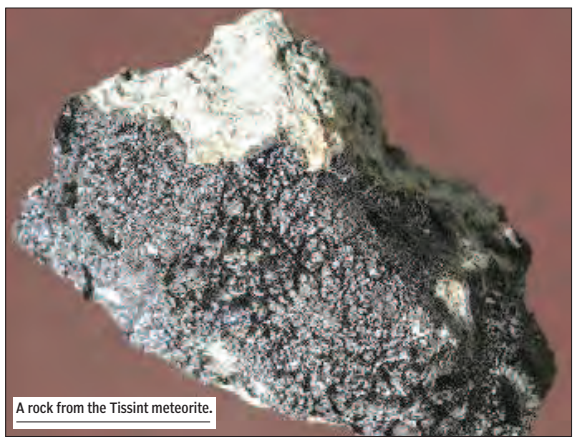
Are we all Martians?

MORE EVIDENCE HAS COME TO LIGHT THAT LIFE ON EARTH MAY HAVE ORIGINS IN MARS, WRITES
S ANANTHANARAYANAN

Earth is the only planet we know of that has the conditions to support life, but the mechanism by which the first living organisms came to be on earth is still in conjecture. One serious possibility is that life originated elsewhere, but came to earth, perhaps on a meteorite. And Mars, which is similar to earth in many ways, has been imaginatively, and is now more scientifically considered a place where life may have originated.

In July 2011, a large meteorite that arose after being ejected from Mars after an asteroid strike crashed near the town of Tissint in the Moroccan desert. Analyses of fragments of the meteorite showed traces of carbon and clear evidence of the presence of water on Mars, some time in the past, which reignited the theory of life having arisen on Mars. Lin Yangtin and others at the Ecole Polytechnique, Lausanne, Switzerland, report in the journal *Meteoritics and Planetary Sciences* that further analyses of a fragment of the meteorite argue strongly for the source of carbon being biological.


A rock from the Tissint meteorite.

Origin of life

That the building blocks of life in the form of amino acid molecules, of which proteins are composed, could self-assemble from the raw material was demonstrated by the celebrated Miller-Urey experiment of 1952. Water vapour, methane, ammonia and hydrogen gases, which may represent the ancient atmosphere of earth, were subjected to repeated electric sparks to simulate stormy conditions that may have prevailed at that time. After a week of such stimulation, it was found that a number of amino acids had been formed.

Similar trials by other experimenters, with a few more components added, have generated many more organic molecules associated with life, including all the 20 amino acids found in nature, and then some more.



Stephen Benner and Philippe Gillet

The Miller-Urey experiment is the basis for *aboigenesis*, the widely held view that life may have originated on early earth, when essential raw materials and the conditions for the generation of many organic substances were present at various stages of our planet's history. But a paper by Professor Stephen Benner, of the Westheimer Institute for Science and Technology, Tampa Bay, USA, in August 2013 said that even the correct raw materials for life would not stick together to form RNA and DNA but would just turn to something like tar when exposed to energy in the form of heat and light.

Professor Benner said there was the need for some specific elements that could enable the building blocks of life to get their act together and two of these were the elements *molybdenum* and *boron*. While the presence of minerals that contain both these elements seem to be vital for life to get started, the form of molybdenum that is required is a highly oxidised one. Professor Benner notes that early earth, of three billion years ago, was oxygen deficient and the molybdenum that was present would not have formed oxides. And then, early earth was covered with water, which rules out the presence of boron, which is found only in the driest of places. Water is also corrosive to RNA, considered the first genetic molecule to have appeared, and this is another reason to consider that life could not have originated on early earth.

Professor Benner noted that analysis of the Tissint meteorite, as the piece of Mars that had come down in 2011 near Tissint had come to be called, showed that there was boron on Mars. The Red Planet, unlike early earth, also had oxygen and that there was now evidence that there was the oxidised form of molybdenum too. And although there is evidence of past liquid water on Mars, it covered only parts of the planet, unlike on early earth. According to Professor Benner, the origin of life was, in fact, impossible on earth and the evidence pointed in the direction of Mars.

But a paper by Andrew Steele and others of the Carnegie Institute in 2012 had suggested that the traces of carbon found in the Tissint meteorite, which suggest organic matter, were associated with rocks that arose in molten magma and were not likely to have come from biological sources. The question of whether life originated on Mars was hence still open.

Lassanne report

The current report from the group in Lausanne appears to swing the evidence back to the side of the carbon in the Mars rocks having been of biological origin. The chemical, microscopic and other analyses of the carbon in the rocks clearly show that the carbon content did not arise from earth and had been deposited in the Tissint meteorite even while it was a rock formation on Mars. And as for the question of how the carbon came into the rocks, this is again indicated by the ratio of C-12 and C-13, the two forms, called isotopes, of the carbon atom in the carbon found in the Tissint meteorite.

The isotopes of atoms are forms that differ only in the number of neutral particles in the nucleus, which means the atoms have the same chemical properties but a small different in mass. While there is a constant ratio of the two forms in the atmosphere, in living things there is a preference for one of the forms over the other, and the ratio is a little different. The ration of the two isotopes in the Tissint rock was compared with the ratio in the atmosphere of mars, which is now known, thanks to the work of the *Phoenix* and *Curiosity* lander probes, and it was found that the ration was different. This then does not agree with the case that the difference between the two ratios is the same as that between the ration in a piece of coal, which is of biological origin, and that of earth's atmosphere! This strongly suggests that the carbon content in the Tissint rock came from biological matter that seeped into fissures in the rock, in at least partly liquid conditions.

"Insisting on certainty is unwise, particularly on such a sensitive topic… but the grounds to hold that there has been biological activity on Mars is compelling," says Philippe Gillet, director of the laboratory at Lausanne. "The evidence seems to be building that we are actually all Martians, that life started on Mars and came to earth on a rock," Professor Benner had said in 2013. "It's lucky that we ended up here nevertheless, as certainly earth has been the better of the two planets for sustaining life. If our hypothetical Martian ancestors had remained on Mars, there might not have been a story to tell," he said.

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COVERING THE GENOME

TAPAN KUMAR MAITRA EXPLAINS HOW LARGE DNA SEGMENTS CAN BE CLONED IN YEAST ARTIFICIAL CHROMOSOMES AND BACTERIAL ARTIFICIAL CHROMOSOMES

Using the vectors mentioned so far, DNA cloning is a very powerful methodology, but it has an important limitation: the foreign DNA fragments cloned in these vectors cannot exceed about 30,000 base pairs in length. Eukaryotic genes are often larger than this and hence cannot be cloned in an intact form using such vectors. For genome-mapping projects, the availability of clones containing even longer stretches of DNA is desirable because the more DNA per clone the fewer the number of clones needed to cover the entire genome.

One of the first breakthroughs in cloning longer DNA segments was the development of a vector called a *Yeast Artificial Chromosome*, which is a "minimalist" eukaryotic chromosome that contains all the DNA sequences needed for normal chromosome replication and segregation to daughter cells, and very little else. As you might guess, a eukaryotic chromosome requires three kinds of DNA sequences: an origin of DNA replication; two telomeres to allow periodic extension of the shrinking ends by telomerase; and a centromere to ensure proper attachment, via a kinetochore, to spindle microtubules during cell division.

If yeast versions of these three kinds of DNA sequences are combined with a segment of foreign DNA, the resulting YAC will replicate in yeast and segregate into daughter cells with each round of cell division, just like a natural chromosome. And under appropriate conditions, its foreign genes may be expressed.

The YAC cloning vector is a circular DNA molecule with nucleotide sequences specifying an origin of DNA replication (ORI), a centromere (CEN), two telomeres (TEL) and two selectable markers. It has two recognition sequences for the restriction enzyme Bamlil and one for EcoRl. Digestion of the YAC vector with both restriction enzymes produces two linear DNA fragments that together contain all the essential sequences, as well as the fragment that connected the BamHI sites, which is of no further use. The fragment mixture is incubated with fragments from light digestion of foreign DNA with EcoRI (light digestion generates large DNA fragments because not all the restriction sites are cut), and the resulting recombinant strands are sealed with DNA ligase. Among the products will be YACs carrying foreign DNA, as shown at the bottom of the figure. After yeast cells are transformed with the products of the procedure, the colonies of cells that have received complete YACs can be identified by the properties conferred by the two selectable markers.

In addition to a replication origin (ORI), centromere sequence (CEN) and two telomeres (TEL), the vector illustrated carries two genes that function as selectable makers as well as three restriction sites. In cloning experiments, the vector and foreign DNAs are cleaved with the appropriate restriction enzymes, mixed together, and joined by DNA ligase. The resulting products, which include a variety of YACs carrying different fragments of foreign DNA, are introduced into yeast cells whose cell walls have been removed. The presence of two selectable markers makes it easy to select for yeast cells containing YACs with both chromosomal "arms".

The YAC vector alone is only about 10,000 base pairs, but the inserted foreign DNA usually ranges from 300,000 to 105 million base pairs. In fact, YACs must carry at least 50,000 base pairs to be reliably replicated and segregated.

Another type of vector used for cloning large DNA fragments is the *Bacterial Artificial Chromosome*, a derivative of the F factor plasmid that some bacteria employ for transferring DNA between cells during bacterial conjugation. BAC vectors are modified forms of the F factor plasmid that can hold up to 350,000 base pairs of foreign DNA and have all the components required for a bactial cloning vector, such as replication origins, antibiotic resistance genes and insertion sites for foreign DNA. One type of BAC facilitates the process of screening for recombint clones by including the SacB gene, which converts sucrose (table sugar) into a substance that is toxic to bacteria. A BamHI cloning site is located within the SacB gene, so when foreign DNA is inserted into the BAC vector at this site, the SacB gene is disrupted. When such a BAC vector is introduced into bacterial cells grown in the presence of sucrose, only cells containing BAC vector molecules with a foreign DNA insert will be able to grow. Those cells receiving BAC vector with no DNA insert will fail to grow because the SacB gene remains intact and produces a toxic substance from sucrose.

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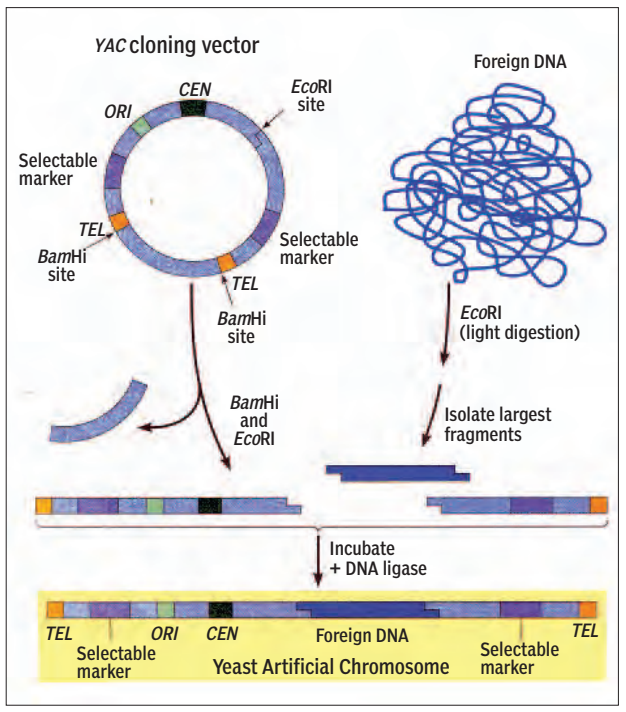


Race against extinction

BAT POPULATIONS RAVAGED, HUNDREDS OF AMPHIBIAN SPECIES DESTROYED, DIVERSE GROUPS OF BIRDS THREATENED… TAKING RISKS WILL BE NECESSARY TO CONTROL DEADLY WILDLIFE PATHOGENS, SAYS
A MARMADUKE KILPATRICK

Few experiences have hit me harder than walking through a bat graveyard. In March 2014, my colleagues and I were doing research in a pair of underground mines in northern Illinois. Five months earlier, these mines had been home to more than 28,000 bats of five species, but on that day they were tombs, littered with lifeless, fungus-covered bodies. The bats' skin was dry and flaking, their bodies, which hung from the walls near the entrances, were so emaciated that their bones nearly protruded through their skin.

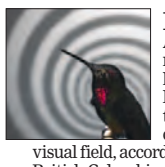
When we surveyed the area, we found just 1,023 live bats in one mine and 5,237 in the other. More than 75 per cent of the bats were dead from white-nose syndrome, an emerging disease caused by the fungal pathogen *Pseudogymnoascus destructans*. We left Illinois the next day, emotionally spent. Our team, along with the broader community of biologists who study this disease, has been searching for ways to prevent this pattern of devastation from repeating itself. Sadly, white-nose syndrome continues to ravage bat populations as it spreads westward across the continent. Over the past seven years, the disease has killed millions of bats in 25 US states and five Canadian provinces, making it one of the most devastating diseases to affect mammals in recorded history.

Unfortunately, bats are not the only animals struggling to survive in the face of emerging pathogens. Amphibians have been decimated by *chytridiomycosis*, another fungal disease that is now found on all continents except Antarctica and is believed to have driven more than 100 species to extinction.

Meanwhile, millions of birds in North America have died from West Nile virus, which became the most widespread mosquito-borne disease on the planet when it spread across the Americas in the past decade. Such destructive outbreaks are often spurred by the emergence of pathogens in new locations, where hosts have not yet evolved sufficient defences against these diseases. Understanding what shapes these epidemics is instrumental in bringing them under control and reducing their impacts on the world's biodiversity.

THE SCIENTIST

PLUS POINTS



Easy to hack

A hummingbird's remarkable ability to hover in place is highly contingent on the tiny bird having a completely stationary visual field, according to University of British Columbia research published in the *Proceedings of the National Academy of Sciences*. UBC zoologists Benjamin Goller and Douglas Altshuler projected moving spiral and striped patterns in front of free-flying hummingbirds attempting to feed from a stationary feeder.

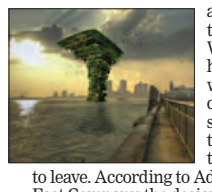
Even minimal background pattern motion caused them to lose positional stability and drift. Giving the birds time to get used to the stimuli didn't eliminate the disruption. Projecting a combination of moving and stationary patterns in front of the birds didn't help either, although they were able to regain some stability.

"We were very surprised to see how strong and lasting the disruption was — birds with hovering and feeding abilities fine-tuned to the millimetre were off the mark by a centimetre," said Goller. "We think the hummingbird's brain is so precisely wired to process movement in its field of vision that it gets overwhelmed by even small stimuli during hovering."

This the first time researchers have directly measured the impact of moving visual patterns on free flight in birds.

Giving back

A Dutch architectural firm has come up with a plan to give birds, insects, and sea life new, protected habitats along city waterways, and has set its sights set on Mumbai or New York for the prototype. Koen Olthius, founder of the Netherlands-based city planning and architectural firm Waterstudio, has come up with a way we can give back some of the city to the wildlife that can't afford to leave. According to Adele Peters at Fast Company, the design of the so-called "Sea Trees" is based on floating oil platforms — large, shelved structures that sit in the ocean for storage.



Each level of the tree-shaped platforms would support a different type of habitat, right down to a coral reef at the bottom, if the climate permits. Birds could come and go as they please and build nests away from people, traps and roads. "We took park zones in urban areas, we divided this in pieces, and put them vertically on top of each other. In the end, it became a vertical hangout for wildlife," Olthius told Peters. "Our inspiration came from a project in Holland where ecologists forced us to provide habitats for animals that couldn't be disturbed by people. Water is, of course, a perfect way to keep people away.

"Our favourite locations would be Mumbai or New York," he added. "Both have such a high price on land that it makes the construction of new park zones on land not feasible." He said this design wasn't just a fun concept to fill out the firm's portfolio — Waterstudio was ready to start building as soon as possible.

Combating obesity

If you're a man, shining a blue light over your dinner could make you eat less, according to researchers. A study published in the scientific journal *Appetite* found that lighting food with a blue coloured light "significantly" decreased how much men ate. There was no effect on women who participated in the study, however. The reason for the change in behaviour appears to be that the food looks less delicious with a blue light shone on it – what the researchers called the "hedonic impression of the food's appearance".

They said, "Since naturally blue-coloured foods are rare, humans may have a doubt as to whether they are safe to eat." They hypothesised that the difference in reaction between men and women to the light was because women had a better sense of smell – meaning men were "more dependent on visual cues" when deciding whether to eat something or not.

The scientists noted that it did not affect the "willingness to eat" by the men or its perceived flavour. "This study provides empirical evidence that the colour of lighting can modulate the meal size. In particular, blue lighting can decrease the amount of food eaten in men without reducing their acceptability of the food."

For the study, researchers took 112 adults and asked them to abstain from food the night before. The participants were seated in booths lit by white, blue and yellow lights and were given a large breakfast of omelettes and pancakes. After eating as much as they wanted, the participants filled out a questionnaire, from which results were derived. The results could have implications for combating obesity. The study was produced by researchers at the University of Arkansas, led by assistant professor Han-Seok Seo.

JON STONE/THE INDEPENDENT