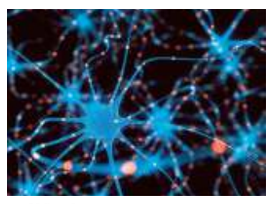
CAPSULE

Amphibians in peril
A fungus *Batracochytrium dendrobatidis* is affecting amphibian species globally, even causing extinctions. Strangely, the fungus does not seem to be causing declines in amphibian populations in Asia, the place of its origin, a report in *Science* says. The analysis also shows evidence of recovery in some species, under favourable conditions..

Saturn's tiny moons
New analysis of observations by Saturn mission, Cassini spacecraft in its close flyby show interesting sides to the five tiny moons embedded among its rings. These are covered with material from the planet's rings as well as icy particles blasting from Enceladus, its large moon. This hints at competing processes shaping these tiny moons, researchers from NASA say.



A lifetime's neurons
Scientists suspect that at least two areas in the brain - the centres of the sense of smell and the hippocampus, the seat of learning and memory - grow new neurons throughout life. Now, a paper in *Cell* describes mice models in which one type of stem cell that makes adult neurons is the source of this lifetime stock of new cells in the hippocampus.

Brain response
Earlier studies on how the brain represents location of an animal only dealt with two dimensions – as in rats running on a floor. A *PNAS* paper analyses what happens when rats moved on the floor and also climbed walls. They found that the firing of grid and place cells constantly changed and the brain has to constantly readjust itself.

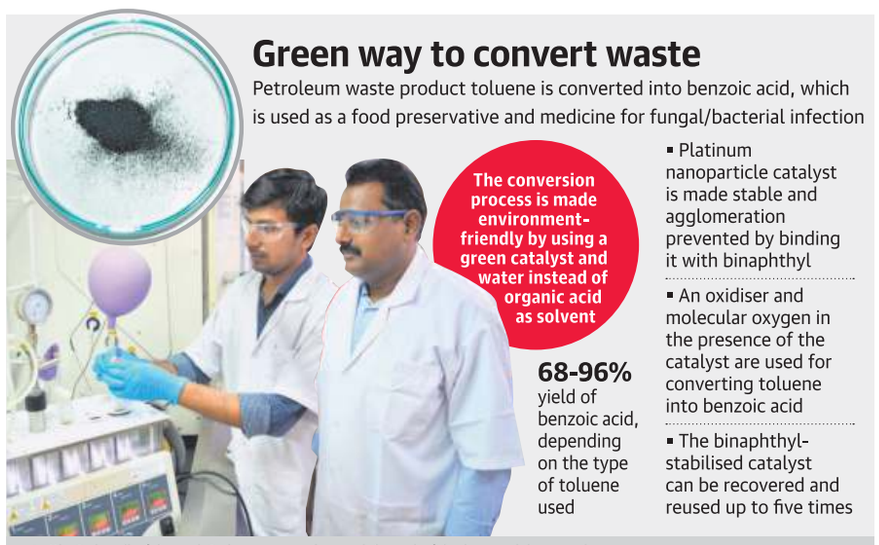
Invading Galapagos
In a stunning discovery, researchers who were studying a part of the Galapagos islands found that over 50 non-native species had found their way into the island, which numbered nearly 10 times more than expected. Sea squirts marine worms and moss animals formed the bulk of these. Most of these arrived in ships from tropical seas.

IIT Madras converts petroleum waste toluene into useful product

A green oxidant and water instead of organic acid were used for converting toluene into benzoic acid

R. PRASAD

Using platinum nanocatalyst, a two-member team at the Indian Institute of Technology (IIT) Madras has successfully converted petroleum waste-product toluene into benzoic acid. Benzoic acid is used as a food preservative (E210) and medicine for fungal/bacterial infection. Toluene is converted into benzoic acid through selective and controlled oxidation in the presence of a catalyst – binaphthyl-stabilised platinum nanoparticles (Pt-BNP).



Rajib Saha (left) and Sekar at work; and (top left) the stable catalyst.

Green oxidant

Generally, organic reactions are carried out using organic solvents, which makes it expensive and also generates toxic waste. So in a departure from current practice, the team led by G. Sekar from the institute's Department of Chemistry has used water as solvent to make it environment-friendly. Also, a green oxidant (70% aqueous tert-butyl hydroperoxide or TBHP) is used for converting toluene into benzoic acid.

"When toluene is oxidised, it gives four products. But when we use the catalyst that we developed, only benzoic acid is produced. No alcohol, aldehyde or ester is produced," says Prof. Sekar. The yield of benzoic acid varied from 68-96% depending on whether the toluene used is electron-deficient or electron-rich. The results of the study were published in the journal *Applied Catalysis B: Environmental*.

Central to the work is the novel catalysts that the team developed. Generally, platinum nanoparticles are not stable in nature as they tend to agglomerate and become macroparticles. The catalytic activity is reduced once it becomes macroparticles. The binaphthyl that is bound to platinum nanoparticles acts as a stabiliser and prevents nanoparticle agglomeration.

"Binaphthyl bound to platinum nanoparticles makes the catalyst easy to handle and stable. It is the stability of the catalyst to remain as nanoparticles that allows us to recover it and reuse the catalyst up to five times," says Prof. Sekar. There was no change in the size of the catalyst even after being reused five times.

Toluene when oxidised gets converted into benzoic acid. Molecular oxygen when used alone does not oxidise toluene and so no benzoic acid is generated. So the researchers used TBHP as an oxidiser. "The catalyst reacts with TBHP to initiate the oxidisation reaction where toluene gets converted into benzoic acid through a series of reaction steps," says Rajib Saha, a PhD student at IIT Madras and co-author of the paper.

Economical combination

When used alone, a large quantity (four parts of TBHP to 1 part of toluene) of TBHP would be required for the conversion, which will not be economically favourable. In order to reduce the amount of TBHP used, the researchers also used molecular oxygen.

"In the presence of molecular oxygen, only two parts of TBHP are needed for the conversion. So molecular oxygen behaves as a co-oxidiser," says Prof. Sekar. "Molecular oxygen is cheap, so using it along with TBHP helps in reducing the cost." The use of TBHP along with molecular oxygen also increased the yield of benzoic acid.

Climate change may hit India's wind power

ASWATHI PACHA

Increased warming in the Indian Ocean and the resultant weakening of the Indian summer monsoon may come in the way of India's goal of leading the world's wind power generation.

Analysing the available wind and atmospheric data from 1980-2016, researchers from Harvard University, U.S., and National Climate Center in Beijing, China, found the potential electricity production of windmills across India had decreased by about 13%. And this trend might continue.

However, researchers in India have raised doubts about the results of the study. "The data used by the team does not correlate with the live data we have. We have started additional studies to validate these results and will publish the findings soon," says Dr. K. Balaraman, Director General, National Institute of Wind Energy, Chennai, under the Government's Ministry of New and Renewable Energy.

In the paper published last December in *Science Advances,* the researchers showed a decline in electricity production in the States of Rajasthan, Maharashtra, Gujarat, and Karnataka. No significant decline was seen in Tamil Nadu, which is located on the east coast and, thus, had different wind conditions during summer.

Long-term goals

"The government could concentrate on setting up more projects in this region [Tamil Nadu] as the lifetime of wind turbines is 20 to 30 years. We need to look at long-term goals," says Meng Gao, a postdoctoral fellow at the School of Engineering and Applied Sciences, Harvard University and senior author of the study in a release.


Long-term: The government could set up more projects in Tamil Nadu, says Meng Gao.

Summer winds

Summer winds in India are driven by the temperature contrast between the Indian subcontinent and the Indian Ocean, and the warming in the Indian Ocean reduced this contrast. Also, warming of the Equatorial Indian Ocean resulted in a decline in the wind speed.

The Indian government has set a target of 60 GW of cumulative wind power capacity by 2022. The researchers say that this goal can be beneficial only if planners in India take these historical reconstructions into account while setting up wind power installations in the future. "Our findings can provide suggestions on where to build more wind turbines to minimise the influences of climate change," said Prof. Michael B. McElroy, from the School of Engineering and Applied Sciences, Harvard University and senior author of the study in a release.

Nanomagnet assembly to make up efficient logic gate

These solutions can complement CMOS devices

SHUBASHREE DESIKAN

A group at Indian Institute of Technology (IIT) Hyderabad has proposed a novel design methodology for constructing an adder logic gate using nanomagnets from magnetic quantum dot cellular automata. At a stage when conventional CMOS (Complementary metal oxide semiconductor) devices are approaching a saturation in terms of power efficiency, this comes as an effective step towards a complementary approach. AI applications such as speech and face recognition, used for instance in self-driving cars, require 3D cameras and real-time processing. These are computation-intensive and in dire need of efficient solutions. This technology is a complementary solution to CMOS devices in this, being both power efficient and non-volatile. In a paper published in *IEEE Transactions in Nanotechnology,* the group shows how modifying the shape and alignment of the nanomagnet assembly can improve earlier models of such adders.

Santhosh Sivasubramani, research scholar and the first author of the paper, explains the advantage: Power dissipation in CMOS logic circuits can be divided into dynamic and static dissipation. The former is caused by on-currents passing through the CMOS logic gates due to logic operations, and the latter by leakage currents in the CMOS gates even during standby mode in which no logical operations are executed. If the system is turned off, it loses its state data; however, in nanomagnetic computing, it possess the property of non-volatility. "Dramatic reductions in power consumption are possible in magnetic chips down to as little as one-millionth the amount of energy per operation used by transistors in modern computers," he says.


Disruptive: Magnetic chips can show drastic reduction in power consumption, says Santhosh Sivasubramani.

Graphene

Initially, around year 2000, copper wires were used in the circuit along with the nanomagnets. However, the size of these wires were large compared with the nanomagnets. This group, under the leadership of Amit Acharyya from Department of Electrical Engineering, IIT Hyderabad, tried and succeeded in using graphene wires which circumvented this problem. "Now, to make the logic gates, we are proposing nanomagnets with special shape and alignment," says Dr. Acharyya.

To obtain a MQCA (Magnetic Quantum-dot Cellular Automata) circuit that performs a logic operation, such as addition, normally three oval nanomagnets need to be used for input and one for output . Further, the input nanomagnets need to be driven by an external driver magnet.

The two techniques the team advocates are using slant-edged nanomagnets (which are rectangular in shape but with a slant cut at one corner) and also those that are aligned at 45 degree angle with respect to the other nanomagnets used. This drastically reduces the number of nanomagnets needed and also the power consumption. "We already have undertaken the work on getting 32-bit and 64-bit adder circuits developed using this proposed concept so that larger circuits implementation will become feasible," says Dr. Acharyya.

Camera traps reveal secret lives of rarely studied small cats

The team obtained 783 photo captures from around 27,500 trap nights between 2013 and 2018

AATHIRA PERINCHERY

We know camera traps can help count tigers. Now, a team has used this technology to estimate activity patterns of some, rarely studied small cats of northeast India. Their findings suggest that factors other than inter-species competition could explain why some of these wild cats occur in the same area together.

Northeast India is home to nine wild cats, including the 'standard four': the clouded leopard, Asiatic golden cat, marbled cat and leopard cat. However, very little is known about these cats in this region at present, such as what times of the day they are most active or how they do not out-compete each other for resources despite living in the same ecosystem.

Standard four

A collaborative study by 14 researchers led by principal scientist Shomita Mukherjee (Salim Ali Centre for Ornithology and Natural History, Coimbatore) compiled information from ten independent camera trap studies to estimate the activity patterns of the 'standard four' in Assam, Arunachal Pradesh, Nagaland, Meghalaya and Mizoram. The team obtained 783 photo captures from around 27,500 trap nights (the total number of nights the camera traps were deployed) between 2013 and 2018. Based on the time that each photo was captured, they analysed their activity patterns.


Habits: Leopard cats are mostly nocturnal. ▪ ROHAN PANDIT

Their results, published in the *Journal of Threatened Taxa,* reveal that all four cats occurred together only in three of the 10 sites surveyed. Analyses of activity patterns showed that Asiatic golden cats and marbled cats were strongly diurnal, the clouded leopard largely crepuscular and nocturnal, and the leopard cat mostly nocturnal. Like others across southeast Asia, this study also found that the activity times of the marbled cat and leopard cat did not overlap much, in areas where they occurred together and otherwise.

According to the authors, this suggests something other than inter-species competition could be at work here. Both cats could be utilising different niches (marbled cats have long tails that suggest arboreality so they could be catching arboreal prey, while leopard cats are known to feed primarily on ground prey, especially rodents), said Dr. Mukherjee.

"However, more detailed studies of several aspects including diet and activity would be required to confirm this," she said. The study also shows how data from already conducted camera trap studies can be used to learn more about other less-known species, she added.

Take a deep breath to be calm and alert

That 'sniffing' or breathing-in drives brain activity has an evolutionary history

SPEAKING OF SCIENCE

D. BALASUBRAMANIAN

In college debate competitions, you had to respond to your opponent effectively and win, and do so in a short time. There was also this competition called 'Just a Minute' where the referee would ask you to talk about a topic that he chooses; you should talk about it for one minute - no hemming and hawing, no irrelevant words and no catching for breath. And the one who makes the most sensible speech in a minute wins.

In all this, our teacher or 'coach' would tell us: "take a deep breath before you start;it will improve your performance". That he was right has recently been confirmed by a study from a group of scientists, led by Professor Noam Sobel of the Weizmann Institute of Science, Israel, titled "Human non-olfactory cognition phase-locked with inhalation" (Perl et al., *Nature Human Behaviour,* 11 March 2019 <https://www.nature.com/articles/s41562-019-0556-z>. A nice 'popular' summary of this work has been presented by Dr. Yivsam Azgad of the media relations group of Weizmann. In this paper, the authors compared performance within a group of volunteers where they presented cognitive tasks to them, concurrent with inhalation or exhalation. The tasks included mathematical puzzles, spatial visualisation problems (whether a 3- dimensional figure could exist in reality) and verbal tasks (whether the words shown on the screen were real).The experiment was designed in such a manner that the subjects were not aware that their inhalation of breath was being monitored. And at the same time, the electrical activity to each of their brains was monitored using EEG (electroencephalograms).

The 'sniffing' brain

Three points of note came out of the trial. First, they found that in trials where the participants inhaled while attempting the task they did better than when they exhaled. Second, whether one inhales through the nose or the mouth, it did not matter much, though 'the picture-perfect' pattern would prefer nasal over oral breathing in. Third, the EEG results also showed altered patterns of connectivity between different parts of the brain which differed along the respiratory cycle.

Note that as we inhale, we take up oxygen from the air. So, is it the oxygen that they inhaled which helped? When asked, Professor Sobel said: "No; the time frame does not fit. The response time was far sooner than the time it takes for oxygen from the lungs to reach the brain... It is not only the olfactory system that is sensitive to inhalation and exhalation, it is the entire brain. We think that we could generalise and say that the brain works better with inhalation...We think of this as the "sniffing brain".

Most ancient sense

The paper also points out that the sniff alone – no odourants – orchestrates neural activity; thus it is not necessarily good or pleasant smell versus bad smell. The group hypothesises that nasal inhalation, apart from processing incoming information, also optimises non-olfactory (not just related to smell) mechanisms for incoming interactions. That 'sniffing' or breathing-in drives brain activity has an evolutionary history. Unicellular organisms and plants take in volatile or gaseous substances in the air into their cells (this may be thought of as the precursor to inhalation). We know how sniffing is carried out in synchrony with whisking and vocalisation in mice and with echolocation in bats. Dr. Ofer Perl points out that olfaction is seen to be an ancient sense, which may have acted as a template for other, later senses and overall brain development in humans. The authors note that the word 'inspiration' in the Oxford Dictionary not only means drawing-in of breath but also the process of being mentally stimulated.

Yoga and meditation

While these authors do not directly address this question, we note that several scientists have suggested that yogic exercises (controlled breathing) lead to calmness and tranquility. In a set of experiments at Stanford University, USA, showed how a group of 175 neurons in the brain act as the breathing pacemaker in mice (used as models), and how controlled breathing promotes mental calmness in the animals (Yackle *et al., Science,* 355, 1411-1415, 2017, <doi:10.1126/science.aai7984>). Turning to humans, the paper by Dr. Bailey and colleagues from Monash University in Australia (https://doi.org/10.1011/396259) compared 34 people who practised meditation with 28 age/gender-matched 'controls'. The 'meditators' had an increased range of brain activities to meet tasks requirements, higher-order processes and sensory anticipation. Likewise, a group from Beijing, China (Ma et al., *Frontiers in Psychology* 2017 <doi:10.3389/fpsyg.2017.0084>) conducted a trial using 20 people, who were trained to breathe at the rate of 4 breaths/min (a la yoga), while 20 others were controls. The comparison revealed that the trained group had significantly lower levels of cortisol and improved sustained attention. Finally, a systematic critical review by Zaccaro and others (doi.org/10.3389/fnhum.2018.00353) concludes that slow breathing techniques enhance parasympathetic activity, emotional control and psychological well being.

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