Maths and artwork on the lizard's back

The spots on some lizards' skin seem to speak with each other while they organise themselves into patterns

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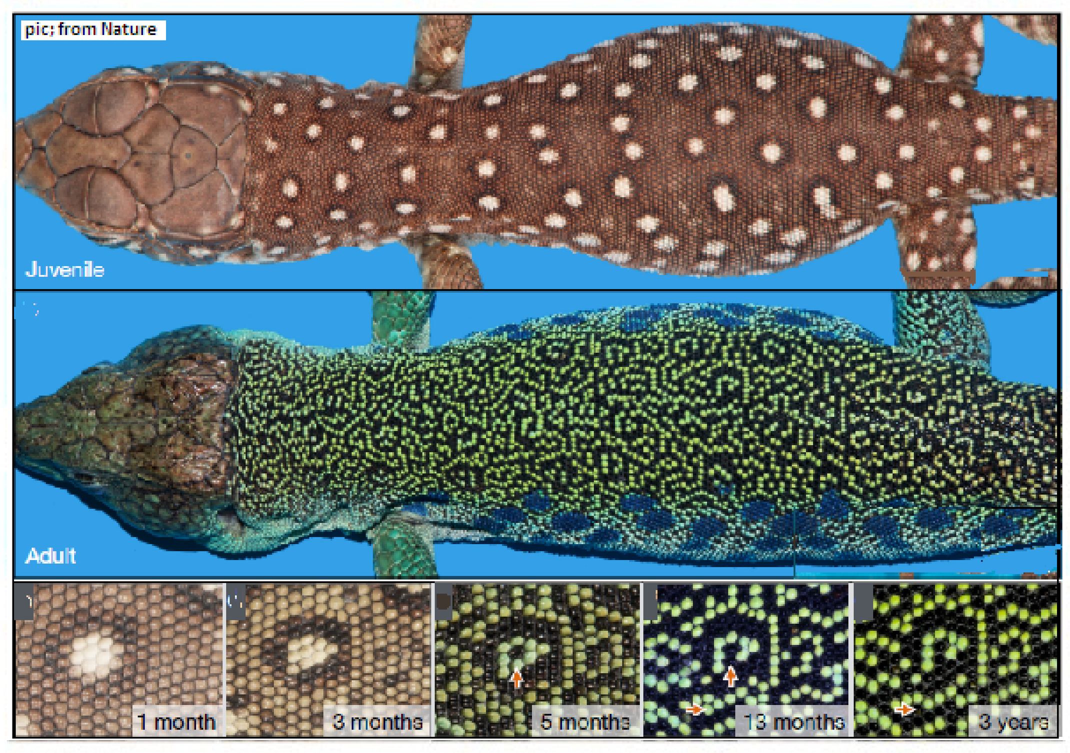


It is evident that the coloured stripes and spots on animal coats are adapted for camouflage and sometimes to help draw attention of prospective mates. The mechanism, by which these patterns form, however, has been a subject of conjecture.

The legendary mathematician and pioneer of digital computing, Alan Turing, first applied the mathematical methods of his fields to examine how shapes or colours appear in living things. The ideas of Turing, which are based on diffusion of possible form-giving agents, called morphogens, from cell to cell, have been carried forward and there are now ways to explain the appearance of colour patterns and even ridges or shapes in living things. Further work has suggested what these agents of form may be — even genetic factors that bring about specific patterns, like the stripes on rodents' backs, have been identified.

Liana Manukyan, Sophie A Montandon, Anamarija Fofonjka, Stanislav Smirnov and Michel C Milinkovitch from the departments of genetics, bio-informatics and mathematics at the University of Geneva and the Skolkova Institute and the University of St Petersburg in Russia, report in the journal, Nature, the working of a known computing model that shows up in the formation, and then variations, of the patterns of spots on the back of Timon Lepidus, a lizard, found in Europe, whose back is decorated with motifs that look like eyes. The lizard is also called the ocellated (with eyelike spots) lizard, eyed lizard or the jewelled lacerta.

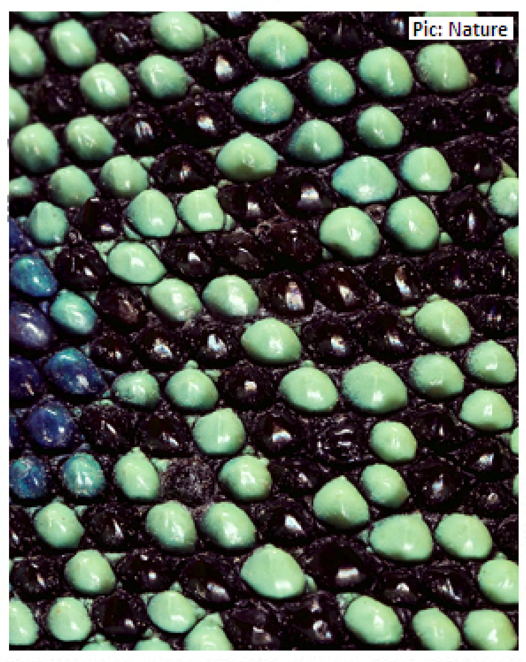
Turing considered that chemical agents may interact and diffuse from cell to cell, at different speeds, so that different patterns of growth appeared along lines or at spots where the agents reinforced. Mathematical treatment of the idea could explain shapes taken by small groups of cells, like the tentacles that grow on the animal, hydra and the patches that appear on the coats of a breed of cows called Friesian cows. The principles have been extended and there is now explanation, based on the interplay of waves of different agents, for the stripes of the tiger or the zebra, the leopard's spots and even the spots on the body, but the stripes on the tail of the cheetah.

The movement of the growth agents, which lead to these patterns, is pre-natal, at the time cells are still being generated in the embryo. The patterned coats are hence fully formed when the animal is born. In the case of the ocellated lizard with the eyelike spots on its back, however, the pattern is more than a distribution of stripes, spots or ridges, or even limbs and protrusions, but is a pattern of more complex shapes. And what is more, the pattern is not fixed at birth but changes as the animal grows!

The group of researchers writing in Nature observe that lizards and snakes display a variety of colours and patterns. The lizard relies on different kinds of cells — those that create colours by structural effects and interference colours of light on cells that have different pigments. Some lizards, like the chameleon, can muscularly adjust the position of units responsible for colours and change them.

The pattern on the skin, however, is generally a result of the distribution of cells, itself a result of the reaction-diffusion mechanism, as analysed by Turing. The same mechanism, however, does not seem to fit the case of the ocellated lizard, the Nature paper says. In that case, the patterns are created by the positioning of larger dimension scales of skin, rather than at the individual colour-giving cell level. The pattern even changes, from white eye-like dots on a brown background on the back of young lizards, to a "labyrinthine pattern" in green and black when the lizard grows to adulthood, the paper says.

The group used a mechanised observation arrangement to create a record of changes in the skin pattern of three male ocellated lizards, from the age of two weeks to three or four years. High resolution scans of the lizard skin were recorded, every two weeks at the start and once every four months towards the end, because the changes in the patterns are slower when the animal is older. The progression of the pattern can be made out in the third panel in the picture.



Analysis of how the pattern develops, the paper says, revealed that the spots are distributed according to the working of a mathematical rule known as the "cellular automaton". The cellular automaton, which finds application in other fields of study, like computability, complexity and physics, is a grid, or a framework of cells, each of which starts out in a state, like black or green. The pattern so formed then evolves, with each cell changing its state at each instant by following some rule that depends on the states of the neighbouring cells. The same rule is applied to all the cells and they change state simultaneously. We can see that there is mutual dependency of clusters of cells and the distribution could tend towards a pattern that would have elements of regularity and still show a great degree of randomness, as seen in the "labyrinths" on the lizards' backs.

With some 5,000 scales being detected at each scan, the team retrieved the information of the state of the neighbours of each scale. The pattern on the young lizard was of about 60 white ocelli (eye-like spots), each composed of five to 17 scales, surrounded by scales of almost uniform brown. Gradually the scales changed colour, the lighter ones turning green and the darker ones turning black.

But the colours did not stay fixed — the individual scales continued to change colour, from green to black and from black to green. Some 1,500 were found to do this, throughout the animal's life. "This causes a gradual qualitative change of the pattern — the outlines of the original ocelli become obliterated and the pattern turns into a labyrinthine assortment of contrasting black and green chains of scales," the paper says.

The function of the adult pattern, the paper says, is unknown but may be for camouflage, as the pattern disrupts the outline of the animal itself. The fact that the evolution of the pattern corresponds to a mathematical procedure, however, is significant. It is another instance of nature, with the help of genetic mechanisms, using the most energy conserving method to attain configurations that match the needs for the survival of living things.

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Then came the microscope

The discovery and oft-forgotten contribution of this humble yet indispensible instrument in light of a startling new invention

A 10-day-old mouse embryo as seen through the Mesolens

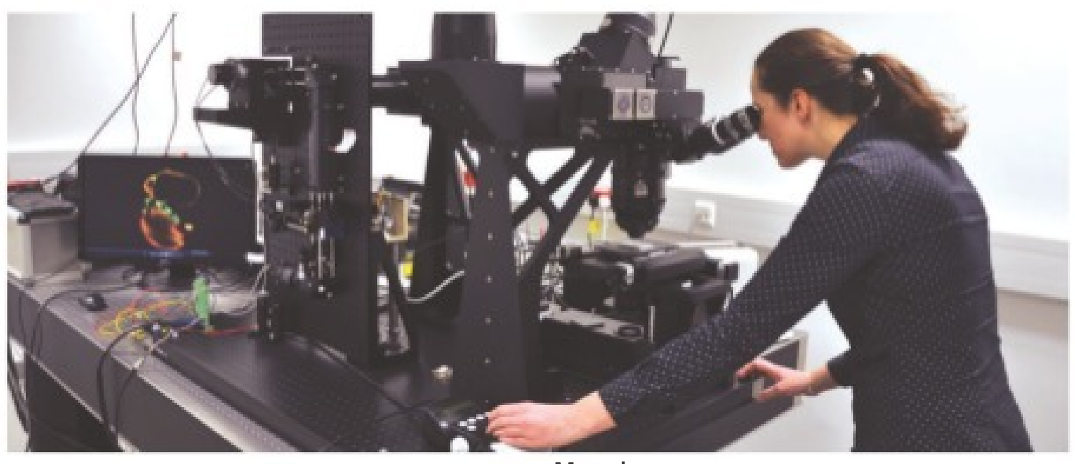
DEEPAK RIKHYE

Early scientists used an item that was destined to be omnipresent in a laboratory — the microscope. 70-year-old Bradshaw Amos has spent most of his time studying a different and very tiny world, also through a microscope. He is a visiting professor, at the University of Strathclyde, Scotland, and works with a team of researchers; they are in the process of designing a large, new, microscope lens, about the length and width of a human arm and the lens is perceived as a significant innovation. The Mesolens is so powerful that it can image entire tumours or even mouse embryos, in one field of view, while simultaneously imaging the insides of cells.

For hundreds of years, optical microscopes have allowed living tissues to be studied in fine detail. Unfortunately, images captured through a typical microscope lens feature a compromise between the level of detail in the image and how much of the sample can be shown. Densely packed individual cells cannot be distinguished in an image that shows an entire mouse embryo. This accentuates the importance of the Mesolens because it can magnify samples to four times, in higher detail than conventional lenses.

Current optical microscopes, which have a low numerical aperture, provide very little depth of resolution to perform well in non-linear microscopy; non-linear is when an image is not conforming to a straight line and demands more clarity. Subcellular details can be resolved effectively when the optical lens system enables 3D imaging of objects up to six mm wide and three mm thick with depth of just a few microns. Ultimately, the Mesolens has the potential to be used in different applications and could assist in many biological studies in the future. The company, McConnell et al, will further test the efficiency of the Mesolens in the realm of microscopic techniques.

After reading about advancements involving the creation of the Mesolens, it is necessary to trace how the first microscopes were invented, in the 16th and 17th centuries. In fact, Amos stated that early microscopes were unimpressive and were not much stronger than a handheld magnifying glass. Amos was attracted to the magical world primarily due to a microscope he was presented with when he was a kid. His fascination of the wonders afforded by a microscope drove him to insatiable limits as he explored many forms of images, from bubbles, to the tip of a needle. The microscope's intriguing domain will forever be the cause for exciting and inspirational findings. Let us now look back at the first incredible discovery of a microscope, some centuries ago.



Mesolens

Bradshaw Amos

A Dutch father-son team, Hans and Zacharias Janssen, invented the first compound microscope in the late 16th century. They discovered that if they put a lens at the top and bottom of a tube and looked through it, objects at the other end were magnified. Magnification at this initial stage of discovery was only between 3x and 9x. Although a magnified view was provided, the first compound microscopes could not increase resolution and that caused the magnified images to appear blurred. Thereafter, no significant scientific breakthrough resulted for about 100 years, asserted Steven Ruzin from the University of California, Berkeley.

By the late 1600s, improvements to lenses increased the quality of images. In 1667, English scientist, Robert Hooke, published his enlightening book, *Micrographia*, with intricate drawings of distinct specimens and detailed sections, within the branch of an herbaceous plant. He called the sections cells because they reminded him of cells in a monastery. Hooke thus became the father of cellular biology.

In 1676, a Dutch cloth merchant, turned scientist, Anthony van Leeuwenhoek improved the microscope; he only intended to view the cloth he sold by checking it through a microscope, but in a surreal coincidence, he unintentionally discovered bacteria! His accidental finding created the field of microbiology and what has now evolved as a foundation of modern medicine.

In 1677, Leeuwenhoek identified human sperm for the first time, by checking the ejaculate of a patient suffering from gonorrhea; he saw through a microscope "tiny wriggling tailed animals." Although he published these findings, as with bacteria, 200 years passed before the scientific world understood the true significance of this discovery.

Moving to the 1800s, German scientist, Walther Flemming, discovered cell division, which decades later clarified how cancer grows. These spellbinding discoveries would have been impossible without microscopes.

In 2014, a team of German and American researchers were awarded the Nobel Prize, for devising a methodology called super-resolution fluorescence microscopy, which is so powerful that scientists can track single proteins as they develop within cells. This path breaking method makes cells glow or "fluoresce" and has the potential to combat Parkinson's and Alzheimer's.

Gary Zukav, in his remarkable book, *The Dancing Wuli Masters: An Overview of The New Physics*, writes about humanity's quest for the unattainable. It includes scientists who have, over the centuries, been involved with the development of microscopes. Through the instrument, they have enlightened the world of every finding — from the tiniest cell to the living embryo of a mouse.

PLUS POINTS

At its most distinct

Jupiter has been captured in unprecedented detail in this new image released by Nasa.

The photograph, taken by the Hubble Space Telescope, views the gas giant at "opposition" — in a position directly opposite the Sun and the Earth. At the time the photograph was taken, all three were aligned, with the Earth between the Sun and Jupiter. At this point, the planet's colourful atmosphere was on full display, since it was at its closest point to the Earth, around 415 million miles away.

Jupiter is the largest planet in the solar system, with a mass two-and-a-half times the size of all the other planets combined. Its atmosphere is divided into a number of distinct, colourful bands that run parallel to the equator.

The proximity of the planet on 3 April allowed a team led by Amy Simon from Nasa's Goddard Space Flight Centre in Maryland, US to capture details in Jupiter's atmosphere as small as around 80 miles wide. Distinct in the photograph is Jupiter's well known Great Red Spot, an anticyclone, or zone of high pressure, which has been observed for at least 150 years.

The storm is larger than Earth, but is slowly shrinking and becoming more round, although it is not known why. Scientists hope photographs such as those taken by the Hubble telescope will help them explain the phenomenon.

The space agency timed the Hubble observation to coincide with when its Juno probe would be near its closest point to Jupiter, so scientists could get concurrent pictures.

The Hubble Space Telescope was launched into the Earth's orbit in the 1990s and from its position has been able to record some of the most detailed photographs of space ever.

the independent

Loneliness worsens cold

If you are lonely, symptoms of the common cold may be more pronounced, according to researchers at Rice University, Texas, US.

A study led by Rice University psychologist Chris Fagundes and graduate student Angie LeRoy indicated lonely people are more prone to report that their cold symptoms are more severe than those who have stronger social networks. A paper on the study was published in Health Psychology.

A total of 159 people aged 18 to 55 were assessed for their psychological and physical health, given cold-inducing nasal drops and quarantined for five days in hotel rooms.

The participants, scored in advance on the Short Loneliness Scale and the Social Network Index, were monitored during and after the five-day stay. After adjusting for demographics like gender and age, the season, depressive effect and social isolation, the results showed those who were screened in advance for their level of loneliness and became infected reported a greater severity of symptoms than those recorded in previous studies used as controls. The size of the participants' social networks appeared to have no bearing on how sick they felt.

The effect may be the same for those under other kinds of stress, Dr Fagundes said in a statement by the university. "Any time you have an illness, it's a stressor, and this phenomenon would probably occur," he said, "A predisposition, whether it's physical or mental, can be exaggerated by a subsequent stressor. In this case, the subsequent stressor is getting sick, but it could be the loss of a loved one, or getting breast cancer, which are subjects we also study."

samantha boh/the straits times