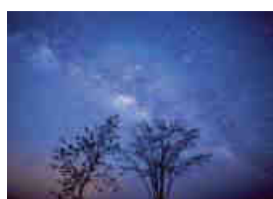


CAPSULE



Heavy planet fragment

Researchers have spotted a small and dense planet that has survived the death of its star. The *Science* report says that this is astonishing as it is so close to its star, orbiting it every two days. It should not survive the tidal forces under normal circumstances. This planet fragment was found amid debris of destroyed planets.



Integrated invaders

A study published in *Science* analysed the structure of seed dispersal networks in Hawaii, where many invasive bird species have replaced native species. They found that native plants now depend on the invaders for seed dispersal. This indicates how survivors and invaders, such as the red-whiskered bulbul in this case, could get integrated into the system.



Food trail

A *Lancet* study that tracked the consumption of 15 dietary factors from 1990 to 2017, across 195 countries found that people in almost every region would benefit if they followed the practice of eating optimal amounts of food and nutrients. The study found one in five deaths globally was linked to poor diet and also that it was a major contributor to chronic illnesses.

IIT Bombay's bacteria preferentially degrade aromatic compounds

A unique bacterial strain isolated from soil contaminants was used in the study

R. PRASAD

Using a unique strain of bacterium isolated from soil contaminated with petroleum products, IIT Bombay researchers can selectively remove from the environment toxic, aromatic pollutants such as benzoate (sodium benzoate is used as a food preservative), benzyl alcohol and naphthalene, to name a few. What makes the bacterial strain (*Pseudomonas putida* CSV86) unique is its preference for aromatic compounds and organic acid as a food source even when glucose is available. The strain can degrade aromatics and organic acids simultaneously.

Peculiar food choice

Since breaking down aromatic compounds is difficult, bacteria generally prefer simple carbon sources such as glucose for obtaining energy. Even the bacteria that are known to degrade aromatic compounds tend to first prefer glucose and other simple carbon sources for energy and feed on aromatic compounds only when glucose gets exhausted. However, this bacteria strain displays a completely different order of food choices – it first feeds on aromatic compounds and organic acids and only when this gets exhausted does it start feeding on glucose.

"This is the first time a bacteria strain that preferentially utilises aromatic compounds even in the presence of glucose has been ever reported," says Prashant Phale from the Department of Biosciences and Bioengineering at IIT Bombay. "We isolated the bacteria from petroleum-contaminated soil in Bengaluru way back in 1986."

- Bacteria, including aromatic-degrading ones, first consume glucose before degrading aromatic compounds
- *Pseudomonas putida* strain's food choice is completely reversed — prefers aromatic over glucose
- The peculiar order of food preference comes from the suppression of glucose utilisation at a molecular level
- Aromatic compounds and organic acid are consumed simultaneously when both are present

Cleaning up toxic pollutants

A unique soil bacterial strain preferentially devours aromatic compounds and organic acid even when glucose is available, thus selectively removing the pollutants



Bhavik Shah (foreground) and Prashant Phale at work.

- Food preference switches when aromatic compound is introduced to the bacteria feeding on glucose
- The bacterial strain is a good candidate for bioremediation or waste water treatment

In studies carried out in the lab, the research team led by Prof. Phale found that even when both benzoate and glucose were available, the bacteria first utilised benzoate, and only when it was exhausted did it start feeding on glucose. "This gives an advantage to remove the pollutants with priority even in the presence of simple carbon source from the contaminated site," says Prof. Phale. The results of the study were published in the journal *Applied and Environmental Microbiology*.

Molecular level

The bacterial strain's peculiar order of food preference comes from the suppression of glucose utilisation at a molecular level leading to a reduction in the level of proteins and enzymes necessary for transport breakdown of glucose. At the same time, proteins and enzymes needed for transport and breaking down of aromatic compounds are enhanced result-

ing in the preference for these pollutants as a source of food. "This is [the] complete opposite of what we see in aromatic compound-degrading bacteria. In those bacteria, glucose will inhibit metabolism of aromatic compounds by reducing the enzymes necessary for breaking down aromatics," says Prof. Phale.

When benzoate and succinate (organic acid) are available together, the bacteria simultaneously consume both pollutants. "The enzymes necessary for breaking down benzoate and succinate were produced in large amounts leading to equal uptake of both," he says. However, when only glucose or benzoate is available the respective enzymes are produced and the carbon source is taken up by the bacteria.

When the researchers introduced benzoate to the bacteria that were already growing on glucose, the level of enzymes responsible for glucose metabolism was seen

to reduce while the level of enzymes for benzoate degradation increased. "We started seeing this effect in 15-30 minutes after benzoate was added. This [synthesising enzymes for benzoate degradation] is a very fast process occurring at the cellular level," says Prof. Phale.

"The bacterial strain is a very good candidate for bioremediation or waste-water treatment. We can increase the metabolic diversity and capacity by genetically engineering the strain," he says. "We would first like to test the viability and efficiency of the strain in breaking down different aromatic compounds." The team hopes to engineer the strain so it can be directly applied to the soil to preferentially degrade aromatic pesticides. The team is now trying to understand the molecular mechanisms and regulatory components involved in preferential degradation of aromatics over glucose using various molecular biology tools.

Meteorite sheds light on the Sun's infant years

Superflares were million times stronger than solar flares

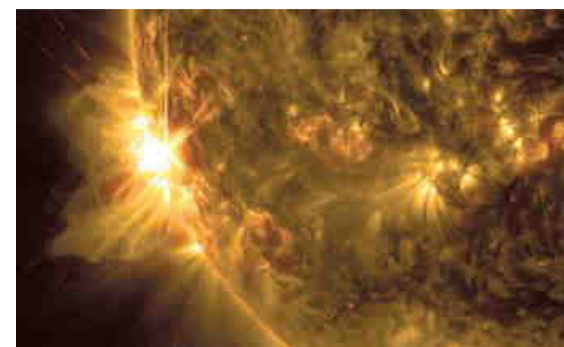
SHUBASHREE DESIKAN

In 1962, a meteorite weighing 21 kg was found at Efremovka, now in Kazakhstan. By analysing a piece of this meteorite and studying the relative abundances of isotopes of lithium, beryllium and boron, two researchers have envisaged how the Sun behaved in its infancy. Then, they deduce, the Sun could let off superflares which were a million times stronger than the strongest recorded solar flare – the 1859 Carrington event. Such superflares must have taken place 4.5 billion years ago, when the Sun was barely forming. Further, they infer that irradiation by such superflares from the Sun is one of the sources of short-lived nuclides, for example, beryllium-7, which has a half-life of approximately 53.12 days.

First-formed solids

Among the first-formed solids of the solar system were the calcium aluminium-rich inclusions (CAI). The CAIs are nearly 4.567 billion years old. They become the refractory components within meteorites with irregular shape and are predominantly composed of oxides and silicates of calcium and aluminium. This study suggests that these were pushed to large distances measuring up to a few times the Earth-Sun distance (which is equal to one astronomical unit). These primordial solids were cooked by the superflares and moved to this distance in short times in the order of a year.

"This study provides a quantum jump in under-



A solar flare bursts off the Sun in this image captured by NASA's Solar Dynamics Observatory. • REUTERS/NASA

standing the activity and events and processes occurring in the early solar system and its protoplanetary disk," says Kuljeet Kaur Marhas from Physical Research Laboratory, co-author of the paper which has been published online in *Nature Astronomy*.

Pristine meteorite

The Efremovka meteorite piece was lent to Professor J. N. Goswami, of Physical Research Laboratory, Ahmedabad, for scientific study. "Efremovka is one of the most pristine meteorites in our collections," says Ritesh Kumar Mishra, the first author, who is at Ruprecht-Karls Heidelberg University. "Hence, there is a much greater probability of finding preserved isotopic records from the time of formation of the solar system, which is contemporaneous with the formation of CAIs," he adds.

The first suggestion of irradiation by the Sun as a source of elements found in early solar system solids came from a study of the beryllium-10 radio nuclide in the Allende meteorite. Before this suggestion, it was believed that the only source of such elements was the contribution from

ambient gas and dust. More recently, another hypothesis was added – namely that the beryllium-10 in CAIs could also arise core-collapse supernova from a low-mass star. Each of these possibilities would lead to different scenarios for the formation of the solar system. Since beryllium-10 has a very long half life of about 1.38 million years, it is possible that a part of it could have been created in any of the above processes. Therefore, studying beryllium-10 does not clearly indicate which of the three hypotheses is correct.

This work, on the other hand, studies both beryllium-7 decaying to lithium-7 and beryllium-10 decaying to boron-10. This short half life of beryllium-7 helps rule out the two competing theories and indicates that it is only irradiation by solar flares that led to the formation of the elements captured by the CAI.

"To understand the activity of Sun further, we could look at recurrence of such events in various time scales and its effect on evaporating and recondensing solids in the early solar system," says Dr. Marhas.

Now, culture more skin cells in less time

Indigenous hydrogel was used in lieu of conventional plastic tissue culture plates

R. PRASAD

By using an indigenously developed hydrogel made of a polymer (polyacrylamide) in lieu of the conventional plastic tissue culture plates, researchers at the Indian Institute of Technology (IIT) Bombay have been able to achieve many-fold increase in the number of skin cells (keratinocytes) cultured in the lab. Unlike traditional methods, no feeder layer or drug is needed when cells are grown on the hydrogel substrate.

Rapid expansion of keratinocytes, which make up most of the skin cells, without losing the physiological functions, is essential when treating chronic wounds and burn patients. Keratinocytes for the study were supplied by Dr. Chitra Nayak of BYL Nair Charitable Hospital, Mumbai and co-author of a paper published in the journal *RSC Advances*.

Compared with plastic plates, cells grown on hydrogel have better physiological functions. Both wound healing and the ability to take up viruses (lentivirus), which act as a gene delivery vehicle, are better when the cells are grown on hydrogel, the team found.

Stiffness of substrate

The relatively less-stiff hydrogel substrate developed by a team led by Abhijit Majumder at the institute's Department of Chem-



Ankita Srivastava (left), Pankaj Mogha and Susant Kumar are the first authors of the paper.

ical Engineering facilitates rapid multiplication of cells. The cells could multiply up to 25 generations while those grown on plastic plates stopped growing after 12-15 generations.

"In 10 days, the number of skin cells grown on plastic plates reaches one million while cells grown on hydrogel become 20 million," says Prof. Majumder, who is one of the corresponding authors of the paper. "There was rapid proliferation of cells and we were able to get more number of cells in less time."

Besides quantity, even the quality of cells grown on hydrogel was better than cells grown on plastic plates. "Cells grown on gel were able to secrete the molecules essential for recruiting the immune cells," says Prof. Majumder.

The hydrogel allows rapid

multiplication as its stiffness is about 1 lakh times less than plastic plates – plastic plates have stiffness of 1 GPa. The team found that growing cells on hydrogel with 10 kPa and 20 kPa produced more cells than when grown on either rigid plastic or gels that are much softer (5 kPa).

The keratinocytes adhere to the substrate and tend to contract, thereby experiencing high tension (traction force). The traction force experienced by cells increases with stiffness of the substrate on which they are grown. As a result, when cultured for long, cells grown on stiffer plastic plates age faster. "Senescence is low when cells are grown on gel. That's why they are able to multiply up to 25 generations," says Prof. Majumder. "Patients with burn and chronic wounds require

plenty of skin cells and need them immediately. So we need a method that allows for rapid multiplication of cells with the physiological functions remaining intact," says Rahul Purwar from the Department of Biosciences and Bioengineering at IIT Bombay and the other corresponding author. Similarly, in the case of epidermolysis bullosa skin disorder requiring gene therapy, the entire sheet of epidermis is defective and has to be replaced with epidermis containing cells with normal copy of the gene.

Quick method needed

Keratinocytes make up more than 90% of the skin cells. Even in the case of deep burns (which are not restricted to the skin surface), covering the skin with keratinocytes helps in preventing infection and water loss. Hence, a technique that produces more cells quickly helps.

Up to two generations, cells grown on plastic plates and gel substrate tend to close the wound in a similar fashion. However, fewer cells are available at the end of two generations when grown on plastic plates. "When cells of eighth generation are used, those grown on the gel are able to better close the wound than cells grown on plastic plates," says Prof. Purwar.

The researchers intend to carry out trials on animal models but that would depend on the availability of GMP facility and funding.

India might soon have the most Caesarean births

ASWATHI PACHA

A new study based on the data from the National Family and Health Survey has shown that there is a significant increase in the rate of caesarean births in India.

While the WHO recommends the rate of caesarean delivery to be 10-15%, the number was 17.2% for India during the period from Jan 2015 to Dec 2016. This is higher than the rate seen in rich countries such as the Netherlands and Finland. The report says that if this trend continues, India could soon have the largest number of C-section births in the world.

But is C-section bad? A 2018 report in *The Lancet* pointed out that the prevalence of maternal mortality and morbidity is higher after caesarean than after vaginal birth. Also, it is noted to be associated with an "increased risk of uterine rupture, abnormal placenta, ectopic pregnancy, stillbirth, and preterm birth." Many studies have pointed out that babies born via C-section have less bacterial exposure, which in turn alters their immunity and gut microbiome diversity. Children tend to have increased chances of allergy, asthma, and childhood obesity.

The study noted the rates varied widely across States, with just 5.8% in Nagaland to 57.7% in Telangana. When taking socioeconomic conditions into account, the researchers found that the rate of C-section was as small as 4.4% among the poorest group to 35.9% among the richest quintile.



The caesarean ward of a primary health centre. (Photo shown for illustrative purpose).

"More than a third of the births are delivered by caesarean section among the richest quintile and in several states of South India such as Andhra Pradesh, Kerala and Telangana – with rates above 50% reported in some districts", underlines Alexandre Dumont, demographer at the Population and Development Center, the French Research Institute for Development, Paris in a release. He is one of the authors of the study published in *JAMA Network Open*.

Class, a factor

The high rates point out that there is increased C-section deliveries among non-risk pregnancies in the privileged classes. "A C-section is carried out only during medical emergencies. But if the individual insists, that is if it is out of choice, we inform them about all the pros and cons and perform only after full consent," explains Dr. Gayatri Kartik, senior Obstetrician and Gynaecologist at Manipal Hospital,

Bengaluru. "While we have no direct information on the factor behind the rise of C-sections among the privileged classes from this survey or other sources, we presume that several factors may be at play such as desire for comfort, and fear of pain and health risks from women, and organisational and medical simplicity as well as financial benefits from clinics," explains Dr. Christophe Z Guilmo, in an email to *The Hindu*. He is the corresponding author of the study.

"There is an urgent need to monitor the deliveries in clinics and hospitals. The government should inform practitioners and women of the unnecessary risks of non-medically justified C-sections," he adds. "India has to face a 'double burden' of providing C-sections to populations that still have no access to it (because of poverty, remoteness or lack of facilities, etc.) and at the same time of curbing overuse."

Tree crickets face low predatory risks during mate-searching

AATHIRA PERINCHERY

Love is risky in the natural world especially for males of most species because their serenades and movements to actively seek out females can be picked up by predators. But deviating from the norm, tree crickets – both males and females – face low and similar predation risks, finds a study. The low predation levels also question the popular notion that predation is the major factor influencing

the evolution of communication, according to scientists at the Centre for Ecological Studies in Bengaluru's Indian Institute of Science.

The team including then doctoral scholar Viraj R. Torsekar estimated predation risk in the tree cricket *Oecanthus henryi*, males of which call loudly. The team first conducted surveys in an unused farmland in Karnataka's Chikkaballapur to identify the main predators of the cricket. Acoustic playback

and field predation experiments revealed that this distinction went to green lynx spiders, which could be picking up acoustic cues and vibrations of crickets' movements.

The team then studied three spatial scales at which the spiders and crickets interacted. First, they quantified the probability that spiders and crickets occurred on the same bush together. They searched around 120 bushes to locate calling males and

counted non-calling males, responding and non-responding females and spiders, to find that all the insects co-occurred in each bush at similar probabilities.

Next, they determined the probability of crickets encountering spiders on a bush. They released a wild-caught cricket (calling and non-calling males, responding and non-responding females) and later, a spider, onto the same bush in an outdoor enclosure; success-

ful or failed attacks and captures by spiders counted as encounters. Almost 200 trials revealed that regardless of whether males were calling or not, and whether females responded or not, crickets encountered spiders at the same probabilities. A similar experiment with 105 trials to determine the probability of a cricket being eaten showed that the spiders captured very few crickets (only six), again, on similar probabilities whether males



Field assistant Manjunatha K. Reddy making observations during one of the experiments. VIRAJ R. TORSEKAR

were calling or not and females responding or not. The three probabilities together reveal predation risk for crickets to be low, and si-

milar across sexes, in the team's paper published in *Evolutionary Ecology*. While searching for mates, males are thought to face a higher

predation risk compared to females but our paper dispels this surprisingly rarely-tested notion, said Mr. Torsekar (currently with The Hebrew University of Jerusalem, Israel).

An alternative explanation for the shared mate-searching behaviour in tree crickets could be the 'direct benefits' that females of some insect species receive from males during mating, added Mr. Torsekar. In *O. henryi*, a gland on the male's back releases nutritious secretions that the female drinks during mating, he said.