miroslava Kopicová, the Czech Minister for Education, Youth and Sports.

'The Council's agreement is excellent news for EU research and for the EU economy,' added European Research Commissioner Janez Potočnik, before going on to say: 'Investing today in the construction of large-scale research infrastructures can certainly contribute to the EU economic recovery and will surely reinforce our competitiveness when we get out of the recession.'

 www.cordis-europa.eu

Research on research

Following EU Research Commissioner Janez Potočnik's presentation of the Science, Technology and Competitiveness Key Figures Report 2008/2009 at the beginning of this year, the Commission now plans to launch a set of studies designed to further develop an evidence-based monitoring system on progress towards the European Research Area (ERA). In particular, the studies should serve as an evidence base for analysis of the contribution of research to economic growth, as well as the impact of research policies and programmes on the competitiveness of Europe.

Six research themes were selected: investments in joint research programmes; internationalisation of business investments in R&D; structural changes in sectors affected by R&D investment; patent costs; knowledge transfer, assessed by patent and licensing data; and bibliometric indicators. Although the six studies will be fully independent of each other, they are defined to be consistent in terms of their methodology and geographical coverage, allowing the results to be combined to provide a broad overview.

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Antibiotics: a call for standardisation

'Antibiotic resistance is a growing problem worldwide, with 10 % of *Streptococcus pneumoniae* isolates recorded as non-susceptible to penicillin in 30 countries in 2007 (...). The proportion of European patients consulting in general practice with lower respiratory tract infection who are prescribed antibiotics ranges from about 27 % in the Netherlands to 75 % in the United Kingdom. Trial evidence suggests that most antibiotic prescriptions do not help these patients to get better any quicker (...).

[This] wastes resources, (...) puts patients at unnecessary risk of side effects, and increases selection of resistant organisms, and so represents an opportunity for improved care through greater standardisation.' Extract from an article entitled 'Variation in antibiotic prescribing and its impact on recovery in patients with acute cough in primary care: prospective study in 13 countries', written jointly by researchers working on the GRACE project (*Genomics to combat resistance against antibiotics in community-acquired lower respiratory tract infections in Europe*). The article was published in the *British Medical Journal (BMJ)*.

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