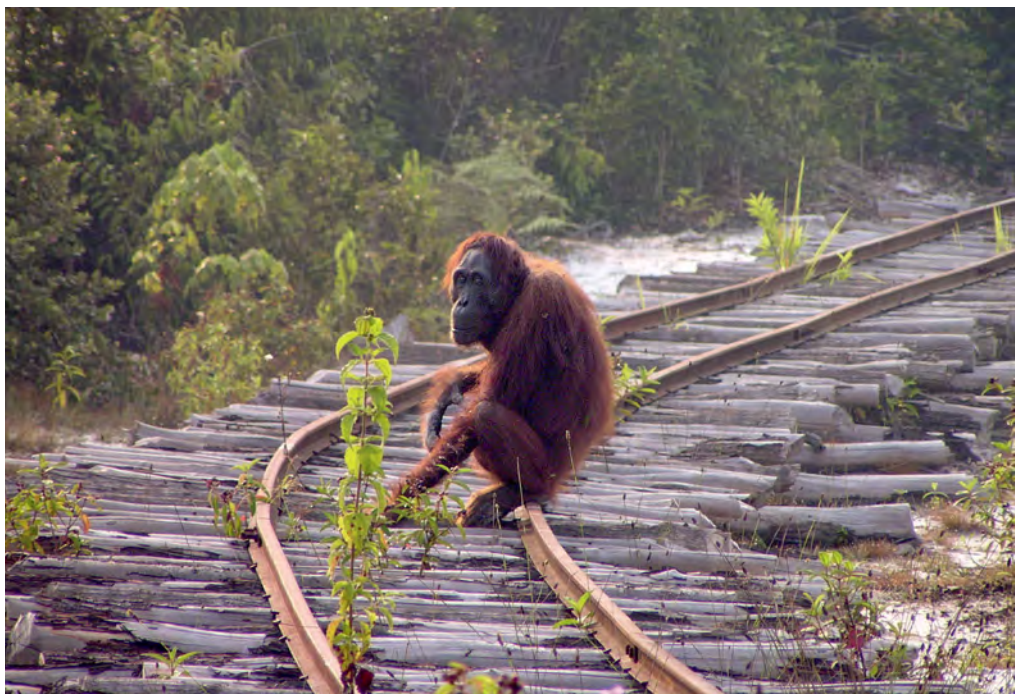


Dramatic Decline of Bornean Orangutans

The number of great apes in Borneo has plummeted by more than 100,000 in the last 16 years

The extinction of species on Earth continues unabated: the latest data from a research team that includes scientists from the Max Planck Institute for Evolutionary Anthropology in Leipzig indicates that the total number of Bornean orangutans dropped by more than 100,000 between 1999 and 2015. That leaves just 70,000 to 100,000 of these animals in Borneo, of which only a fraction live in viable populations. Persecution by humans is likely one of the main reasons why the greatest loss of great apes has occurred in selectively logged and primary forests. Many of them are killed for their meat and for the pet trade – but many also to protect crops from them. Although the numbers show that there are more orangutans than was previously thought, and that they can survive even in oil palm plantations, the rapid decline must be stopped. As a previous study showed, if only one in 100 adult orangutans is removed from a population per year, that population is very likely to go extinct. (www.mpg.de/11939623)



Habitat loss and poaching are the main causes of the disappearance of orangutans. In Borneo, for example, 10,000 orangutans live in forests that are slated for conversion into oil palm plantations. If this happens, most of these animals will die.

Fighting Malaria with Chemistry

The active ingredient artemisinin can now be produced more efficiently and economically and with less environmental impact



Developed in the lab, suitable for large-scale production: Obtained from plant waste, the source materials for manufacturing artemisinin (white powder) now no longer need to undergo cleaning, and the plant's own chlorophyll can be used as a catalyst.

Millions of people – especially in developing countries – who are infected with malaria may soon be able to access the key active ingredient against this disease more easily. Currently, 650,000 people die every year from the effects of malaria; of those, nearly 600,000 are children. Now we have the opportunity to prevent many of these deaths. Artemisinin, the key ingredient in the most effective anti-malaria drugs, can now be produced significantly more efficiently and economically and with less harm to the environment than before. This was made possible by researchers at the Max Planck Institutes for Dynamics of Complex Technical

Systems in Magdeburg and of Colloids and Interfaces in Potsdam by refining a process the chemists in Potsdam presented a few years ago. They now no longer need to clean the raw materials used to produce artemisinin, which is obtained from waste from sweet wormwood (*Artemisia annua*), an annual plant. In addition, they use the chlorophyll from the plant as a catalyst, allowing them to forgo the expensive and environmentally harmful photoactivators they previously needed for this. ArtemiFlow, a startup founded by Max Planck researchers, is now working to implement the process on an industrial scale. (www.mpg.de/11958775)

The Nose Knows

Study shows cognitive performance of dogs when tracking a scent

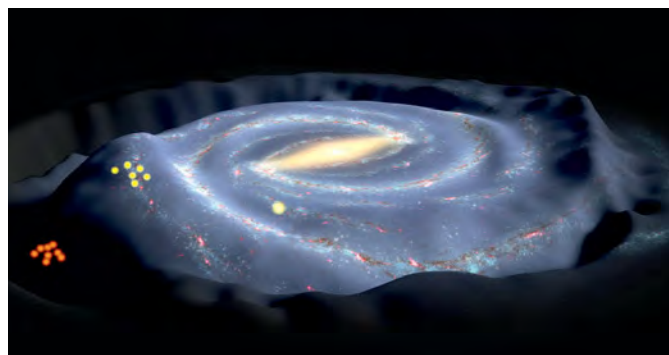
Dogs are well known for their excellent sense of smell, be it in searching for people or for a variety of substances. The question of how well dogs understand what they perceive with their sense of smell, though, remains largely unexplored. Scientists at the Max Planck Institute for the Science of Human History therefore subjected 48 dogs to a test:

Each dog underwent a total of four trials in which they followed, unaccompanied, a scent trail marked using one of two of the dog's favorite toys. At the end of the trail, some of the dogs found, not the toy that was used to lay the track, but the other one. Many of the dogs seemed to be surprised by this, especially in the first test run. They continued to

search even though they had obviously noticed the toy. However, this "surprise effect" disappeared in the subsequent test runs. Nevertheless, the results indicated that dogs have a mental representation of the target when tracking a scent. In other words, they have a specific expectation of what they will find at the end of the trail. (www.mpg.de/11966983)

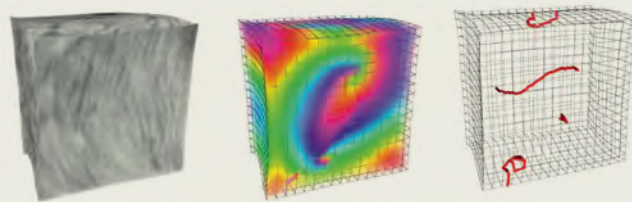
Star Migration

Our Milky Way is an average spiral galaxy. Most of its stars orbit the center within a disk, but some are also found in the surrounding halo, which is made up of dark matter. Many halo stars are grouped together in giant structures. These structures are considered to be signatures of our galaxy's turbulent past – debris from the many smaller galaxies that evidently collided with our Milky Way time and again, and that were torn apart in the process. A team of researchers headed by Maria Bergemann at the Max Planck Institute for Astronomy studied two groups of halo stars and discovered that their chemical composition is similar to that of the galactic disk. This is regarded as evidence that the stars they have now analyzed originated from within the disk and not, for instance, from trapped satellite galaxies. The scientists suspect that this stellar migration is caused by oscillations in the Milky Way disk as a whole, which in turn may have resulted from the tidal interaction between the disk and a passing massive satellite galaxy. (www.mpg.de/11959728)



A view of the galaxy: Illustration of a simulation of the Milky Way disk, perturbed by the tidal interaction with a dwarf galaxy. The locations of the two halo star structures the researchers studied – the Triangulum-Andromeda (Tri-And) and the A13 overdensities – above and below the galaxy disk are indicated.

Maelstroms in the Heart

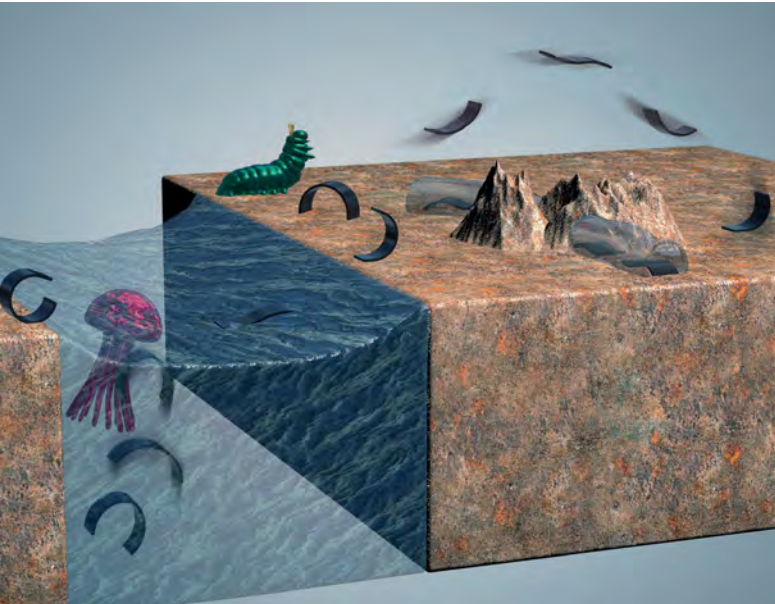


Getting to the core of ventricular fibrillation: From ultrasound images (left), Max Planck researchers reconstructed how the heart muscle contracts in a vortex-like manner in cardiac arrhythmia (center). In this way, they can also localize the filaments at the center of the vortices (right).

Every five minutes in Germany alone, someone dies of sudden cardiac arrest resulting from ventricular fibrillation, the most common cause of death worldwide. A new diagnostic method could help make future treatment of ventricular fibrillation and other types of cardiac arrhythmia more effective. An international team working with physicists and physicians at the Max Planck Institute for Dynamics and Self-Organization and the Heart Center at the University Medical Center Göttingen developed a technique that allows them to use common ultrasound devices to produce 3-D images of the vortex-like contractions that lead to the heart muscle spasms that occur in ventricular fibrillation. The researchers can even localize the eyes of the vortices and track them as their positions in the muscle change. A precise image of the vortex cores is crucial for stopping the ventricular fibrillation more gently than is currently possible. Today, this type of cardiac arrhythmia is treated with strong and very painful electric shocks from a defibrillator. This is why some patients with recurrent cardiac arrhythmias decline to have a defibrillator implanted, especially since these devices often emit electrical pulses unnecessarily. If the electrical shocks could be applied at the vortex cores, they could be much weaker, as they are particularly effective there. (www.mpg.de/11953915)

A Millirobot with a Talent for Movement

A magnetic drive allows a tiny vehicle to walk, crawl, jump and swim through a complex environment



Soon, tiny robots will be able to master any obstacle course. Scientists at the Max Planck Institute for Intelligent Systems in Stuttgart developed a four-millimeter-long strip of elastic silicone that can run, jump, crawl and roll through difficult terrain, as well as transport small loads and swim on and in liquids. The tiny vehicle owes its ability to perform these different types of movements to magnetic particles the researchers embedded in a sophisticated arrangement in the silicone strip. As a result, the rubber can be deformed in various ways depending on the orientation and strength of an external magnetic field. The researchers hope it will one day be possible to use this master of motion as a model to build tiny robots that perform medical procedures in the body. They could transport drugs to the source of an illness, for instance, or stop minor hemorrhages. (www.mpg.de/11895964)

The millirobot presented by the Stuttgart-based Max Planck researchers can move on land and in water. Jellyfish and caterpillars are just two of the natural role models that inspired the scientists who developed it.

Interconnected Sensory Impressions

It is estimated that one in 25 people have synesthesia, a union of sensory perceptions that are normally separate. Synesthetes may see or taste sounds, for example, or perceive them as geometric shapes. The phenomenon often occurs in multiple members of a given family, so it is likely hereditary. Researchers at the Max Planck Institute for Psycholinguistics and the University of Cambridge have now analyzed the DNA of three families in which several family members across various generations see colors when they hear sounds. They were able to identify genetic variants and see how they were passed on from one generation to the next. While the highlighted DNA variants differ between the three families, they also have one thing in common: a concentration of genes that are involved in axonogenesis and cell migration. Axonogenesis is a key process that enables brain cells to connect with the right partners. This tallies with findings from imaging studies that showed that the brain circuits in adults with synesthesia are wired somewhat differently than in people who don't experience these kinds of sensory couplings. (www.mpg.de/11964360)

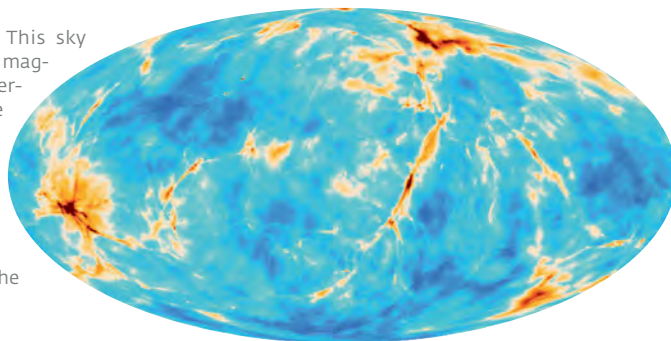
Colonial-Era Pathogen Identified

After the indigenous population in America came into contact with Europeans, numerous deadly epidemics swept through the New World. To date, contemporary reports have proved insufficient for identifying the causes. Now, for the first time, an international research team with significant participation of scientists from the Max Planck Institute for the Science of Human History has used DNA analyses to microbiologically identify the pathogen behind such an epidemic. The genetic material the researchers used was extracted from 29 skeletons in a cemetery associated with the epidemic in the abandoned Mixtec town of Teposcolula-Yucundaa in Mexico. The individuals buried there were victims of what is known as theocoliztli epidemic, which took millions of lives in Guatemala and Mexico between 1545 and 1550. The team analyzed genetic material from the human skeletal remains using a novel computer program that enables them to examine the samples for non-specific bacterial DNA. Ten of the samples contained evidence of *Salmonella enterica* bacteria, which cause enteric fever – a disease that, similar to typhoid, causes fever, diarrhea and vomiting. The scientists consider it possible that the pathogen was introduced from Europe. (www.mpg.de/11884269)

A Relic of the Big Bang

Astrophysicists calculate the original magnetic field in our cosmic neighborhood

Viewing the invisible: This sky map shows the Harrison magnetic field strength, averaged across a sphere with a radius of approximately 300 million light-years. The two regions with particularly strong magnetic fields are the Perseus Pisces galaxy cluster (left) and the Virgo cluster (top).



The first fractions of a second following the birth of the universe saw the emergence of not only elementary particles and radiation, but also magnetic fields. A team headed by the Max Planck Institute for Astrophysics has now calculated what these magnetic fields in our vicinity should look like today – in great detail and in 3-D. To do this, the researchers first analyzed the distribution of galaxies around us and, based on this, calculated the distribution of matter at the time of the Big Bang. This is where the Harrison effect came into play: friction from what was then a very strong radiation field

resulted in vortex movements in the plasma of the early universe, producing electrical currents and thus inducing magnetic fields. Subsequently, the scientists translated these fields back into the present and into our cosmic neighborhood, enabling them to predict the structure and morphology of the original magnetic field in the surrounding 300 million light-years. Unfortunately, this theory can't be tested through observation: the calculated magnetic field is 27 orders of magnitude smaller than that of the Earth, and thus far below the current measurement threshold. (www.mpg.de/11991394)

Brains of Jazz and Classical Pianists Work Differently

A musician's brain differs from that of a non-musician: making music requires a complex interplay of various skills, and this is also reflected in the brain structures. Scientists at the Max Planck Institute for Human Cognitive and Brain Sciences have now discovered that even the style of music plays a role: they observed that the brain activity of jazz pianists differed from that of classical pianists – even when they play the same piece of music. One major difference is in how they plan movements. While pianists generally have to know what they will play – that is, which keys they will press – and how they will play it, meaning which fingers they will use, the weighting of these two steps varies depending on the music genre. Classical pianists, for instance, focus particularly on the “how” – on their finger placement – in order to play a composition perfectly and with feeling. Jazz pianists focus primarily on the “what” so that they can improvise. (www.mpg.de/11881616)

The Spread of the Bell Beaker

DNA studies solve mysteries surrounding the spread of special ceramic vessels in prehistoric Europe

During the transition from the Neolithic to the Bronze Age, people in western and central Europe increasingly used pottery in a new, bell-shaped style. It was long debated whether the spread of the beaker ceramic style was due to migration or merely to the spread of new ideas. To shed light on the matter, an international team of researchers including members from the Max Planck Institute for the Science of Human History analyzed the DNA of 400 prehistoric skeletons that were buried together with beaker vessels. According to their findings, both explanations may be correct depending on the region. The beaker pottery must have initially spread between central Europe and the Iberian Peninsula without any appreciable migration, as the DNA of the skeletons in the two re-

A popular burial object: Beaker vessels were often placed in the grave with the deceased. Today, scientists can determine how the pottery spread based on the skeletal DNA.



gions differs significantly. In ancient Britain, in contrast, among the dead who were buried with beaker vessels, the research team found genetic material from inhabitants of the eastern European steppe who migrated across central Europe to the British Isles some 4,500 years ago. At that time, they replaced more than 90 percent of the original population of Britain. Beaker pottery was not found in that region before the arrival of these immigrants. (www.mpg.de/11953055)

Neanderthals as Artists

New method yields older age of artwork in Spanish caves

Anthropologists previously believed that only modern humans were capable of creating cave art, sculpted figures, decorated bone tools and jewelry. Previous analyses of such artifacts in Europe showed that they were created some 40,000 years ago, just as modern humans first settled the continent. Using a new measurement method known as uranium-thorium dating, an international research team including scientists from the Max Planck Institute for Evolutionary Anthropology in Leipzig has now obtained very different results: according to their findings, Neanderthals were already producing symbolic objects more than 115,000 years ago, and creating cave art in Europe more than 20,000 years before modern humans. This dating technique is based on the radioactive decay of uranium isotopes into thorium and facilitates

age determination much further back in time than the commonly used radiocarbon method. In this way, the scientists dated carbonate crusts on paintings and on seashells with remnants of pigment and were thus able to determine the minimum age of the cave art. From this, the researchers conclude that Neanderthals, too, were able to think symbolically and were cognitively indistinguishable from modern humans. The origins of language and human perception and cognition must therefore go back to the last common ancestor of Neanderthals and modern humans, more than half a million years ago. (www.mpg.de/11948095)

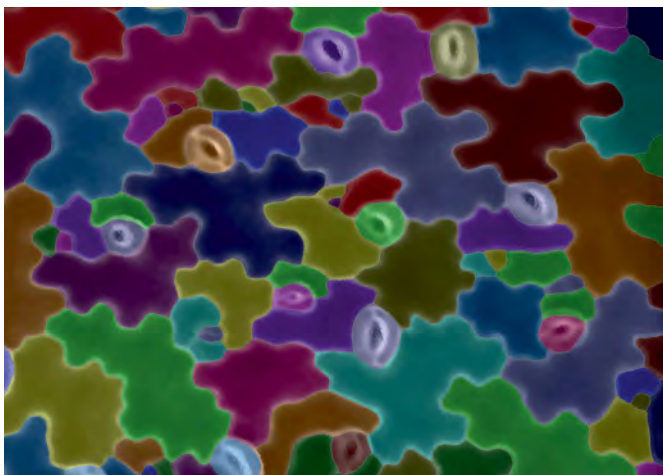


Researchers analyzed carbonate samples that had formed over paintings on the walls of three caves in Spain. The paintings, mostly in red, but sometimes also in black, show groups of animals, dots, geometric signs and hand prints. According to the new measurements, the ladder-like painting composed of horizontal and vertical lines in the La Pasiega cave is more than 64,000 years old and therefore must have been created by Neanderthals.

A Jigsaw Puzzle of Plant Cells

Their irregular shape enables epidermal cells to withstand the high pressure in their interior

Plant cells are under tremendous pressure, so they had to come up with a way to keep from bursting. According to scientists at the Max Planck Institute for Plant Breeding



Research in Cologne, epidermal cells with an irregular shape can withstand the pressure in their interior better than round cells can. Using a specially developed computer model, the scientists simulated the pressure conditions in cells of various shapes. The researchers' calculations show that long, thin cells or those with an irregular shape can withstand turgor pressure better because they have no large, open areas, which tend to bulge out. The shape of these surface cells is determined by how a plant organ grows: epidermal cells of leaves, which grow uniformly in all directions, resemble pieces of a jigsaw puzzle, while plant organs that have a preferred direction of growth, such as roots and stems, usually have cylindrical cells. (www.mpg.de/11956824)

As the epidermal cells of thale cress (*Arabidopsis thaliana*) are shaped like puzzle pieces, they can withstand greater pressure. The interspersed guard cells of the stomata, which help regulate the plant's exchange of water and gas, are an exception. Their small size is what prevents them from bursting.

Humans Limit Animal Movements

Biologists identify decline in migration in areas with a high human footprint

While humans travel more and more frequently and cover ever greater distances, animals' freedom of movement is becoming ever more restricted. Researchers at the Max Planck Institute for Ornithology in Radolfzell, the Senckenberg Nature Research Society and Goethe University Frankfurt analyzed the GPS movement data of more than 800 animals and compared it with the Human Footprint Index of the areas through which they move. The results showed that mammals in areas that are influenced by humans move only one third to one half as far as in the wild. One reason for this is that the animals are impeded by human settlements and roads. Species such as deer and wild boars then increasingly retreat to smaller woodland areas that are surrounded by human infrastructure. Others, such as grouse, completely avoid regions with a significant human footprint, for instance with ski lifts, aerial cableways and alpine sports. In addition, some animals change their behavior in the presence of humans. Urban foxes, for instance, can find food more quickly in areas with a strong human presence, so don't need to cover as much distance. Human hunting and leisure activities also affect the animals: the research findings show that wild boars and other species alter their activity times and territories to avoid humans. (www.mpg.de/11892788)



Some animal species require large ranges, so they can no longer be found in the vicinity of humans. Zebras, for example, travel up to around 500 kilometers during their annual migration – more than any other mammal in Africa. From 1968 to 2004, a fence blocked the zebras' migration in the Okavango Delta in Botswana. Only after the obstacle was removed were the animals able to resume their migrations.

Photos: Franz Lanting/Fotolia (top), MPI of Molecular Cell Biology and Genetics/J. Rink (bottom)

Axolotl and Planarian Flatworm Genomes Decoded

The data from these DNA analyses is helping researchers understand the astounding ability of these animals to regenerate



Even when the flatworm *Schmidtea mediterranea* is cut into tiny tissue pieces, each piece regenerates back into a complete mini-flatworm. The worm owes this ability to regenerate to stem cells that remain active throughout the worm's life. Each one can form a complete worm.

When the Mexican axolotl loses a body part, it grows it back within just a few weeks. The planarian flatworm *Schmidtea mediterranea* can even form new mini-flatworms when it is cut into small tissue pieces. Thanks to new sequencing techniques, two international research teams have now completely decoded the genome of both of these animals – in both cases together with researchers at the Max Planck Institute of Molecular Cell Biology and Genetics in Dresden. With 32 billion base pairs, the axolotl genome is more than ten times larger than that of humans, making it especially difficult to sequence. Moreover, it consists of many long, repetitive segments. Large portions of the flatworm genome are also com-

posed of these nearly identical sequences, so it, too, posed a great challenge for the researchers. In the axolotl genome, the researchers discovered several genes that occur only in amphibians and that are expressed in regenerating tissue. It is also striking that an important and widespread developmental gene named PAX3 is completely missing. The flatworm, on the other hand, is missing two universal genes that, during cell division, ensure that both daughter cells receive the same number of chromosomes. The researchers plan to use the new genome data to study why the axolotl and planarian flatworm can regenerate organs and body parts. (www.mpg.de/11886544, www.mpg.de/11886639)