

SNAPSHOTS



Fireflies under threat

Along with familiar hazards of habitat loss and pesticides, night lighting proves to be an added menace that plays havoc in courtship behaviour of fireflies. In a worldwide assessment published in *Biosciences*, researchers concluded that some of the 2,000-plus firefly species may face extinction threats.



Mammoth's end

The world's last woolly mammoths suffered from serious genetic defects due to inbreeding that may have hampered sense of smell and male fertility. Scientists decoded the genome of one of the last mammoths from Wrangel Island off Siberia's coast. The study has been published in *Genome Biology and Evolution*.



Pluto's beating heart

A new study published in *Journal of Geophysical Research: Planets* finds that Pluto has a 'beating heart' of frozen nitrogen that may control the winds on its surface, giving rise to various structures there. Pluto's thin atmosphere consists mostly of nitrogen, small amounts of carbon monoxide and methane.



Silent sand-shake

Sand dunes can interact and 'communicate' with their neighbouring dunes, actually repel them, according to a new study published in *Physical Review Letters*. Identical dunes close to each other move further apart with time, the researchers observed. Turbulent swirls from the upstream dune push the downstream dune away.

How bats harbour several harmful viruses without falling sick

Bats avoid excessive virus-induced inflammation, often a cause of severe diseases in humans

R. PRASAD

Bats serve as natural hosts for numerous viruses including Ebola virus, Nipah virus, coronaviruses such as severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) and the 2019 novel coronavirus that has infected nearly 10,000 people and killed over 200 others. Even as these viruses cause harm in humans, they rarely if at all cause any harmful effects in bats. This is the case even when the viral load is extremely high in bats.

A study carried out last year and published in the journal *Nature Microbiology* revealed the mechanism responsible for bats to harbour numerous viruses without themselves getting affected and also live long. Compared with terrestrial mammals, bats have longer lifespan.

How bats differ

The reason why bats can harbour these viruses without getting affected is simply because bats can avoid excessive virus-induced inflammation, which often causes severe diseases in animals and people infected with viruses.

When pathogens infect humans and mice, the immune system gets activated and typical inflammatory response to fight the microbes is seen. While controlled inflammatory response to fight infection helps



Resilient mammal: The inflammatory response is dampened in bats immaterial of the variety of viruses that are present and the viral load. • ANTON CROOS

keep humans healthy, it can contribute to the damage caused by infectious diseases, and also age-related diseases when the inflammatory response becomes excessive.

In complete contrast, the researchers found that the inflammatory response is dampened in bats immaterial of the variety of viruses that are present and the viral load. The researchers from Duke-NUS Medical School, Singapore used three different viruses – Melaka virus, MERS coronavirus and influenza A virus – and tested the responses of immune cell and other cells (peripheral blood mononuclear cells and bone-marrow derived macrophages) of bats, mice

and humans to these viruses. While inflammation was high in the case of humans and mice, it was significantly reduced in bats immune cells.

Disease tolerance

"This supports an enhanced innate immune tolerance rather than an enhanced antiviral defence in bats," they write. "This may also contribute to our understanding of the role of the inflammation in disease tolerance in bats as reservoir hosts" they say. This is in complete contrast to what is seen in mice and humans for disease-causing zoonotic viruses.

The researchers found that significantly reduced inflammation in bats

was because activation of an important protein – NLRP3 – that recognises both cellular stress and viral/bacterial infections was significantly dampened in bat immune cells.

Studying further, the researchers found that reduced activation of the NLRP3 protein was in turn due to impaired production of mRNA (transcript). Since mRNA production is impaired the NLRP3 protein production gets compromised leading to less amount of the protein being produced. But this was not the case with mice and humans – there was no impairment to mRNA production so the NLRP3 protein was unaffected.

Four variants

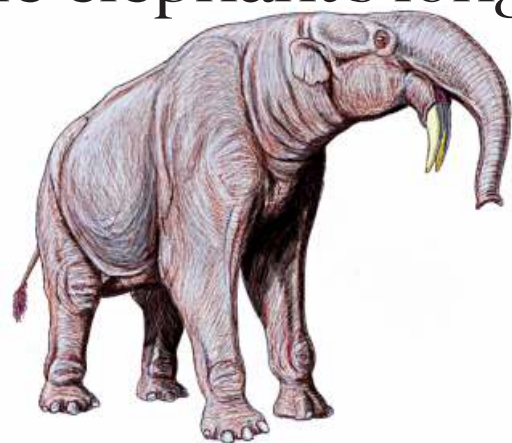
The NLRP3 protein is found as four variants in bats. The researchers found that the function of all the four variants was dampened compared with human NLRP3. To test if their finding on NLRP3 hold true in evolutionally distant bats, the researchers studied two very distinct species of bats – *Pteropus alecto*, which is a large fruit bat known as the Black Flying Fox, and *Myotis davidii*, a tiny vesper bat from China.

The variations have been found to be genetically conserved through evolution. Further analysis comparing 10 bat and 17 non-bat mammalian NLRP3 gene sequences confirmed that these adaptations appear to be bat-specific.

Finding the elephant's long-lost relatives in Kutch

ASWATHI PACHA

It was a pleasant January winter morning last year and Ningthoujam Premjit Singh along with his team was out on their excavation work at Kutch. When he stumbled upon a premolar tooth of about 6 cm width and 7 cm length, little did he know that what he held belonged to an extinct ancient elephant called *Deinotherium indicum*.



Large mammal: An artist's impression of *Deinotherium* showing flatter skulls than elephants. • WIKIMEDIA COMMONS

First occurrence

Interestingly, this turned out to be the region's first occurrence of the mammal which weighed between eight and 10 tons in weight. Dr. Singh adds that this new find also expands the distribution range of this species, hitherto only known from two or three localities (Tapar of Gujarat, Haritalyangar in Himachal Pradesh, and Piram Island off the coast of Gujarat). It also increases our understanding of the variations in dental morphology of the

South Asian *Deinotheres* species. Dr. Singh is a postdoctoral fellow at the Department of Geology at Panjab University and the first author of the paper recently published in the *Journal of Paleontology*.

Biostratigraphy

Using a technique called biostratigraphy, it was noted that *D. indicum* lived roughly between 11 and 7 seven million years ago in India. In

biostratigraphy, the presence of certain species from a known time period can be used to estimate the age of a deposit containing the same species in a different locality. "Remains of *D. indicum* have been found in well-dated Siwalik deposits from Haritalyangar of Himachal Pradesh. Based on the similarity in species, we inferred a similar date for the Kutch's *D. indicum*," Advait M. Jukar from the Department of Pa-

leobiology, National Museum of Natural History, Smithsonian Institution explains in an email to *The Hindu*. He is the co-first author and corresponding author of the paper.

He adds that definite dates can only be procured when paleomagnetic and radiometric studies are performed on the rocks that these fossils came from.

When asked how morphologically different this species is from today's elephants, he explained that though they had similar large bodies with column-like limbs, their heads were very different. "They had flatter skulls, and a set of downwards pointing, curved tusks only on the lower jaw. Analyses of their skulls have shown that they probably also had a short, slightly bulbous trunk. If you looked inside their mouths, all of their teeth would have erupted and were used in chewing at the same time. Modern elephants have only one tooth

in use on each side of their jaw," explains Dr. Jukar.

Distant relative

This species was a fairly distant relative of today's elephants, both evolutionarily and in time. The deinotheriidae, the family that includes *D. indicum*, was first found in the fossil record approximately 28 million years old in Africa, but the family that includes modern elephants doesn't appear until about eight million years ago.

The team plans to continue their studies in the Tappar beds of Kutch as it may be hiding many more fossils. "The plan now is to keep describing different species until we have a solid understanding of the diversity of vertebrates from western India. We hope to create a dataset of species occurrences through time in western India and compare the trends in diversity seen there with those seen in the well-studied fossil record from the Siwaliks," adds Dr. Jukar.

Question Corner

Exercise and high blood pressure

Q Why are people with high blood pressure discouraged from doing exercises that involve lifting weights (isotonic)? What is the mechanism by which aerobics, walking and swimming help in reducing blood pressure?

A DR VIJAYA BHARAT

Isotonic exercises are high intensity activities for a short duration, like weight lifting. The contracting muscles exert pressure on the arterioles causing increased peripheral vascular resistance which necessitates the heart to pump more forcefully. Increased contractility of the heart muscle and increased vascular resistance increase the blood pressure. Therefore isotonic exercises are to be avoided by those with high blood pressure. Aerobic exercises like walking, swimming and

cycling start gradually and remain sustained for a longer time. This causes dilatation of the arterioles in the muscles in order to supply more blood to the exercising muscles. By increasing the venous blood flow from legs to the heart and by reducing the resistance in the arterioles, the heart is able to pump blood with ease. Regular aerobic exercise reduces blood pressure and improves cardiac function.

This week's questions

Unlike when connected directly to an electrical socket, why does it take a long time to charge a mobile phone when connected to a computer through USB?

What is fast charging seen in certain mobile phones? Does fast charging reduce the longevity of the battery?

What is the force that drives blood flow from the limbs to the heart against gravity?

Readers may send their questions / answers to questioncorner@thehindu.co.in

IIT Madras: candle flame oscillators shine light on combustor stability

Studying flames of candle bunches, the team understood how combustors used in rockets work

SHUBASHREE DESIKAN

Using stacks of candles tied together, and studying pairs, and quartets, of such candles, an IIT Madras team of researchers has come up with interesting inputs that will help in building combustors in rockets.

We know that Apollo 11 successfully landed men on the Moon in 1969. Stories of the failures that paved the way to this success are less known. One such failure was due to thermo-acoustic failure of the F1 engine of the rocket during a test stand in 1962. When NASA tried to test how to launch the rocket, it just blew apart. The reason was uneven burning of the fuel. Like a candle whose flame flickers due to uneven presence of oxygen around it, the flames inside the F1 engine flickered, only at a higher frequency - an instability that blew the rocket apart. This is called a thermo-acoustic instability, which is another name for high-amplitude pressure oscillations, in the combustor. Combustors contain several flames due to the presence of multiple fuel injection systems. "The

interaction of these flames with the acoustic field (pressure variations) collectively results in the onset of thermo-acoustic instability. In order to understand the interaction between multiple flames in a much simpler and economical environment, we started to study candle-flame oscillators," says R. I. Sujith in whose lab these experiments were carried out. He is a Chair Professor in Department of Aerospace Engineering at IIT Madras.

Candle oscillators

The thermo-acoustic instability problem, and others like it, can be understood, albeit in a scaled-down manner, by studying stacks of two or three candles tied together so that their flames merge. The flames of such candles, when placed beside other candles, oscillate in synchronicity and show a rich variety of phenomena. The IIT Madras researchers have studied such candle flame oscillators and shown experimental manifestations of some phenomena that have hitherto only been known theoretically in oscillators. The research on this has been published in the



Synchronicity: The candle flames placed close together oscillate and show a rich variety of phenomena. • R.I. SUJITH

journals *Scientific Reports* and *Physical Review E*.

One such phenomenon is amplitude death, which is the complete quenching of oscillations due to a coupling between the different flames. Another phenomenon is phase-flip bifurcation, which is an abrupt change from in-phase synchronisation to out-of-phase synchronisation.

First study

"Our candle study is the first to experimentally prove the existence of both states in a single system. The coexistence of these two states in a single system brings the

possibility of evading undesirable states in various other oscillators," says Prof. Sujith an author of the papers, in an email to *The Hindu*. He explains how studies on neural diseases such as Alzheimer's and Parkinson's disease model these conditions as a consequence of the occurrence of the amplitude death state in the neural oscillators. On the other hand, there are systems such as thermo-acoustic oscillators and oscillations of bridges and skyscrapers, where amplitude death is actually a welcome thing.

"The coexistence of the states of amplitude death



Energy transfer: The milk swirls in large blobs, dissolves into smaller blobs, then gets dispersed in the coffee decoction. • GETTY IMAGES

A new way of getting a sense of how time flows

The way energy flows can determine the direction of the 'arrow of time'

SHUBASHREE DESIKAN

Time, as we experience it, flows only in one direction - forward. We cannot easily reverse the 'arrow of time' as it is called. An example is that it is easy to squeeze a toothpaste container and bring out the paste, but well-nigh impossible to push it back without making a mess. It is a fascinating exercise to see how physicists view this concept.

Physics and time

The laws of elementary particle physics remain the same when time is reversed. That is, take the questions which govern gravitational, electromagnetic and strong-nuclear forces and replace "t" by "-t" and the equations are invariant. Does this mean that time reversal is indeed a possibility? We do not see it in practice, hence there must be something defining the arrow of time. This is the second law of thermodynamics, which says that a quantity known as the entropy of the system will either remain a constant or increase with time. The entropy is directly related to the disorder in a system. The more the entropy the greater the disorder. So, we can break an egg and go from an ordered state into a disordered state, but the reverse - broken bits of egg joining to form a whole - does not happen. Thus, the direction of increasing entropy determines the arrow of time. This is a popular way of defining the arrow of time.

Energetics and time

Professor Mahendra K. Verma from the Physics Department of IIT Kanpur has come up with a different way of defining the arrow of time, which is described in a paper published in *The European Physical Journal B*.

The concept is readily illustrated taking the example of milk being stirred into coffee decoction in a cup. First the milk swirls in large blobs, then it dissolves into smaller and smaller blobs until it gets dispersed in the decoction. Therefore, there is a transfer of milk from large blobs to smaller blobs and then to still smaller blobs. In the same way, energy gets transferred from a large scale to the small scale, there by defining a direction for the arrow of time.

Such alternative definitions of arrow of time are needed, for example, in cosmology to explain cosmological models like the oscillating universe. According to this model, the universe, which we know to be expanding, will reach a maximum size and then start contracting once again due to gravity. In such a contracting phase, entropy may actually decrease. If this happens, it will mean the arrow of time defined using entropy will reverse, and that sounds physically impossible.

Oscillating universe

"The second law of thermodynamics encounters difficulties in explaining cosmological arrow of time for oscillating universe. However, energy transfers can predict the arrow of time for the collapsing universe," says Prof. Verma.

In a gravitating system, such as the collapsing universe, cluster or star formation is somewhat similar to the formation of cyclones or hurricanes. "[In contrast to the example of coffee] here the energy flows from small scales to large scales. For such systems, the clustering or structure formation is in the forward direction of time," he adds in explanation.

Basmati rice genome sequenced

PRESS TRUST OF INDIA

Scientists have mapped the complete genome of two basmati rice varieties, including one that is drought-tolerant and resistant to bacterial disease. The findings, published in the journal *Genome Biology*, also show that basmati rice is a hybrid of two other rice groups.

Despite the economic and cultural importance of basmati and related aromatic rice varieties, their evolutionary history is not fully understood, the researchers said.

Two varieties

The researchers focused on two basmati rice varieties: Basmati 334 from Pakistan, known to be drought tolerant and resistant to rice-killing bacterial blight, and Dom Sufid from Iran, an aromatic long-grain rice that is one of the most expensive on the market.

Most genetic material in basmati comes from japonica - a rice group found in East Asia - followed by the rice group aus found in Bangladesh.

The researchers aim to work with the scientific and rice breeding communities to identify important genes, see what makes the basmati group unique, and even develop molecular markers to help breed new varieties.