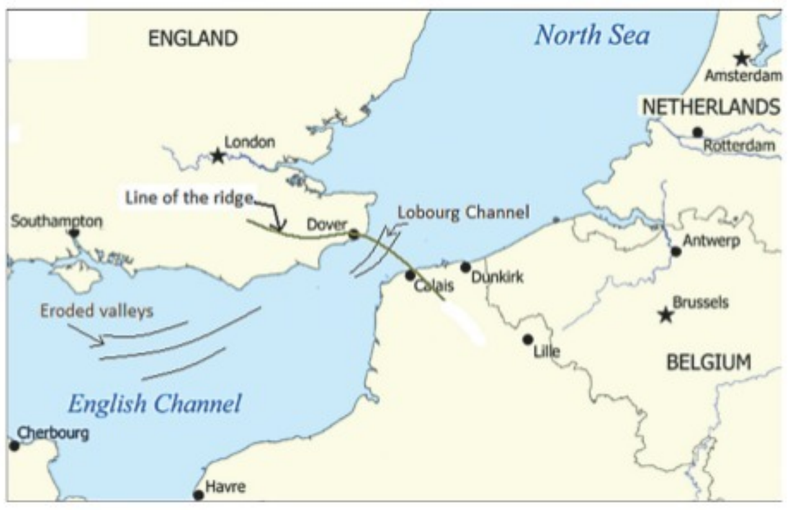
The Brexit nobody voted for

Great Britain has a long history of separating from the European landmass

S ANANTHANARAYANAN



Much of the British Isles is known to be a mound of chalk, deposited over ancient bedrock and covered with soil, except at Dover and plain of Salisbury, where the whiteness is exposed. A wall of chalk continues eastwards under the English Channel and appears again at Cap Gris Nez, on the French coast. A chalk ridge is understood to have once bridged the channel and theories of how it came to be breached have remained conjectures.

And in the same week that Prime Minister Theresa May has set in motion the UK's economic separation from the European Union, Sanjeev Gupta, Jenny S Collier, David Garcia-Moreno, Francesca Oggioni, Alain Trentesaux, Kris Vanneste, Marc De Batist, Thierry Camelbeeck, Graeme Potter, Brigitte Van Vliet-Lanoe and John CR Arthur from institutes in London, Somerset and Surrey in the UK and in Belgium and France report in the journal, *Nature Communications*, recent improvements in our understanding of how the physical, chalk connection between the British Isles and mainland Europe gave way to the English Channel. "This is Brexit 1.0 — the Brexit nobody voted for," remarks Gupta of Imperial College, London.

The chalk in the White Cliffs of Dover, extending across the Channel to north-west France, was deposited on the rock below in a warmer world a hundred million years ago, when this part of the Earth was under water. Calcium carbonate, in the shells of single celled algae, the Coccoliths, sank to the bottom of the sea and gradually built up the mound that forms large parts of present day Britain. Rising of the Earth's crust and recession of sea water into ice sheets when the planet cooled lifted the land mass into view, with the British Isles connected by the chalk ridge with the rest of Europe. And then, during the ice age, 450,000 years ago, the waters receded even more and the entire English Channel was dry, a frozen landscape covered, at best, by sparse shrubbery.

The current understanding of how the chalk ridge was worn down and the now busy waterway, the English Channel, came to be, is that melting of icebergs created a vast pond in the North Sea, and the water was held back from flowing further south by the wall of chalk between Britain and Europe. Continued melt and discharge from rivers, the paper says, led to a spill-over, which breached the wall and released a "mega-flood" into the low lying plain beyond the ridge. There is a network of valleys eroded in the bedrock in centre of the English Channel, which have the signs of "high magnitude flood flows" that have been interpreted as the result of "catastrophic drainage" of the build-up of glacial water, the paper says.

There are also other models of both less violent and sudden breakdown of the barrier, where the lake to the north of the chalk ridge need not be proposed, or where there are other explanations for the furrows eroded in the downstream channel. The models, however, have not been tested, as there is little detailed data about the geological features of the sea bed in the places where the chalk ridge is considered to have been breached, the paper says.

The first significant bit of information about the Channel seabed was what was discovered when the route for the Channel Tunnel, the undersea rail link between England and France, which runs as deep as 75 metres below the sea bed, was being surveyed. The direct route revealed a set of kilometres-wide depressions in the rock, filled with sand and gravel sediment. How the depressions, which were named Fosse Dangeard (the word, fosse means deep), arose was not understood but the tunnel route had to be changed. An explanation of the depressions being caused by the waterfalls, which is like what has now been found to be the case, was attempted, but dropped for lack of detailed data to support the idea.

What the authors of the paper in *Nature Communications* have now done is to collate a great deal of the latest information, from maps of the seabed, geophysical data and maps of the bedrock, obtained by bouncing shock waves off the sea bottom, to piece together an explanation of how the data could all fit together. While the depth map was created using sonar based seabed surveys, the map of the bedrock was created using seismic reflections where vibrations that pass through the seabed get partially reflected when they meet the underlying bedrock. The reflected waves are picked up by an array of sensors and the structure of the reflecting surface can then be worked out.

The depth map of the seabed shows a path of flow, a valley, the Lobourg Channel, which passes through the Dover Strait and into a network of valleys eroded in the bedrock further southwest, the paper says. The continuity of the Lobourg Channel and the eroded network downstream suggests that they form part of the same drainage system. And then, the path of flow, in the central part of the Dover Strait, contains the enigmatic collection of one-to-four kilometres-wide depressions. This group, the Fosse Dangeard, consists of seven main depressions, which go down as far as 140 metres deep, with flank slopes as steep as 15?. Detailed analyses of the orientation, disposition and the nature of sediment with which the depressions are filled indicate that they are plunge pools, drilled into bedrock where kilometre-wide waterfalls landed, just as was suggested by Alec Smith, Bedford College, London, in 1985. It is difficult to reconcile the depth of these features with any process of formation by flow of water or tidal erosion, the paper says. The depth of erosion, in fact, suggests that the waterfall was from substantial height, the paper adds.

The picture painted is thus of "a huge rock ridge made of chalk joining Britain to France, looking more like the frozen tundra in Siberia than the green environment we know today — a cold world dotted with waterfalls plunging over the iconic white chalk escarpment of the White Cliffs of Dover," to use the words of Jenny Collier of Imperial College. While this was the landscape of waterfalls is the first stage of the collapse, that explains the depressions in the seabed, it appears that this was the first stage, to be followed by a second, catastrophic breakdown and flood, that explains the erosion of valleys the bedrock downstream. "Perhaps part of the ice sheet broke off, collapsing into the lake, causing a surge that carved a path for the water to cascade off the chalk ridge and an earth tremor weakened the ridge and caused the chalk ridge to collapse," says Collier.

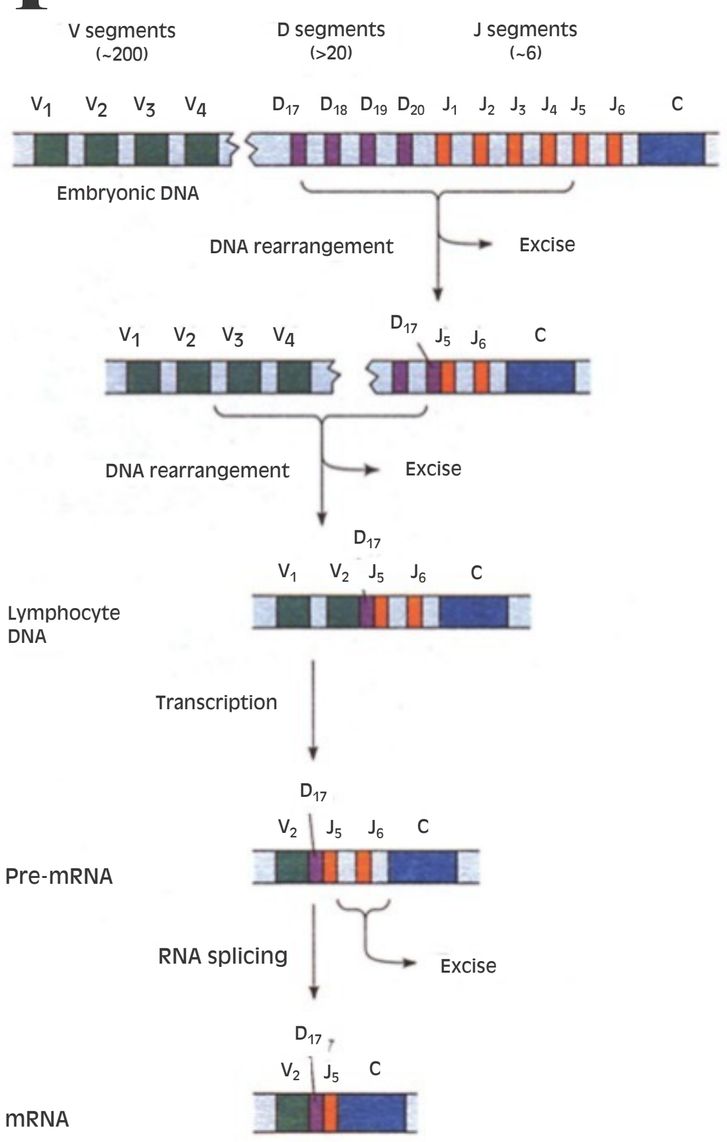
Improved understanding of how the Dover Strait was opened helps model how northwest European meltwater drained into the north Atlantic. It would also be useful to fix the time of when Britain became isolated from mainland Europe and the early human colonisation of the breakaway island, says the paper.

The writer can be contacted at response@simplescience.in

Control & production

DNA rearrangements can alter the genome

TAPAN KUMAR MAITRA



Genes coding for the human antibody heavy chains are created by DNA rearrangements involving multiple types of V, D, and J segments. In this example, an initial DNA excision randomly removes several D and J segments, bringing D17 adjacent to I5* A second random excision removes several V and D segments, bringing V2 adjacent to D17* After transcription, the sequences separating the V2D17J5 segment from the C segment are removed by RNA splicing.

Gene regulation is based on the movement of DNA segments from one location to another within the genome, a process known as DNA rearrangement. Two particularly interesting examples involve the mechanism used by yeast cells to control mating and the mechanism used by vertebrates to produce millions of different antibodies.

In the yeast Saccha-romyces cerevisiae, mating occurs when haploid cells of two different mating types, called and a, fuse together to form a diploid cell. All haploid cells carry both alleles for mating type, however, a cell's actual mating phenotype depends on which of the two alleles, *alpha* or a, is present at a special site in the genome called the Mat locus. Cells frequently switch making type, presumably as a means of maximising opportunities for mating. They do so by moving the alternative allele into the Mat locus. This process of DNA rearrangement is called the cassette mechanism, because the mating-type locus is like a tape deck into which either the *alpha* or the a "cassette" (allele) can be inserted and "played" (transcribed).

A somewhat different type of DNA rearrangement is used by lymphocytes of the vertebrate immune system for producing antibody molecules. Antibodies are proteins composed of two kinds of polypeptide subunits, called heavy chains and light chains. Vertebrates make millions of different kinds of antibodies, each produced by a different lymphocyte (and its descendants) and each capable of specifically recognising and binding to a different foreign molecule. But this enormous diversity of antibody molecules creates a potential problem — if every antibody molecule were to be encoded by a different gene, virtually all of a person's DNA would be occupied by the millions of required antibody genes.

Lymphocytes get around this problem by starting with a relatively small number of different DNA segments and rearranging them in various combinations to produce millions of unique antibody genes, each one formed in a different, developing lymphocyte. The rearrangement process involves four kinds of DNA sequences, called V, J, D, and C segments. The C segment codes for a heavy or light chain constant region whose amino acid sequence is the same among different antibodies — the V, J, and D segments together code for variable regions that differ among antibodies and give each one the ability to recognise and bind to a specific type of foreign molecule.

Human antibody heavy chains are constructed from roughly 200 kinds of V segments, more than 20 kinds of D segments, and at least six kinds of J segments. The DNA regions containing the various V, D, and J segments are rearranged during lymphocyte development to randomly bring together one V, one D, and one J segment in each lymphocyte. This random rearrangement allows the immune system to create at least 200 x 20 x 6 = 24,000 different kinds of heavy chain variable regions.

In a similar fashion, thousands of different kinds of light chain variable regions can also be created (light chains are constructed from their own types of V, J, and C segments; they do not use D segments). Finally, any one of the thousands of different kinds of heavy chains can be assembled with any one of the thousands of different kinds of light chains, creating the possibility of millions of different types of antibodies. The net result is that millions of different antibodies are produced from the human genome by rearranging a few hundred different kinds of V, D, J, and C segments.

The writer is associate professor, head, department of botany, ananda mohan college, kolkata, and also fellow, botanical society of bengal, and can be contacted at tapanmaitra59@yahoo.co.in

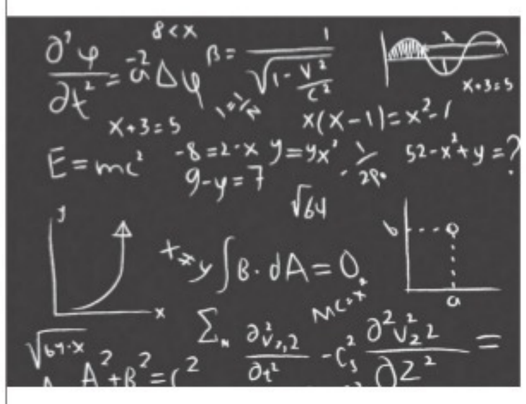
Matter of a simple proof

A retired German man solved one of the world's most complex maths problems while brushing his teeth but his achievement has largely gone unnoticed

CHLOE FARAND

A retired German man has found the proof to a complex geometry and probability problem that experts have tried to solve for decades, only for his achievement to go largely unnoticed.

Thomas Royen was reportedly brushing his teeth when he struck upon an idea in July 2014. Then 67 years old, the former statistician for a pharmaceutical company, from Schwalbach am Taunus, a town on the edge of Frankfurt, found the solution to the conjecture, known as the Gaussian Correlation Inequality. But at the time, Royen's cogent solution had gone largely unheralded and is still slowly permeating the scientific community, Quanta Magazine reports.



The GCI conjecture originates in the 1950s but was more clearly formulated in the 1972. Since then, scores of mathematicians have unsuccessfully tried to solve it. According to the GCI principle, if two shapes overlap, such as a rectangle and a circle, then the probability of striking one, for example in a game of darts, increases the chances of also striking the other.

Donald Richards, a statistician at Pennsylvania State University, told the science magazine he had been working on trying to solve the equations for 30 years without success. On the other hand, Royen is not one who has spent most of his life working to explain the conjuncture. His primary aim was to improve statistical formulas for the pharmaceutical industry to make sense of drug trial data.

While brushing his teeth, it dawned on him that GCI could be analytically explained through statistical formulas. This enabled him to simplify his function and use equations he had worked with all his life. "In mathematics, it occurs frequently that a seemingly difficult special problem can be solved by answering a more general question.

"The evening of this day, my first draft of the proof was written," he told Quanta. His answer, compiled in a paper called, "A simple proof of the Gaussian correlation conjecture", is short and only uses classic mathematical techniques.

Experts said that any graduate student would be able to follow Royen's argument. And Royen said he hoped the "surprisingly simple proof … might encourage young students to use their own creativity to find new mathematical theorems", adding that "a very high theoretical level is not always required".

The retired statistician wrote up his solution on Microsoft Word rather than using the go-to maths software, LaTeX. He published his findings on the academic preprint website arxiv.org and emailed a copy to Richards, who said he "knew instantly" that the problem had been solved.

But other experts were dismissive to Royen's claim he had found the solution. False and flawed solutions of the GCI have been floating in recent years.

Royen reportedly sent his findings to Bo'az Klartag of the Weizmann at the Institute of Science, Tel Aviv University. But his solution arrived in a batch with three other papers and when Klartag found a mistake in one of them, he allegedly overlooked the two others for lack of time.

With no intentions of bothering with peer reviews and the time-consuming process to get his paper published in top academic journals, Royen's achievement continued to go unrecognised. But the retired man said the "feeling of deep joy and gratitude" that came from finding an important proof has been reward enough.

"It is like a kind of grace. We can work for a long time on a problem and suddenly an angel - (which) stands here poetically for the mysteries of our neurons - brings a good idea," he said.

THE INDEPENDENT

PLUS POINTS

Mysterious cosmic flashes

Astronomers gazing into the sky — via some of the most powerful X-ray imaging ever — have spotted mysterious cosmic flashes deep in outer space. For just a few minutes, the flashes were a thousand times brighter and produced a thousand times more energy than all the other stars in its galaxy.

The cosmic explosion was spotted in a small unnamed galaxy 10.7 billion light years from Earth, in a field of space known as Chandra Deep Field-South. It occurred in 2014 but the entire event lasted just a few hours and after one day, no noticeable energy was produced at all. It is the first time an event of this magnitude has been observed and has left scientists puzzled. "We may have observed a completely new type of cataclysmic event," said Kevin Schawinski, of ETH Zurich University. "Whatever it is, a lot more observations are needed to work out what we're seeing." Franz Bauer of the Pontifical Catholic University of Chile added, "Ever since discovering this source, we've been struggling to understand its origin.

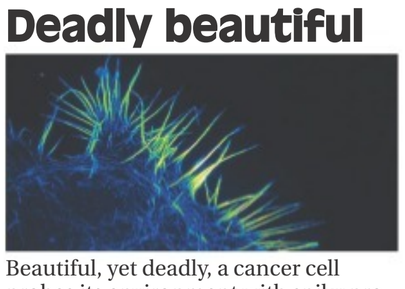
"It's like we have a jigsaw puzzle but we don't have all of the pieces."

Some type of destructive event is cited as the most likely cause, most probably the last moments of a neutron star, white dwarf or massive star. An event of this type would cause a gamma-ray burst, which are explosions triggered after the collapse of massive stars or mergers with black holes and can be detected by astronomers if the energy is directed at Earth.

The images were taken by Nasa's Chandra X-ray Observatory at Harvard University.

WILL WORLEY/THE INDEPENDENT

Deadly beautiful

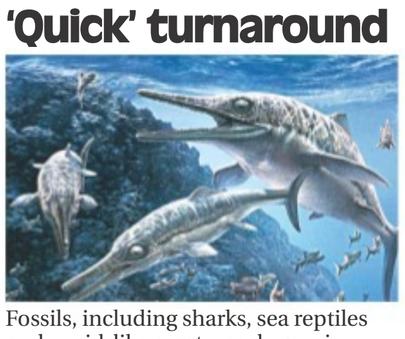


Beautiful, yet deadly, a cancer cell probes its environment with spiky protrusions called filopodia in this award-winning picture.

Scientists at the Agency for Science, Technology and Research's Institute of Medical Biology used a state-of-the-art super-resolution imaging technique known as structured illumination microscopy to illustrate how fine, delicate and complex these cellular structures are. Captured with a resolution of 120nm (a nanometre is a billionth of a metre), the image shows a single neuroblastoma cell induced by biochemical signals to form filopodia protrusions. Neuroblastoma is a type of cancer that forms in certain types of nerve tissue. This photo recently won the first prize in Cell-ebrate Science, an imaging competition open to entries from South-east Asia and Taiwan.

THE STRAITS TIMES/ANN

'Quick' turnaround



Fossils, including sharks, sea reptiles and squid-like creatures dug up in Idaho in the US reveal a marine ecosystem thriving relatively soon after Earth's worst mass extinction, contradicting the long-held notion that life was slow to recover from the calamity.

Scientists recently described the surprising fossil discovery showing creatures flourishing in the aftermath of the worldwide die-off at the end of the Permian Period about 252 million years ago that erased roughly 90 per cent of species.

The fossils of about 30 species unearthed in Bear Lake County near the Idaho city of Paris showed a quick and dynamic rebound in a marine ecosystem. The ecosystem flourished 1.3 million years later, "quite rapid on a geological scale", said palaeontologist Arnaud Brayard of France's University of Burgundy- Franche-Comte.

The researchers found bones from what could be the earliest-known ichthyosaur, a dolphin-like marine reptile group that prospered for 160 million years, or a direct ancestor. "The Early Triassic is a complex and highly disturbed epoch, but certainly not a devastated one as commonly assumed, and this epoch has not yet yielded up all its secrets," Brayard said.

SAMANTHA BOH/THE STRAITS TIMES