The Genetic Diversity of Rice

A map showing which genetic changes result in specific characteristics might make breeding new varieties more straightforward.

It might be easier to breed new varieties of rice in the future. A database now shows breeders which genetic modifications give rise to specific characteristics in rice plants. An international team of researchers, including scientists from the Max Planck Institute for Developmental Biology and the Max Planck Society’s Friedrich Miescher Laboratory in Tübingen, found 160,000 differences in the genes of 20 rice varieties and used the information to create a variation map. Many of the changes affect metabolic processes such as production of amylose, a sugar, or of cellulose. The variation map could also help identify which genes are important for breeding rice varieties that give better yields or are more nutritious or more resistant to drought. It also shows the scientists which varieties were used to breed the rice plants in use today. It appears that the first rice breeders crossed rice plants from India and Africa with other varieties in order to make them more resistant to drought and to high salt levels in the soil. (PNAS, July 13, 2009)

Genetic variation in rice can explain both the visible differences between the different varieties and their preference for certain environmental conditions – for example, whether they thrive in the lowlands or at higher altitudes.

Getting to the Root of Dangerous Hairs

A short circuit can be quite hairy. Satellites have failed, a NASA computer center was repeatedly paralyzed, and the US public health authority recalled thousands of pacemakers – all because tin hairs sprouting from the solder and plating of copper components caused the devices to short-circuit. A team of scientists from the Max Planck Institute for Metals Research working with Robert Bosch GmbH measured in detail the forces that trigger this metallic hair growth. According to their findings, the pressure of the tin atoms at the root of a hair, which is called a whisker in technical jargon, must be lower than the pressure further away. Furthermore, this difference in pressure must exist in every direction throughout the layer of tin. The result is similar to what happens in a tube of toothpaste: squeeze the sides and the toothpaste comes out the top. The pressure builds up because an intermetallic compound forms at the interface between the tin and the copper and forces its way into the layer of tin. The tin whiskers can be up to several millimeters in length and just a few micrometers in diameter. An accurate understanding of how they grow could help prevent them. (Applied Physics Letters, June 2009)

A highly magnified metal hair: This image from an ion beam microscope shows the form in which a tin whisker grows.
**Do You Speak Formula?**

Mathematical syntax is processed in specific areas of the brain

Like language, mathematics has grammar rules. However, our brain makes use of significantly more areas to analyze mathematical formulas than it does to understand the natural language that we speak. In order to process mathematical grammar, or syntax to be more precise, the brain also activates areas that are involved in solving brain teasers. Scientists at the Max Planck Institute for Human Cognitive and Brain Sciences use these findings to explain why the weather forecast makes more sense to us than the statement “If a is less than b and b is less than c, then a is less than c.” The researchers asked their subjects to read formulas without any numbers in order to distinguish between the processing of mathematical syntax and the processing of number values.

Nevertheless, the functional magnetic resonance tomograph revealed activity in the intraparietal sulcus (IPS), where numerical awareness is located. Other areas that work on the analysis of formulas are located around the Broca’s area, the actual language processing center, and the left frontal cerebral cortex.

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**Generosity Pays**

Generosity could help the music industry escape the plight to which it has been brought by illegal music downloads. The online music label Magnatune is setting an example. It allows its customers free and unlimited access to music streaming before they make a purchase so that they can get an idea of how the music sounds before they buy an album. Researchers at the Max Planck Institute for Economics think that this generosity is the reason for consumers’ subsequent generous spending. They set a price between $5 and $18 for an album themselves and pay on average USD 8.20, or 64 percent more than the minimum required and also more than the USD 8.00 Magnatune recommends. If people were only out to maximize their profits, as economists have long suspected, they would offer the bare minimum. Various tests show that the amount paid depends very much on the fixed price range and on the recommended purchase price. (JOURNAL OF ECONOMIC BEHAVIOR & ORGANIZATION, August 2009)

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**A Sky Full of Fungi**

There are more types of fungal spores floating in the air than previously thought. Scientists at the Max Planck Institute for Chemistry have used DNA analysis to identify several hundred types of fungi. One cubic meter of air contains between 1,000 and 10,000 fungal spores. In order to find out what type they are, the researchers filtered fine and coarse dust from the air and examined its genetic content. Using various types of genetic tackle, they fished the genes of different types of fungi out of the gene soup. The researchers are mainly interested in fungal spores because they act as biological aerosol particles and play a role in the climate. The spores can function as condensation and crystal nuclei on which water precipitates or freezes. The spores thus contribute to the creation of clouds, fog and precipitation. Fungal spores also indicate how climate change is affecting ecosystems. Finally, they trigger allergies and cause disease in humans, animals and plants. Knowing which fungi are present in the air might help combat these ill effects. (PNAS, July 13, 2009)
Full Sight with One Brain Hemisphere

One brain hemisphere is able to process information from both eyes

The neurologists must have doubted their MRI scanner when they examined the girl they presented to the world as AH: The right hemisphere of her brain was missing. The fact that AH suffered only slightly restricted movement and minor convulsions was thus surprising. Max Planck scientists have now established that even her eyesight is almost as good as that of a person with a complete brain. This is astonishing because, normally, the left hemisphere of the brain processes the right-hand field of view, and the right hemisphere handles the left-hand field of view. “A case where half of someone’s brain can represent the whole field of vision has never been described before,” says Wolf Singer, Director at the Max Planck Institute for Brain Research. The researchers suspect that, due to a developmental failure, the right hemisphere stopped growing about a month after fertilization. It appears that, at that point, the brain is able to compensate for such massive damage itself. One reason for this is that all the nerve fibers from the left eye can still be diverted to the left hemisphere.

Bats Can See Color

Even notorious night flyers find the ability to see color helpful. Researchers at the Max Planck Institute for Brain Research and the University of Oldenburg have found cone cells – sensory cells with pigment for color vision – in the retina of two types of bats native to Central and South America. As cone cells are useful only in daylight, they make up no more than 4% of the visual cells. The remaining visual cells are rods, which are sensitive to light and dark. They allow nocturnal creatures to see well – although only in black and white – even when light conditions are poor. The scientists have found two different types of cone cells: L-cones, which respond to yellow-green light, and S-cones, which are sensitive to ultraviolet light. The UV-sensitive visual cells could help these bats find food, as they collect pollen and nectar from flowers, and many flowers reflect UV light. The color-sensitive cells also help the creatures orient themselves in the twilight and see birds of prey, at least at distances of more than ten meters. They completely rely on echo location over shorter distances. (PLoS One, July 28, 2009)

A Butterfly with Baggage

Some Monarch butterflies will soon be loaded with ballast as they fly thousands of miles from Mexico to Canada. For the first time, researchers from the Max Planck Institute for Ornithology and Kansas University attached radio transmitters to the abdomens of butterflies, fed them well and then sent them on their way as part of an experiment. Although the transmitters are tiny, they weigh half as much as the butterflies themselves. Their purpose is to reveal more about Monarch butterfly migration. In two or three generations, the creatures move north from their winter quarters in Mexico’s Sierra Nevada. Some of them reach the Great Lakes in Canada. The next generation then manages the 3,600 miles back to Mexico in the late fall. The researchers want to compare the data on butterfly migration with that of whales, birds and bats. They may then be able to derive laws with which migration phenomena, such as that of the migratory locust, can be predicted.
A Powder to Prevent Energy Waste

Max Planck chemists use a simple method to convert methane to methanol, which might make it possible to access previously unusable natural gas. It might no longer be necessary to burn off natural gas. Scientists at the Max Planck Institute of Colloids and Interfaces have developed a catalyst that simply and efficiently converts methane, the main constituent of natural gas, into methanol. The catalyst is a powder consisting of a nitrogenous material, a covalent triazine-based framework (CTF), into which platinum atoms have been inserted. CTF is very porous and thus has a large surface area, giving the methane ample room to react. This is what makes the catalyst so efficient, and because it is a solid, it is also easy to handle. It could also be worthwhile to use it to convert methane to methanol where other chemical processes or even a pipeline are not economical. It might then no longer be necessary to burn off more gas during oil extraction worldwide than is consumed by Germany each year. The process could also be helpful in tapping unprofitable sources of natural gas. It is currently estimated that natural gas resources will last another 130 years; however, the reserves where extraction is economical will flow for no longer than the next 60 years or so. (Angewandte Chemie Int. Ed., in press)

Molecules in a Microtrap

The way Sam Meek and his colleagues manipulate molecules on a chip is reminiscent of the skills of a soccer player: in the same way as he intercepts a pass with a deft movement of his leg, holds the ball still and then shoots it into the back of the net, these researchers at the Fritz Haber Institute of the Max Planck Society use electric fields to slow down carbon monoxide molecules and then speed them up again to be picked up by a detector. All of this happens over a distance of just five centimeters. What is more, the molecules move approximately ten times faster than a ball with a powerful boot behind it. Using 1,240 gold electrodes, the physicists control how the electrical fields, which catch the molecules as they fly past, move the molecules over the chip. Their clever trick makes it easier to carry out experiments with gas molecules. Such experiments could bring new knowledge about chemical reactions in industry or in the atmosphere. Previously, this required very large and expensive pieces of equipment. (Science, June 26, 2009)

A Giant in Turmoil

It’s a form of astronomical end-of-life care: an international team working with researchers from the Max Planck Institute for Radio Astronomy observed a dying giant star in better resolution than ever before. The astronomers used the Very Large Telescope Interferometer (VLTI) on Cerro Paranal in Chile to observe Betelgeuse, which is the bright orange star that sparkles at Orion’s left shoulder. They found that the atmosphere of the star creates gas bubbles that move up and down at speeds of around 40,000 kilometers per hour. The bubbles explosively eject material and become as large in diameter as the orbit of Mars around the Sun. This makes the bubbles almost as large as Betelgeuse itself—which, if it occupied the same place as the Sun, would swallow up Mercury, Venus, Earth, Mars and very nearly Jupiter, too. (Astronomy & Astrophysics 2009)
Gone with the Wind – A Volcanic Plume

The jet stream drives gas and ash toward Europe at speeds of 540 kilometers per second

The monitoring flight was almost over and the Leverkusen was approaching Frankfurt airport when it snatched a few more air samples – and these were very special ones. The aircraft with the Caribic project’s measurement container on board flew through the plume that the Kasatochi volcano had ejected the previous week. However, the researchers from the Max Planck Institute for Chemistry in Mainz did not discover this until later. The volcano is situated in the Aleutians, a chain of islands in Alaska. When it erupted, it sent 1.5 million tons of sulfur dioxide several kilometers into the air. The jet stream, a wind that blows at an altitude of more than ten kilometers, must have blown the cloud of gas and ash to Europe at speeds of 540 kilometers per hour. This was the only explanation that the chemists from Mainz could find for the concentration of sulfur, which was ten times higher than expected, and for the quantity of very fine dust particles, which was as much as 1,000 times greater than normal. Besides the sulfur, they also detected large quantities of carbon in the plume. These findings highlight the role that volcanic eruptions play in the climate: particles containing carbon, often dark soot, have the potential to warm the atmosphere because they absorb sunlight. Sulfurous particles, on the other hand, cool the atmosphere because they reflect light. The results can also be interpreted as a natural test run for the idea of “seeding” the atmosphere with sulfuric acid as a coolant.

Greedy Andromeda

Astronomers have never been so close to galactic cannibalism. An international team including researchers from the Max Planck Institute for Astronomy has observed stellar streams in the vicinity of the Andromeda Nebula in greater detail than ever before. The streams reveal that the galaxy has used its strong gravitational pull to consume smaller star systems. As part of the Pandas project, short for Pan-Andromeda Archeological Survey, the scientists discovered traces of six acts of cannibalism, including the remains of two as yet unidentified victims. They also found that Andromeda is already nibbling at the next one. A plume of stars extends toward Andromeda from the Triangulum Nebula. It was previously thought to be a companion to Andromeda and not in danger, but the plume indicates a past collision. Simulations created by the team show that Andromeda will also consume this nebula in the long run. (Nature, September 3, 2009)

The Thymus Arrived with the Sharks

The thymus gland acts as a kind of training camp for special units in the immune system, where lymphocytes, a group of white blood corpuscles, specialize in offering an immune response to specific intruders. Scientists at the Max Planck Institute for Immunology in Freiburg have been tracing the origin and evolution of this organ. They found that the thymus first appeared around 500 million years ago based on already existing genes in sharks, the first animals in which it was shown to exist and in which also the crucial Foxn1 gene was first detected. Foxn1 contains the blueprint for a transcription factor that triggers the formation of the thymus. However, that on its own is not enough, because immature lymphocytes need to spend some time in the thymus in order to develop. In

The end in sight: A simulation shows that Andromeda – the circular disc to the right of the center – will eventually consume the Triangulum Nebula. In the stroboscopic projection, the shape of the Triangulum Nebula changes under the influence of the gravity exerted by the larger galaxy.

Illustration: John Dubinski (bottom), photo: Chris Waythomas, AVS/USGS (top)
A Switch for Blood Vessel Growth

Max Planck researchers have identified the biochemical instruction that spurs blood vessels into growth. It is a protein called Jagged 1. At the same time, they have explained how all the different players in blood vessel development interact. Biologists have known about Jagged 1 for some time. It performs functions in various organs. The protein binds to the notch receptor on blood vessel cells and acts like a switch for the growth of new blood vessels. As scientists at the Max Planck Institute for Molecular Biomedicine in Münster have established, Jagged 1 sets the switch to “on.” The cell is then receptive to the VEGF growth factor and divides, creating a new vessel. The adversary to Jagged 1 is Delta-like 4, or Dll4 for short. This protein turns the switch to “off.” Such detailed knowledge of the mechanism could help develop cures for various diseases. Systematically allowing blood vessels to grow could prevent or repair damage from a heart attack or stroke. It might also be possible to use the method to integrate transplanted organs into the blood circulation more quickly. On the other hand, the mechanism might help slow the growth of tumors if doctors can stop new blood vessels from developing in them.

(Cell, June 12, 2009)

Counting on Interference

Turning a weakness into a strength is something only therapists – and physicists – can do. An international team of researchers, including members of the Max Planck Institute for Quantum Optics, has proposed a way of using interference for quantum calculations. Up to now, physicists have been in agreement on the fact that it is possible to build a quantum computer only if its central processing units, the quantum bits, can be protected from interference. Quantum bits are very susceptible to interference, but it is very difficult to avoid, as any contact with the environment gives rise to interference. The researchers have thus worked out a calculating specification in which they use the contact with the environment for mathematical operations. However, this works only under one condition: the physicists must know exactly what the external influence does to the quantum bits. The interference could put the quantum bits in a state that holds the result of the calculation. The researchers’ want to use their proposal to show their colleagues that it is worth asking whether a disadvantage can be turned into an advantage.

(Nature Physics, September 2009)