The Genetic Legacy of Farming

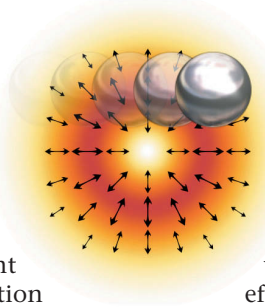
Agriculture and livestock farming leave their mark on the genes of Europeans

Agriculture and livestock farming spread across central Europe around 7,500 years ago. The associated selection processes are reflected in the genome of today's Europeans. Based on the analysis of genetic data from different periods and regions, an international team of researchers headed by Wolfgang Haak and Johannes Krause from the Max Planck Institute for the Science of Human History has shown that agricultural knowledge from Anatolia in today's Turkey made its way to Europe. This knowledge spread because Stone Age farmers from the region migrated to different parts of the continent. According to the study, the gene mutation that enables adult humans to tolerate milk occurred for the first time between 4,200 and 4,300 years ago. It had previously been assumed that this happened shortly after the domestication of cows 8,000 years ago. The researchers also succeeded for the first time in demonstrating the adaptation of genes that play an important role in the immune system. This became necessary as a result of close contact with domestic animals and their pathogens. As the Anatolian migrants were considerably lighter-skinned than the original European hunters and gatherers, the skin of the Europeans also became lighter. This resulted in an improvement in their vitamin D supply, as paler skin allows more light to penetrate. (Nature, November 23, 2015)

On the trail of Europe's first farmers: The genetic data of an adult male from the Salzmünde culture in the district of Saalekreis (Saxony-Anhalt) were incorporated into a study on the spread of agriculture. This grave is between 7,100 and 7,400 years old.

Speeding Particles in the Sights of a Laser

A mysterious phenomenon from the quantum world is acting as a model for a new kind of motion sensor. Researchers from the Max Planck Institute for the Science of Light use the entanglement of the polarization and the spatial distribution of the electromagnetic field in a radially polarized laser beam to track the movement of objects. In this kind of laser beam, the oscillation planes of the light waves arrange themselves like the spokes of a wheel. Entanglement is known from quantum physics, where it causes the properties of two particles to influence each other without exchanging any information, even if they are located at a considerable distance from each other. The entanglement with which the Erlangen-based physicists are working, however, is not all that spooky, as what is involved here is not a quantum physical effect but a classical one in a laser beam. It enables the determination of the position of a particle flying through the beam based on relatively simple measurements of the polarization. Because the polarization can be determined several billion times in a second, a particle moving as fast as a bullet can also be tracked without difficulty – something that is surely of interest for research applications. (Optica, September 28, 2015)



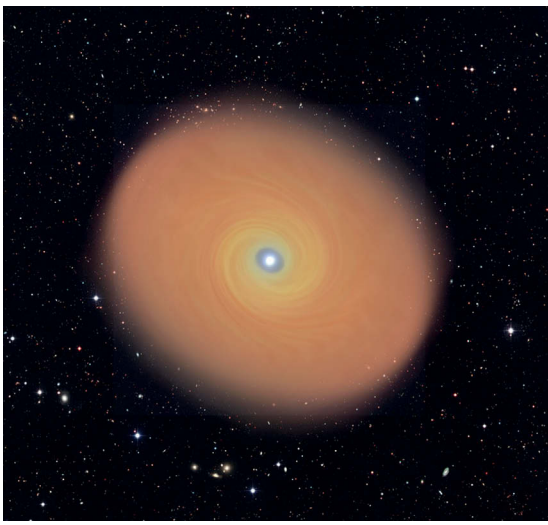
The path of a metal ball that flies through a radially polarized light beam can be reconstructed from the measurements of the polarization. The arrows show that the oscillation planes of the light waves in the beam arrange themselves like spokes of a bicycle wheel.

Photo: Juraj Lipták, LDA Sachsen-Anhalt (top); illustration: Optica 2015, MPI for the Science of Light, p. 43 (bottom)

How Stars Grow into Heavyweights

Astronomers find a stable disk around a massive young sun

Stars come in both lightweight and heavyweight form. They are all born in clouds of gas and dust; however, the more massive a baby star, the earlier nuclear fusion ignites in its core. The radiation pressure produced in this way should actually purge its surroundings, and thus prevent the infall of matter that would enable the star to grow bigger. Despite this, some stars manage to reach masses of over one hundred times that of our Sun. Stable flat disks – like those that the researchers from the Max Planck Institute for Astronomy have now found around a young star in the Centaurus constellation – appear to play a key role in this process. A stable disk like this can, on the one hand, direct enormous volumes of matter onto the nascent star; on the other hand, it presents a very narrow profile to the radiation pressure and thus a smaller area of attack than gas, which surrounds the star like a spherical shell. In this way, the star can continue to accommodate mass and grow into a heavyweight. (Astrophysical Journal Letters, October 29, 2015)



A star gains weight: This artist's impression shows the disk of gas and dust around the massive sun AFGL 4176.

The Origin of the Very First Species

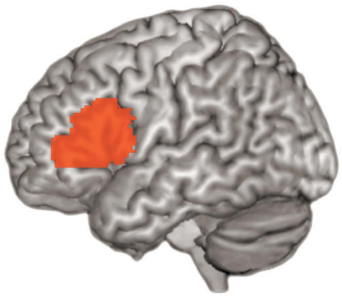
A model provides a possible explanation for the origin of the first biological species, from which all of today's life forms descended

When life emerged, probably around 3.8 billion years ago, the first biological species did not suddenly exist on Earth. Instead, it is likely that there was a big genetic muddle in the first cells due to the promiscuous exchange of genetic material between unrelated individuals via horizontal gene transfer. It took quite some time for the first biological species that reproduced over many generations with more or less the same genome and had a relatively functional biochemical apparatus to develop. A team of researchers headed by Marc Timme at the Max Planck Institute for Dynamics and Self-Organization in Göttingen used a theoretical model to investigate how this might have occurred. According to this model, life fluctuated back and forth between a genetically highly mixed state and a partially unmixed state. Over time, the entire population became biologically fitter on average and the importance of horizontal gene exchange and the genetic mix probably declined. The first species, from which all subsequent species emerged, may have formed in this way. (Physical Review E, November 13, 2015)

Dual Challenge for the Brain

If you listen to music while reading a book, the brain does not cleanly separate the two tasks. A new study shows that there is an area of the brain that processes both tasks simultaneously: Broca's area. A research team headed by Richard Kunert from the Max Planck Institute for Psycholinguistics in Nijmegen carried out a series of tests on this, in which the participants' brain activity was measured with the help of functional magnetic resonance imaging. The researchers discovered that the two tasks influence each other: "When we played a particularly complicated series of notes to the participants, they found it more difficult to process the structure of a sentence," reports Kunert.

These new insights also support the theory that Broca's area is not responsible for language processing in general, but specifically for combining different elements to form an overall image. During language processing, individual words must be combined to form sentences, and in the case of music, individual notes are combined to form melodies. (PLOS ONE, November 4, 2015)



Broca's area has long been known as an important part of the brain's language center. However, it also plays a key role in processing music.

Illustration: K. G. Johnston and ESO (top), MPI for Psycholinguistics (bottom)

Dispatches from the Middle Ages of the Universe

MAGIC telescopes measure gamma radiation from a remote galaxy

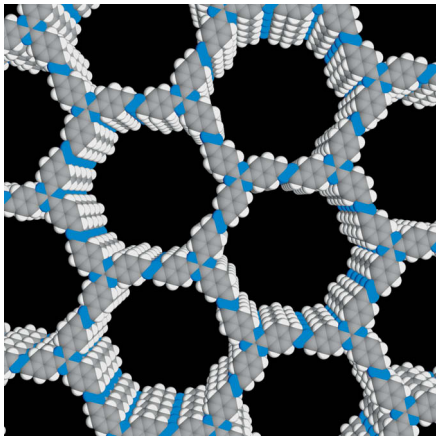
Researchers using the MAGIC telescope on La Palma have detected high-energy gamma radiation at a distant active galaxy for the first time. The center of this quasar, which is called PKS 1441+25, contains a high-mass black hole that is surrounded by a luminous disk of matter. The activity of the quasar is extremely variable: the most energy-rich gamma rays detected were around 250 gigaelectronvolts. This means that the outbursts are up to 100 times stronger than the normal gamma radiation profile. Astronomers are still unable to explain the reasons for this vast range. However, they discovered that the outbursts arise many billions of kilometers away from the active core. And yet another aspect: because the universe was born around 13.8 billion years ago and the light from PKS 1441+25 has been en route to Earth for around 7.6 billion years, its observation also provides insights into the "middle ages" of the universe. (Astrophysical Journal Letters, December 16, 2015)

Massive monster with radiant power: The PKS 1441+25 galaxy belongs to the group of quasars. A black hole at the center of the galaxy attracts matter, some of which is hurled outward in the form of jets at the speed of light.

Let There Be Hydrogen

An organic framework acts as a catalyst for photolytic conversion of water into hydrogen

Hydrogen is part of a climate-friendly energy mix, but only if it is produced regeneratively – that is, using energy from sunlight. Scientists from the Max Planck Institute for Solid State Research in Stuttgart and from Ludwig-Maximilians-Universität München have developed an innovative catalyst that produces this energy source from water and light. The material consists mainly of a covalent organic framework, to which, however, platinum nanoparticles and a compound that donates electrons must be added. Although the catalyst doesn't yet fulfill all requirements for technical use, it has the advantage that its properties can be chemically tuned at the molecular level. (Nature Communications, September 30, 2015)



Covalent organic frameworks are able to produce hydrogen. They form a regular structure with a large surface, which is required by technical catalysts (gray – carbon, blue – nitrogen, white – hydrogen).

Touchless Touchscreens

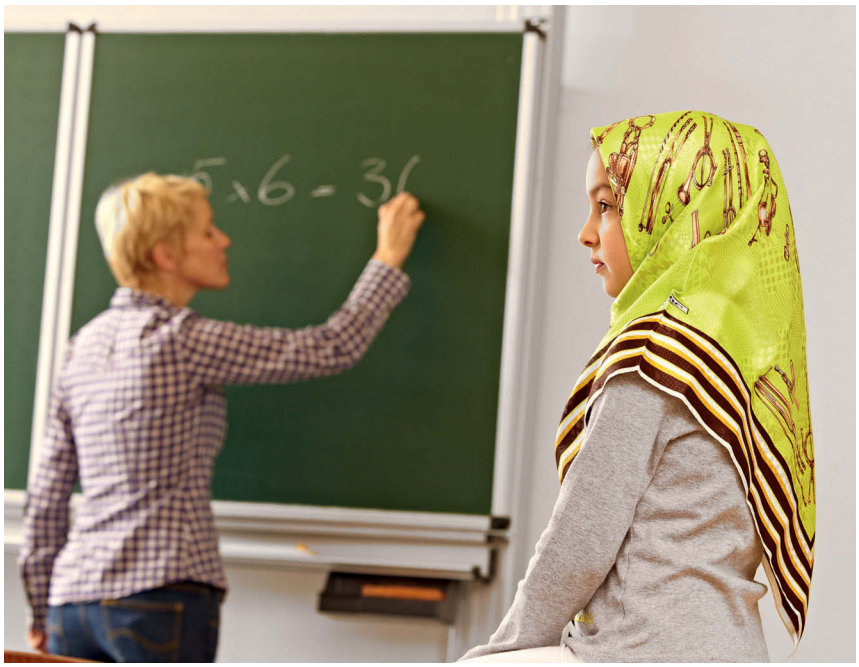
Touchscreens are practical, but touchless ones would be even better. Touching wears out screens and spreads bacteria and viruses. In order to avoid this, a team of researchers headed by Bettina Lotsch at the Max Planck Institute for Solid State Research in Stuttgart and Ludwig-Maximilians-Universität München developed a layered nanomaterial, comprising antimony, phosphorous, oxygen and hydrogen, whose electrical conductivity changes when it absorbs water. The material even reacts to the moisture released by a finger that comes anywhere near it, thus fulfilling an important requirement for touchless displays. (Advanced Materials, September 23, 2015)

Illustration: M. Weiss/CfA (top), Nature Communications/Macmillan Publishers (bottom)

Poverty Linked to Bad Grades

Compendium provides overview of ethnic inequalities in education and training

Performance gaps between children and young people from migrant and non-migrant backgrounds are observed throughout their educational careers. However, this is due mainly to social factors. Although migration-related reasons, such as language difficulties, are immediately observable, they are less significant. A volume co-edited by Christian Hunkler from the Max Planck Institute for Social Law and Social Policy provides an up-to-date overview of the current state of research in this field. According to the research, there are clear differences in the performances of children from different ethnic groups: children and adolescents of Turkish origin generally achieve much lower results than, for instance, pupils from the former Soviet Union. One of the reasons for this is the targeted recruitment of low-skilled guest workers from Turkey in the past. Their families still tend to have a low education level. Overall, the percentage of educationally disadvantaged families is disproportionately high among children with a migration background. (Springer VS, 2015)



Discrimination by teachers is not a major factor when it comes to explaining ethnic educational inequalities. Social background is more significant in this case, as well.

Following Their Noses to Lake Victoria

Without sense of smell, lesser black-backed gulls are unable to compensate for deviations from natural migratory route

Lesser black-backed gulls (*Larus fuscus fuscus*) are often on the move: In the fall, birds from Russia and Finland fly across the western Black Sea and the Nile Delta to Lake Victoria in East Africa. They spend the winter there and fly back north again to breed.

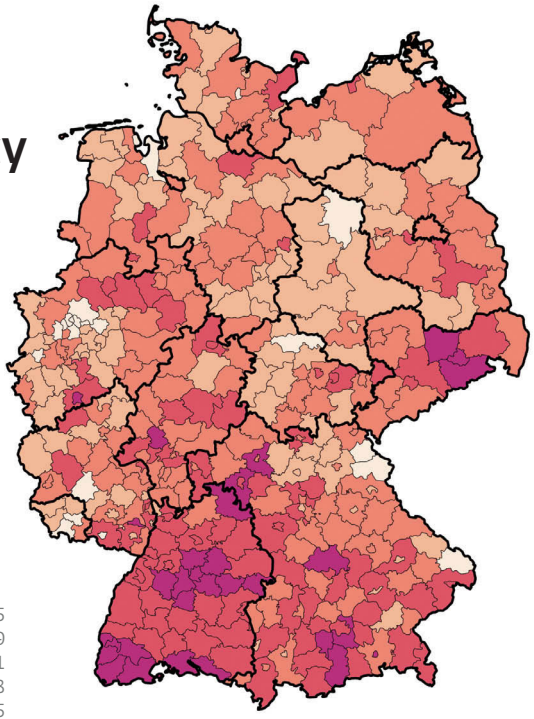
There's not much you can teach seagulls about navigation: they cover thousands of kilometers and reach their final destination with pinpoint accuracy. Exactly how they do this has not yet been fully explained. Together with colleagues from other research institutes, scientists from the Max Planck Institute of Ornithology in Radolfzell have provided further proof that some birds also use their sense of smell to navigate on their migratory journeys. The scientists used GPS transmitters to track the movements of lesser black-backed gulls whose olfactory nerves had been severed; the nerves grow back together again after a few months, so the birds aren't permanently impaired. Without their sense of smell, the gulls failed to reach their wintering area on Lake Victoria in Africa. The researchers have not yet identified the smells the birds follow. Individual olfactory cues along the route, such as the Black Sea and the Nile Delta, probably provide an indication of the general migratory direction. The lesser black-backed gulls do not, however, appear to use the Earth's magnetic field for navigation. (Nature Scientific Reports, November 24, 2015)

Photos: allesalltag (top), fotolia (bottom)

South-North Divide in Life Expectancy

Economically weak regions in western Germany falling behind in life expectancy

Twenty-five years after reunification, the once considerable differences between life expectancy in eastern and western Germany have almost disappeared. Instead, as scientists at the Max Planck Institute for Demographic Research discovered in an analysis of regional trends in life expectancy, the divide today is more along north-south lines. Southern Germans live longest: women in Baden-Württemberg have a record life expectancy of 83.6 years, followed by their counterparts in Saxony, Bavaria and Hessen. At the bottom of the list for the first time is a western German state, Saarland. Overall, the life expectancy map increasingly resembles a patchwork quilt. Economically weak areas in the west are falling behind. The regions with the shortest lifespan for women are now concentrated in North Rhine-Westphalia. The demographers see migrant flows as the cause of this. Highly developed areas attract people with a high level of education, who live considerably longer. (Kölner Zeitschrift für Soziologie und Sozialpsychologie, September 21, 2015)



The patchwork quilt of life expectancy: The fact that life expectancy in the east once lagged clearly behind that in the west – as was the case in the immediate aftermath of unification – is hardly noticeable now, at least among women. Instead, regional economic performance increasingly determines the length of life. Men in the east also now live only 1.4 fewer years than those in the west.

Colorful Birds

Plumage color in male and female birds from a single species can evolve separately only to a limited extent

The differences in color are not as striking between all male and female birds as they are in the white-winged fairy wren (*Malurus leucopterus*) from Australia.

The magnificent plumage of many male birds is the result of sexual selection: success in the mating game is limited to the males with the most beautiful plumage. In many bird species, however, the females are also strikingly colored. Scientists from the Max Planck Institute for Ornithology in Seewiesen analyzed the plumage of almost 6,000 species of passerine birds and found that the coloration of the males and females of a species is closely linked. Surprisingly, strong selection pressure on males reduces plumage coloration in females more than it increases it in males. Thus, the fact that high selection pressure can lead to major differences in coloration is mainly due to the fact that the females become less colorful. The analysis also revealed that birds in the tropics are more extravagant in their appearance than elsewhere because the competition for resources there is greater. Large tropical birds have the most magnificent plumage – big birds are less likely to fall prey to predators there and can afford to be more brightly colored. Colorful females occur above all in species with long-lasting partnerships and breeding communities. The competition between females for the opportunity to reproduce is higher in these cases. (Nature, November 4, 2015)

Graphic: Max Planck Institute for Demographic Research; photo: Kapar Delhey, Monash University, Australia

Infectiously Fertile

A gene makes male mosquitoes more fertile and also increases the females' susceptibility to malaria

The TEP1gene influences whether female *Anopheles* mosquitoes can fight infection with malaria pathogens. In male mosquitoes, in contrast, it controls fertility.

Malaria is one of the most common infectious diseases in the tropics. Infected female Anopheles mosquitoes transmit the single-celled parasite from human to human through biting. According to researchers from the Max Planck Institute of Infection Biology in Berlin, the susceptibility of the females to the malaria pathogens also depends on the males. The mosquitoes have different variants of the TEP1 gene, as it is known. The corresponding TEP1 protein variant in the blood of the females attacks the malaria pathogens with varying degrees of success. The TEP1 protein is also active in the male testes. There, it removes low-quality sperm, increasing fertility. However, the most effective protein variant for this makes the females particularly susceptible to malaria. Consequently, that which benefits the males damages the females. Which of the variants spread among the mosquitoes depends on whether a higher rate of reproduction or protection against malaria is more important.

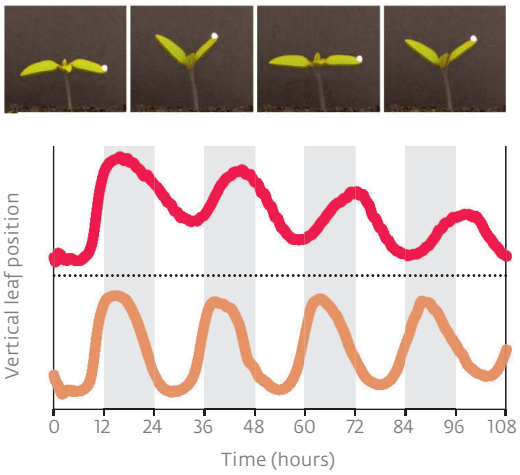
(PLOS Biol., September 22, 2015)

Tomatoes with Jet Lag

Domestication altered circadian clock of wild tomato plants

When we travel to different time zones, our internal clock often lags behind. Not only in humans – plants, too, have an internal clock that synchronizes such processes as leaf movements with the natural circadian rhythm. Researchers from the Max Planck Institute for Plant Breeding Research in Cologne have now discovered that the circadian clock of cultivated tomato plants ticks more slowly than that of wild tomato plants. The cultivated forms apparently adapted to the longer summer days at higher latitudes when they were transported from their original home in Ecuador to Europe during the course of domestication. Summer days in Naples, for example, last more than three hours longer than in Ecuador. During domestication, gene variants must have arisen that are responsible for the altered rhythm. According to the researchers, these variants affect only two genes. One of them, EID1, enables plant cells to perceive light stimuli. It is not yet known whether the circadian clocks of other crops have also changed through domestication.

(Nature Genetics, November 16, 2015)



An internal clock controls the leaf movements of tomato seedlings over the course of a day. The leaves of the cultivated tomato (red) move more slowly than those of the wild ancestor (orange).

The Curious Body

Robots could gain a lot of knowledge from babies – for example, how they learn their first movements. Children explore the world through play, and in the process, they discover not only their environment, but also their own bodies. As Ralf Der, a researcher at the Max Planck Institute for Mathematics in the Sciences, and Georg Martius, a scientist at the Institute of Science and Technology in Klosterneuburg, Austria, have now shown in simulations with robots, the brain of a mechanical being, or even that of a human, doesn't necessarily need a high-level control center to generate curiosity. Curiosity arises solely from feedback loops between stimuli input from sensors that convey information about interactions between the robot's body and the environment, and commands for new movements. From initially small and even passive movements, the robot develops a motor repertoire without specific higher-level instructions. Up to now, robots with the capacity to learn have been set specific goals and are rewarded when they achieve them. Researchers have also tried to program curiosity into the robots. (Proceedings of the National Academy of Sciences, November 10, 2015)

Photo: Christine Panagiotidis/MPI of Molecular Cell Biology and Genetics (top); photos and graphic: Niels Müller/MPI for Plant Breeding Research (bottom)