An Addition to the Human Family

Scientists have discovered the fossilized remains of a previously unknown human species in a cave in South Africa

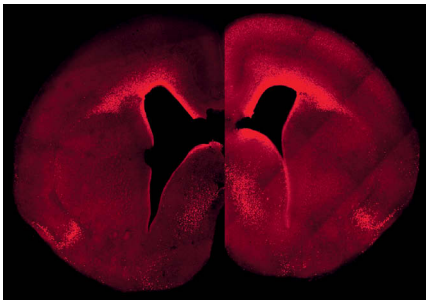
The human genealogical line has long since become more of a bush than a tree. It's easy to lose track owing to the sheer number of branches. And now another member, known as *Homo naledi*, has been added. An international team of researchers including scientists from the Max Planck Institute for Evolutionary Anthropology in Leipzig discovered well over a thousand bones of at least 15 individuals in a South African cave and attributed them to a previously unknown human species. *Homo naledi* was around 1.5 meters tall and weighed 45 kilograms with a brain the size of an orange. Several characteristics of its skull and teeth show that it was one of the early members of the human genus. The researchers don't yet know precisely when *Homo naledi* lived. Although it was able to use tools with its hands, the extremely curved fingers indicate that *Homo naledi* – "naledi" means star in the local language – possessed climbing capabilities. It was also an able walker, as its feet are virtually indistinguishable from those of modern humans, and it had long legs. Its shoulders, however, are more similar to those of apes. This combination of primitive and modern features distinguishes it from any previously known species. The researchers discovered the bones deep in the caves, in a chamber that is connected to the rest of the underground system only by a 20-centimeter wide crevasse. The site of the find has led researchers to conclude that *Homo naledi* may have intentionally disposed of its dead in this inaccessible place. (eLIFE, September 10, 2015)

The modeled head of *Homo naledi*. It took around 700 hours of work to reconstruct the head from the skeletal remains. (Image from the October issue of National Geographic)

Stem Cells for a Larger Brain

A single key gene changes production of nerve cells in the neocortex

With its grooves and bumps, the surface of the human brain resembles a walnut. This exterior is the result of a lack of space: over the course of evolution, the cerebral cortex – and in particular the neocortex – has grown to such an extent that it only fits into the skull when folded. However, the human neocortex isn't just larger; it also contains more nerve cells than that of other mammals. These nerve cells are formed by progenitor cells during embryonic development. In humans and monkeys, they divide multiple times, thus producing a large number of nerve cells, whereas in mice, for instance, they divide only once. The neocortex of mice therefore remains smaller. Scientists from the Max Planck Institute of Molecular Cell Biology and Genetics in Dresden have now adapted the activity of a regulator gene in a particular group of progenitor cells in the mouse brain to activity in the human brain. These progenitor cells also produced more nerve cells in the brains of rodents and created the conditions for a larger brain. The activity of an individual key gene can therefore have a significant influence on brain size. (PLOS Biology, August 6, 2015)



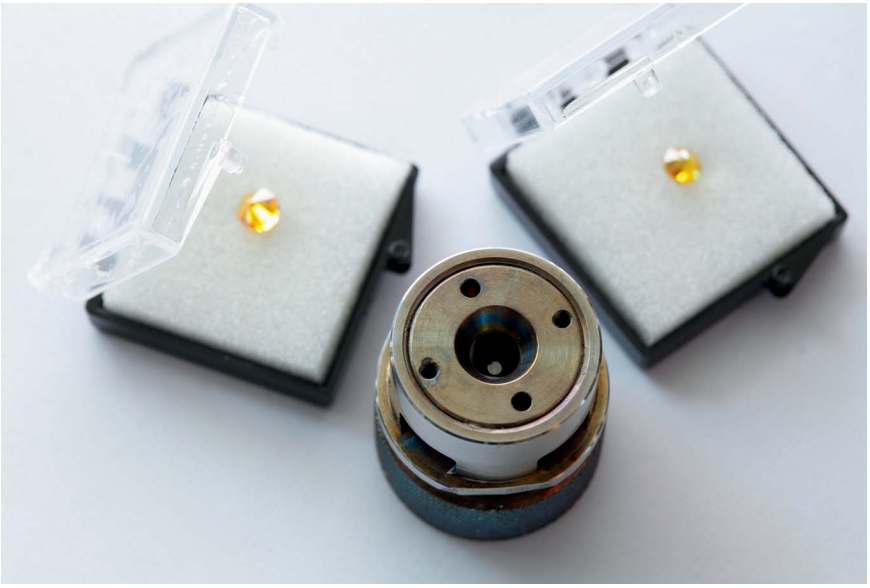
Cross section of a mouse brain: In the neocortex of a genetically modified mouse (right), the Pax6 regulator gene is more active than in normal mice (left), with similar activity to that in humans. These animals possess more progenitor cells with active Pax6 (red).

Photos: Mark Thiessen/National Geographic (top), MPI of Molecular Cell Biology and Genetics (bottom)

No Resistance at Record Temperatures

Hydrogen sulfide becomes superconductive under high pressure at minus 70 degrees Celsius

No material has previously been able to conduct current without resistance at such a relatively high temperature. Researchers at the Max Planck Institute for Chemistry in Mainz and the Johannes Gutenberg University Mainz observed that hydrogen sulfide becomes superconductive at minus 70 degrees Celsius when the substance is placed under a pressure of 1.5 million bar. This corresponds to half of the pressure of the Earth's core. With their high-pressure experiments, not only have the researchers in Mainz thus set a new record for high-temperature superconductivity, but their findings have also given fresh impetus to the search for materials that transport current at room temperature with no loss. Such superconductors could be found among hydrogen-rich compounds that might possibly even lose their resistance at a much lower pressure. (Nature, August 17, 2015)



Amazingly handy: The apparatus that the team at the Max Planck Institute for Chemistry used to generate extremely high pressures. In the center are two diamonds between which the sample is compressed.

Cancer Drug Prolongs Life in Flies

Trametinib inhibits the same signal pathway in flies and humans and could therefore conceivably also work on us

Humans, yeasts and fruit flies began to evolve separately millions of years ago, but their cellular processes are nevertheless often similar. One example is the Ras-Erk-ETS signal pathway. This controls cell division and cell death in all three organisms. Overactivation of the signal protein Ras can turn healthy cells into cancerous ones – also in humans. The Ras protein has mutated in around one-third of cancer patients. Cancer drugs such as Trametinib are deployed here and halt tumor growth. Scientists from the Max Planck Institute for Biology of Ageing in Cologne have now discovered that Trametinib extends the life of fruit flies by 12 percent. When the researchers administer the active substance to older flies, their life expectancy is still increased by 7 percent. The researchers observed no adverse effects on the insects' digestive system or food intake. As human cells contain the same molecular switches for the effect of Trametinib, the cancer drug could, in the future, conceivably also be used as an anti-aging drug. (Cell, June 25, 2015)

A fruit fly in old age. Drugs that extend the life of flies could also increase human life expectancy.

Photos: Thomas Hartmann (top), Nazif Alic (bottom)

Turbines Lessen Wind Energy

Large wind farms with a high density of installed capacity slow down the wind and generate less electricity than previously thought

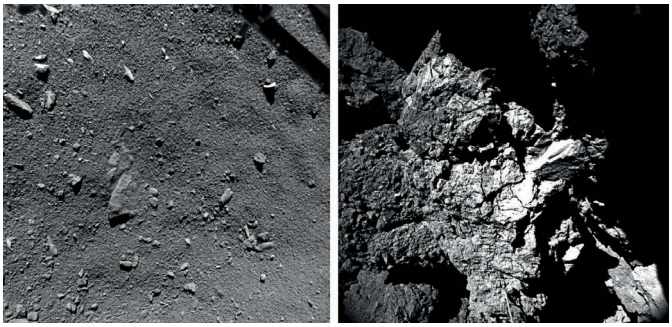
Less energy can be harnessed from the wind than was previously assumed. For example, a 2013 study by the German Federal Environmental Agency concluded that almost seven watts of electrical power per square meter could be generated from wind energy. However, an international research team headed by scientists from the Max Planck Institute for Biogeochemistry in Jena has now shown that the rate is significantly lower. The researchers calculated for the state of Kansas, USA, that a maximum of 1.1 watts of electricity could be generated per square meter. The correlation between the amount of energy generated and the number of wind turbines isn't linear, as more turbines slow down the wind. This is particularly noticeable with very high turbine density. The effect occurs everywhere. The amount of electricity actually generated by wind power varies slightly from one region to another. In Kansas, a lot more wind energy could be used efficiently. However, it is unlikely that it would be feasible to exploit the wind energy potential the Federal Environmental Agency identified in Germany. (Proceedings of the National Academy of Sciences, August 24, 2015)

Expandable only to a limited extent: Wind parks such as this one at Smoky Hills Wind Farm in Kansas, USA.

Messages from the Surface

The measurements recorded by the *Philae* lander on Churyumov-Gerasimenko deliver initial results

The surface dust of the comet 67P/Churyumov-Gerasimenko contains a wide variety of organic molecules. A team of scientists led by the Max Planck Institute for Solar System Research in Göttingen has detected no fewer than 16 compounds. To accomplish this, they used the COSAC instrument aboard *Philae*, which recorded the data shortly after first touching down on the comet on November 12, 2014. Many of the substances are considered to be key molecules for biochemical reactions, such as alcohols, amines and nitriles, which have already been discovered in the gas clouds of various comets; but methyl isocyanate, acetone, propanol and acetamide were also found. The majority of the molecules contain nitrogen, but carbon dioxide and ammonia weren't present. New data from *Philae* also indicates that the first landing site, Agilkia, is covered by a layer of dust around 20 centimeters thick whose pressure resistance is comparable to that of freshly fallen snow. The firmness of its final landing site, Abydos, in contrast, was two thousand times higher. (Science, July 31, 2015)



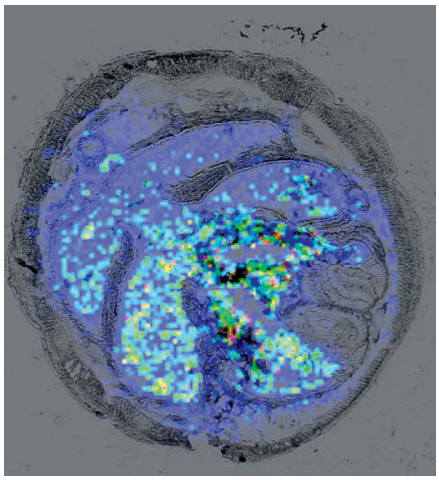
One soft and one hard landing: The left-hand image of the Agilkia landing site was taken using the ROLIS camera from a distance of nine meters, shortly before *Philae* touched down on the comet's surface.

The right-hand image of the final landing site, Abydos, was taken by the CIVA camera on November 13, 2014.

Earthworms Decontaminate Their Food

Worms' antibodies enable them to decompose billions of tons of foliage each year

Up to 300 earthworms live in an area of one square meter. They feed on dead organic matter that provides them with the nutrients they need to survive. But the worms must also protect themselves against toxic organic substances. They succeed in doing so thanks to drilodefensins in their intestines, as researchers at the Max Planck Institute for Marine Microbiology in Bremen discovered. The more toxins found in the worms' food, the more this protective substance forms in their intestines. These molecules coat the food proteins and digestive enzymes in the intestines, preventing the plant toxins from attaching to them. The drilodefensins appear to be extremely useful to the worms, as they recycle the substances several times. (Nature Communications, August 4, 2015)



Cross section of an earthworm. Substances that protect against toxic organic residue (light blue to red) accumulate in the intestines (dark blue).

Repetition Yields Negative Results

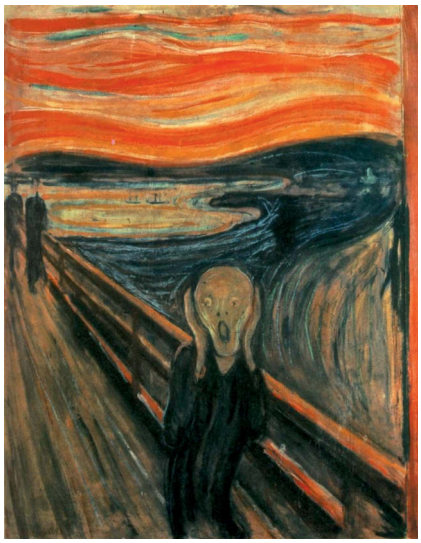
Open Science project attempts to verify 100 psychology studies

How well can psychological studies be reproduced? This question was addressed by an international team of around 300 researchers, including four scientists working with Susann Fiedler at the Max Planck Institute for Research on Collective Goods. Using the Open Science Framework web platform, they compiled data for the reproduction of 100 research studies that were published in 2008 in three prestigious journals. Less than half of the repeated tests produced the same results originally achieved, regardless of the analytical method used. The team emphasized that failure to achieve individual replications didn't necessarily indicate that the original findings were incorrect. Rather, it should be understood that small changes in the context or in the research conditions may have remained undetected despite being of fundamental importance to the achievement of the results. Susann Fiedler also welcomed the fact that science is actively analyzing itself and starting to undertake corrective action to improve the quality and efficiency of the research process. The established incentive system, however, still predominantly rewards the publication of new and surprising research results. (Science, August 28, 2015)

Alarm Signal for the Brain

Acoustic niche ensures impact of screams

Anyone can differentiate a scream from all other sounds, and is put on alert by it. David Poeppel from the Max Planck Institute for Empirical Aesthetics, together with colleagues from New York University and the University of Geneva, have examined why this is the case. The researchers determined that screams have a trait called "roughness." Sounds obtain a temporal structure due to change of amplitude or frequency. When these changes happen very quickly, the ear is no longer able to "break down" these temporal changes – such sounds are then perceived as rough and therefore unpleasant. In this way, screams activate the region of the brain used for processing and remembering fear. (Current Biology, July 16, 2015)



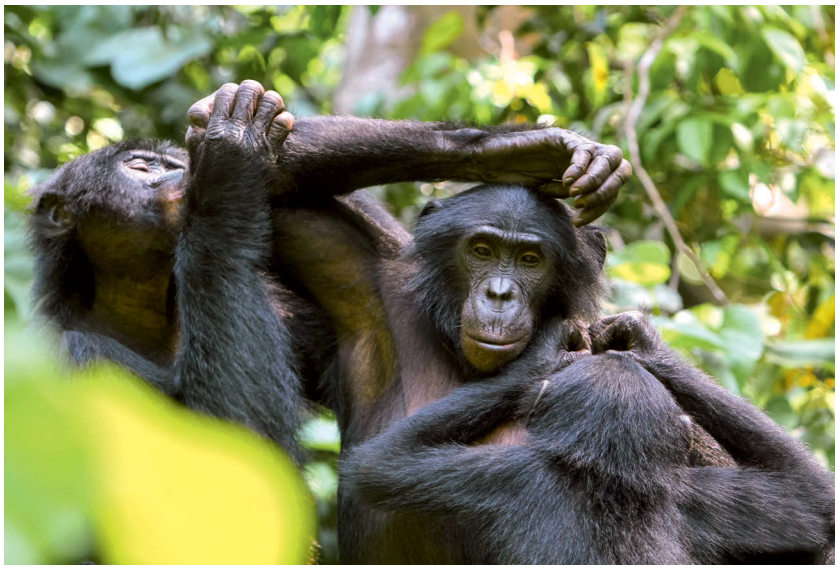
"The Scream" by Norwegian artist Edvard Munch is one of the world's most famous paintings.

Photos: Manuel Liebeke (top), in the public domain (bottom)

How About Getting Together?

Female bonobos communicate their intentions using pointing and pantomime

Humans can describe objects, people and processes through facial expressions and gestures. Such symbolic understanding is a significant part of human communication. Researchers at the Max Planck Institute for Evolutionary Anthropology in Leipzig have observed that bonobos can also communicate in this way. To solve conflicts, female bonobos invite other females to engage in socio-sexual behavior by using pointing gestures and mimicking hip swings, thus peacefully defusing potential conflicts. Sexual contact with other females plays a special role in the process. The observations revealed that the females emphasize a need for physical closeness through pointing and an unmistakable hip swing. The action is performed, as it were, in pantomime. Humans also use similar gestures. Sexual relations in humans were perhaps the motivating force for more complex forms of communication, as gestures and facial expressions play an extremely important role here. (Scientific Reports, September 11, 2015)

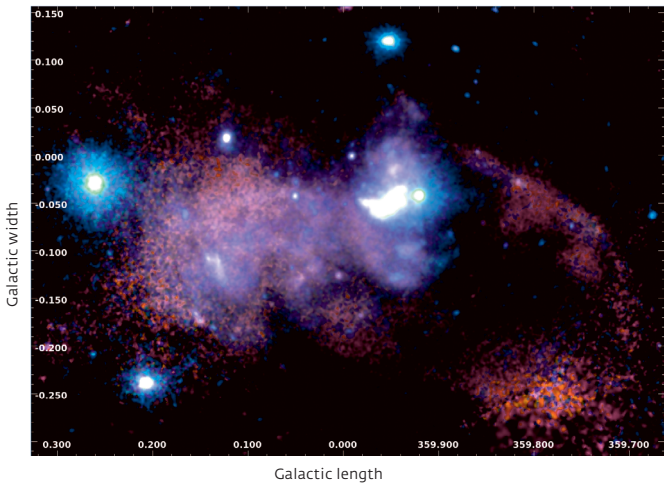


Social interaction among bonobos: The animals also communicate through pointing and pantomime.

The Turbulent Heart of the Milky Way

Using X-ray light, astronomers observe the events around the black hole at the center of our galaxy

Researchers from the Max Planck Institute for Extraterrestrial Physics used the X-ray satellite *XMM-Newton* to X-ray the heart of the galaxy. The best map of the region produced to date shows a pair of bipolar lobes that extend tens of light-years above and beyond the galactic plane and that are centered on the location of the supermassive black hole that is presumed to exist there. Matter and energy in the gas lobes apparently come from three possible sources: outflows from very near the event horizon of the black hole; winds from massive stars orbiting the hole; and catastrophic events associated with the death of massive stars close to it. The team also discovered fingerprints of warm plasma in the outskirts of the region depicted on the map. The processes at the heart of the Milky Way evidently have an impact that extends far beyond this central region. (Monthly Notices of the Royal Astronomical Society, August 20, 2015)



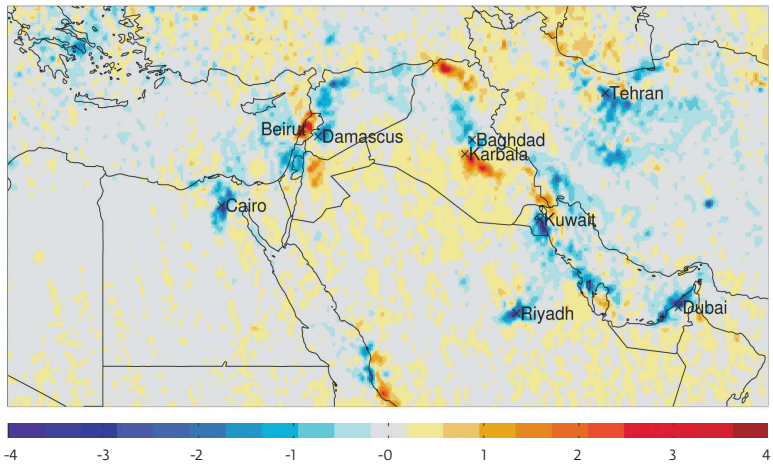
Zoom onto the center: Magnified image of the central 100 light-years around the heart of the Milky Way in the light of the soft X-ray. The galactic black hole and the emission from its surroundings are located in the brightest, central region of the image; the bipolar lobes extend above and below that location.

Photos: LuiKotale Bonobo Project/Zana Clay (top), MPE/ESA (bottom)

Signs of Crisis in the Air

Social tensions impact the quality of the atmosphere

Civil wars, as well as political and economic crises, can have a rapid and dramatic impact on a region's pollutant emissions. That is what researchers at the Max Planck Institute for Chemistry discovered in a study focusing on the Middle East. The scientists analyzed nitrogen oxide pollution in the atmosphere over the last ten years. They determined the data from satellite measurements of atmospheric nitrogen dioxide levels. These indicated that nitrogen oxide emissions fell particularly sharply in regions where armed conflict is taking place – such as Syria – and from where large numbers of people have fled. In contrast, the emissions rose in Lebanon and other regions into which refugees have retreated. "It is tragic that the negative trends we are observing in nitrogen oxide emissions accompany humanitarian catastrophes," says Jos Lelieveld, who headed the study. (Science Advances, August 21, 2015)



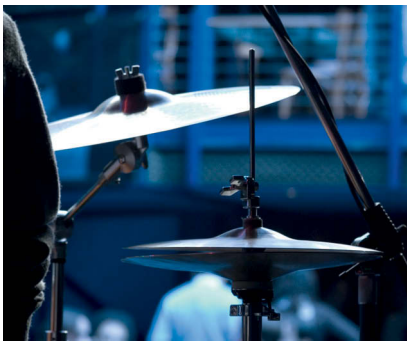
Nitrogen oxide emissions fell in many regions of the Middle East between 2010 and 2014. The colors indicate the changes in the concentration of nitrogen dioxide in 10^{15} molecules per cubic meter of air during the period observed.

Fractals Set the Tone

Self-similar patterns occur in the rhythm and variation of loudness in a drummer's playing

Music may owe its human touch to a mathematical pattern. A team headed by researchers from the Max Planck Institute for Dynamics and Self-Organization in Göttingen and Harvard University in Cambridge, Massachusetts, observed fractal patterns in the playing of Jeff Porcaro, the drummer in the band Toto. This is what mathematicians call self-similar structures, or patterns that resemble one another on a large and small scale. The researchers determined that both the rhythm and loudness of Porcaro's beats vary in a similar way over a whole piece and in just a few bars. People evidently prefer this type of variation: totally precise percussion or beats varied purely at random were perceived as less agreeable. Porcaro is regarded by many fans as setting the standard in drumming. The researchers now want to establish whether fractals also appear in the playing of other musicians. (PLOS ONE, June 3, 2015)

Well-dosed irregularities: Fractal patterns occur in the playing of the drummer of the band Toto.



Baby Blues

The study touches on a taboo: Family happiness doesn't usually occur that quickly after the birth of a child. This is the conclusion reached by Mikko Myrskylä of the Max Planck Institute for Demographic Research and Rachel Margolis of the University of Western Ontario in an analysis of data from a socio-economic panel. On average, mothers and fathers rated their life situation in the first year of parenthood as being 1.4 satisfaction levels lower than in the previous two years. Only just under 30 percent indicated no decline in satisfaction. Over a third of parents revealed a decline of two or more satisfaction levels. Satisfaction falls by only around one level on average as a result of unemployment or the death of a partner. The evaluations also show how experience with the first child influences the chances of a second child being born. Of 100 parents who indicated a drop of two or more satisfaction levels, only around 60 percent had a second child within 10 years. (Demography, August 2015)

Photos and graphic: Science Advances 2015/MPI for Chemistry (top), iStockphoto/panzer72