CAPSULE

Elephants and carbon
If forest elephants go extinct, it can seriously increase carbon dioxide levels, a study published in *Nature Geoscience* claims. Elephant populations in African forests encouraged the growth of slow-growing trees which had a high wood density and sequestered more carbon, it found. This is because they preferentially eat fast-growing varieties leaving slow-growing ones.

Habitable world
TESS, NASA's mission to search for exoplanets, may have found the first potentially habitable world. The super-Earth exoplanet is named Gj 357 d, which is only 31 light years away, was discovered earlier this year. The exoplanet orbits a diminutive dwarf star and is 22% larger than the Earth. There are two other exoplanets in the system. The super-Earth has a thick atmosphere and may possess water.

Tigers in India face lurking threat from virus

There is heightened risk of disease transfer from dogs to tigers, leopards in Ranthambhore National Park

ASWATHI PACHA

The Prime Minister's announcement that tiger numbers have increased in the country may be good news. But the loss of habitat, a decline of prey and poaching continues to be a threat to tigers' survival. Along with these, a potential virus – Canine Distemper Virus (CDV) – that can be transmitted from CDV-infected dogs living in and around wildlife sanctuaries has started to raise concern among wildlife biologists.

Canine distemper is a contagious and serious disease caused by a virus that attacks the respiratory, gastrointestinal and nervous systems of puppies and dogs.

Loss prevention: Last year, over 20 lions from the Gir forest succumbed to the canine distemper virus infection, and now a guideline has been prepared by the National Tiger Conservation Authority . ▪ RAJEEV BHATT

Risk of disease transfer

A recent study published in *Threatened Taxa* notes that 86% of the tested dogs around Ranthambhore National Park in Rajasthan carried CDV antibodies in their bloodstream. This means that the dogs are either currently infected or have been infected sometime in their life and have overcome the disease. This finding points out that there is an increased risk of disease transfer from the dogs to tigers and leopards that live in the park.

Last year, over 20 lions from the Gir forest succumbed to the viral infection and now a guideline has been prepared by the National Tiger Conservation Authority to prevent the spillover of the disease to wild animals.

"The main aim should be to vaccinate the free-ranging and domestic dogs in the area around national parks. A lot of NGOs have started started animal birth control programmes. They need more support from the government," says Dr. Jimmy Borah, Consultant, Species Conservation and Law Enforcement, Panthera, and the corresponding author of the paper. "The disease needs to be recognised and more targeted studies need to be initiated to collect baseline data on CDV from wherever they are reported from in wild carnivores. Understanding the role of domestic animals as contributors to a local CDV reservoir is imperative precursor in considering control measures."

Blood samples

The study was done from July to August 2015 when the team visited villages (in a 4 km radius) around the Ranthambhore National Park and collected blood samples from over 100 dogs. The results showed that 86% of the studied dogs had CDV antibodies in their blood. These dogs wander into the forest along with the humans, and there have been cases where leopard have hunted these dogs. "Studies from Russia and Africa have shown that small, isolated wildlife populations are more susceptible and when the virus transmits from one species to another the disease manifestation is worse," adds Dr. Borah.

Easier route

"The easy way out is prevention. Managing any disease in a wildlife population is extremely difficult. Most dogs are free ranging and not owned by any particular person in the village. The government should take the initiative to vaccinate the dogs around wildlife sanctuaries in the country. This would be a good time to vaccinate against rabies as well. It is an investment that requires time and effort but increasing herd immunity will reduce chances of disease spillover to wildlife," says Nadisha Sidhu, first author of the work. She was a researcher with the World Wide Fund for Nature-India when the work was done and is now a consultant for Ashoka Trust for Research in Ecology and the Environment, Bengaluru.

Ms. Sidhu says there were only a few CDV suspected cases in India when she started her work in 2015, and so was considered not important. But with the CDV confirmed deaths of lions in Gir, more attention has been drawn to the disease. She hopes more studies are conducted to get countywide data on the disease prevalence so that necessary prevention guidelines can be laid out.

Bonding: Eye contact has an important role in dog-human relationships. ▪ S. RAMESH KURUP

Eyes of the beholder and the beheld

It is not how the dog looks, but how he 'puppy looks' at his owner

SPEAKING OF SCIENCE

D. BALASUBRAMANIAN

A recent report described the remarkable prowess of a female dog in the Kaziranga National Park in Assam. She could sniff the presence of poachers of the rhinoceros and tigers and warned the forest officials about it. The officials named it Quarmy since she was equal to a quarter of an army. Likewise two dogs named Nirman and Myna sniffed the presence of tigers and their poachers in the Madhya Pradesh forests.

Keen senses

Dogs belong to the wolf family and have inherited a keen sense of smell and vision from them. Wolves have over 300 million smell receptors compared to just 6 million in humans and can smell the presence of someone 3 kilometres away. And they have sharper vision and hearing – they can hear their prey 10 km away. Dogs have inherited these senses of smell, sight and hearing. We know of how dogs sniff malaria and even cancer in humans (see earlier article on 9-12-2018). Happily enough, dogs are tamer than wolves and can be domesticated. A recent report by a team of researchers from UK and USA describes yet another feature of dogs, namely how a dog's facial muscles have evolved over the years as they were domesticated and that their ability to raise their eyebrows resembles ours. This ability, argue the researchers, have triggered their nurturing by humans, making dogs our "best friends" (Kaminski et al., Evolution of facial muscle anatomy in dogs, *PNAS*,116: 14677-81,July 16, 2019).

Dogs were domesticated about 33,000 years ago. As they were domesticated by us, we started selecting and preferring those that better matched our relationships. Such selections have involved the ability of dogs that are able to read and use our communications better than other animals are not able to. As the authors point out: "dogs are more skilful in using humans communicative cues like pointing gestures or gaze direction even than human's closest living relative chimpanzees."

Eye contact has turned out to be an important contribution to the dog-human relationship. A Japanese group points out that mutual gaze between dogs and human leads to biochemical changes both in the owner and the pet dog, and an attachment akin to that between a mother and her infant! To quote the researchers again: "The most likely evolutionary scenario is that dog's ancestor must have, to some extent, expressed characteristics that elicited care-giving response from humans. Humans then consciously or unconsciously favoured and therefore selected for those characteristic leading to the analogous adaptations in dogs today".

Mutual gaze

And of these, mutual eye contact and gazing has been an important contribution. Dog owners know only too well how moving the gaze of their pet is – sometimes so sad that they need to be hugged, and some other time so upsetting that you want punish them. The UK-USA group has done particular research on how the facial muscles and the anatomy of dogs have been selectively evolved to contribute to this mutual eye contact and the "language" expressed in such gazes. We humans favour dogs that show "paedomorphic" (infant-like) features like large forehead, large eyes and so on. The team has also shown that a particular set of facial muscles make the eyebrows raise and lower, which is appealing to us humans.

In order to determine whether domestication has shaped facial muscles to facilitate dog-human communications, the researchers compared in detail the facial anatomical features of domestic dogs on the one hand and grey wolves on the other. Compared to dogs, wolves are unable to raise the inner part of their eyebrows. Also, while dogs have a muscle that pulls the eyelid towards the ear, wolves are not able to. Dogs are also able to produce eyebrow movements that are more frequent and expressive. These are what people call the "Puppy Dog" eye movements – sad, happy, don't care, and other expressions remarkably similar to human infants. There is no such "Puppy Wolf" movement of the eyebrow. And this puppy dog movement of the facial muscle anatomy has come about thanks to selection pressure in breeding based on human preferences.

The best dog need not be the cutest or the most beautiful. It is the one that looks at you and you return. The look is mutual affection. In the California annual contest called the World's Ugliest Dog, the winner in 2019 is "Scamp the Tramp", one with beady eyes, no teeth, short stubby legs, and his owner Ms Yvonne Morones is justly proud of him. It is not how the dog looks, but how he 'Puppy Looks' at his owner and she at him. Beauty is in the eyes of the beholder and the beheld.

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▪ AFP

Extreme weather and humans

Study finds European heat wave was made more likely, intense by human-induced climate change

ASIAN NEWS INTERNATIONAL

The extreme heat waves that enveloped parts of Western Europe last month were made much more likely and intense by human-induced climate change, a study has found.

A recent report from the World Weather Attribution group has suggested that the continuous days of extreme heat that hit countries like France and Netherlands would have been a once-in-a-millennium occurrence without climate change but were made up to 100 times more probable as a result of it.

In the U.K. and Germany, the event is less rare (with estimated return periods of around 10-30 years in the current climate) and the likelihood is about ten times higher (at least 3 times) due to climate change, the study added.

Though in all these countries, the temperature would have been 1.5 to 3 degrees Celsius lower without climate change.

The said group has analysed all seven heat waves in the 21st century in Europe (2003, 2010, 2015, 2017, 2018 and June 2019), and found that each one was made more likely and more intense due to human-induced climate change.

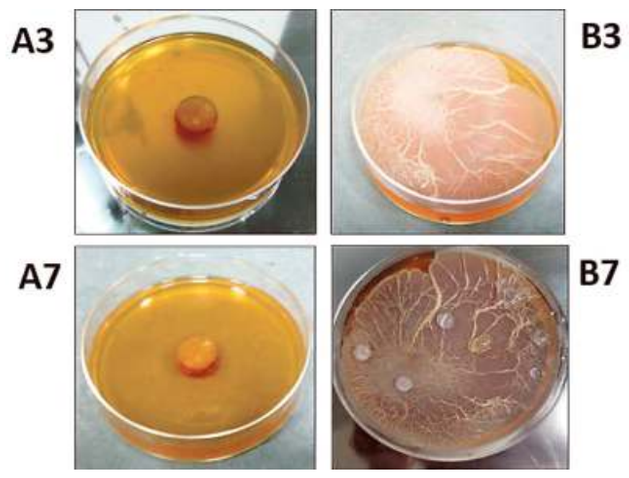
"The July 2019 heatwave was so extreme over continental Western Europe that the observed magnitudes would have been extremely unlikely without climate change," the report concluded.

A step closer to oral administration of kala-azar drug

IIT Hyderabad achieved controlled, sustained drug release for 10 days

R. PRASAD

By encapsulating an antifungal drug in polymer nanofibres, researchers at the Indian Institute of Technology (IIT) Hyderabad have been able to achieve controlled and sustained release of the drug for up to 10 days. As a result, no fungal growth was seen up to seven days when the drug (Amphotericin B) was encapsulated in the polymer. The encapsulated drug can also be used for treating kala-azar.



Effective: Drug-loaded tablet displayed antifungal activity on days 3 and 7 (left column) compared with control (right column)

Oral administration

Most importantly, the antifungal activity against *Candida albicans* was observed when the encapsulated drug was compressed to form oral tablets. This would mean that oral administration of the drug might become possible if initial results achieved in the lab can be replicated in animal and human clinical trials. Currently, oral administration of the drug has major challenges – high toxicity, reduced bioavailability in the body due to poor solubility in water and high cost.

Researchers from IIT Hyderabad led by Chandra S. Sharma and Saptarshi Majumdar from the Department of Chemical Engineering produced nanofibres containing the drug by electrospinning the drug-gelatine polymer solution. The gelatine polymer is extremely water-loving (hydrophilic) and so is not stable. To increase the stability and allow the drug to be released in a controlled and sustained manner, the researchers used a commercially available crosslinker.

"The drug is found on the surface of the gelatine nanofibres but remains encapsulated when compressed into tablets," says Prof. Majumdar.

"The cross-linked polymer matrix allows the drug to diffuse slowly when the polymer degrades. We have controlled the diffusion rate so it is released over a period of 10 days," says Prof. Sharma. Only *in vitro* studies have been carried to test the stability of the tablet and controlled release. The results of the study were published in the journal *Nano-Structures & Nano-Objects*.

Stability of tablet

Since the main goal was to study if the drug can be administered orally, the researchers tested the stability of the tablet for eight hours at extremely acidic condition (1.5 pH). The stomach has acidic pH and the polymer should be stable for up to four hours. After eight hours at low pH, the tablets were kept for 10 days in an alkaline medium of 7.4 pH. "The tablets were stable for eight hours at low pH. The polymer matrix showed signatures of degradation after the sixth day but was stable for 10 days," says Mrunalini K. Gaydhane from IIT Hyderabad and one of the first authors of the paper.

The researchers found that each day 10% of the drug was released from the polymer through diffusion. The drug was completely released from the polymer matrix at the end of the 10th day.

Negligible toxicity

"We had used mice fibroblast cells for testing toxicity of the drug. There was negligible toxicity to cells even at the end of five days. In fact, the cells continued to multiply," says Gaydhane.

Only 20 mg of the drug in 500 mg of polymer was used for making the table used for testing. "Our next target is to achieve the same drug release profile with dosages used for therapeutic purposes," Prof. Sharma says.

The chemical crosslinker used in the study is highly toxic. In order to reduce toxicity, the researchers exposed the gelatine polymer to saturated vapour of the crosslinker for just six-eight minutes. In the conventional process, crosslinking takes 24 hours to complete. "Reducing the time taken to cross-link reduces toxicity. But we are now looking at increasing the stability of the polymer matrix without using any crosslinker," Prof. Majumdar says.

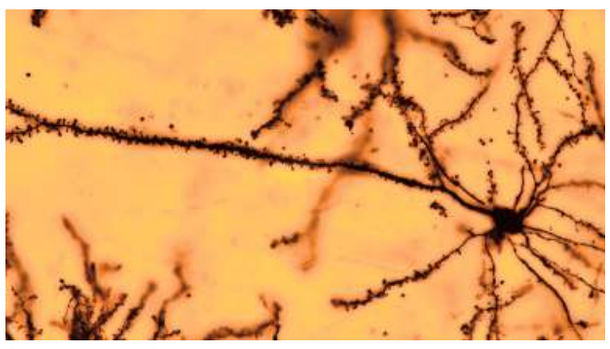
NCBS study shows how stress can affect fear memory

It may be possible to reverse fear memories that have been abnormally strengthened by severe stress

SHUBASHREE DESIKAN

Fear memories formed before and after experiencing chronic stress can have very different behavioural effects. They also affect the brain morphology differently, finds a study. The researchers, based in National Centre for Biological Sciences (NCBS) Bengaluru came to this conclusion by studying male Wistar rats.

The researchers find that it may be possible to reverse fear memories that have been abnormally strengthened by severe stress. This is because, they find, the process of fear memory reversal itself is not impaired by stress. "This is the good news emerging from our study. Of course, these ideas need to be tested in human subjects in great detail before therapeutic relevance can be fully assessed," says Sumantra Chattarji of NCBS in whose lab the study was conducted. The results are published in the journal *Psychopharmacology*.



Spiny neurons: Pyramidal neuron from the medial prefrontal cortex of a rat, showing the dendritic spines.

In a pair of experiments that studied the behavioural aspects, the rats were taught to fear a 20-second-long tone of approximately 70 decibels. Later, they were subjected to a training where they were made to realise and learn that they need not fear the tone, which the scientists call as fear extinction exercise.

In the first experiment, the experimental rats were subjected to chronic immobilisation stress for 10 days after which fear memories were formed. Another group was subjected to same stress for 10 days but here the fear memories were formed on the first day. The control groups in both cases were not subjected to the stress treatment and were only given the fear formation and extinction treatments.

The results showed that when fear memories were formed after stress treatment, both acquisition and overcoming the fear were impaired.

In a separate experiment, the morphological effects of stress were studied by studying eight rats. Four of these were controls and four were subjected to stress. After 10 days, the rats were sacrificed and thin slices of their brains were examined.

The researchers studied and counted the dendritic spines on specific neurons in the two sets of animals. Dendritic spines are contact points where a neuron communicates with other neurons. "We found that due to stress, the number of dendritic spines increases in the amygdale [where fear memory is formed], but decreases in the infralimbic area [where memory reversal happens] of the medial prefrontal cortex," explains Prabahan Chakraborty from NCBS and the first author of the paper.

Effect on neurons

An increase in the number of dendritic spines is seen as an increase in the capacity of the neuron to communicate with other neurons. This strengthens the functioning of that neuron. So the above morphology experiment shows that stress acts in two ways. It not only increases the capacity of neurons involved in fear memory formation but also decreases the capacity of the neurons involved in memory reversal, thereby making it doubly difficult to erase the fear memory.

"While these results are pretty novel and add an entirely new dimension to earlier research, we feel that our findings are quite robust for several reasons," says Dr Chattarji. According to him, an important reason is that the analysis of cells in different brain regions involved in these behaviours also undergo structural changes that are consistent with the results of the behavioural experiments.

One of the main challenges was to train the animals and execute the experiments flawlessly over a long time. "Experiments in animal behaviour are often susceptible to the finest fluctuations in something as trivial as handling the animals. Extreme care was needed to avoid unnecessary experimental confounds," says Mr Chakraborty.