JANTAR MANTAR

CHILDREN'S SCIENCE OBSERVATORY

English Bi-Monthly

Volume 21 Issue 5 September-October 2021 Rs. 15.00

Water, heat, storms and lightning

D. Indumathi,

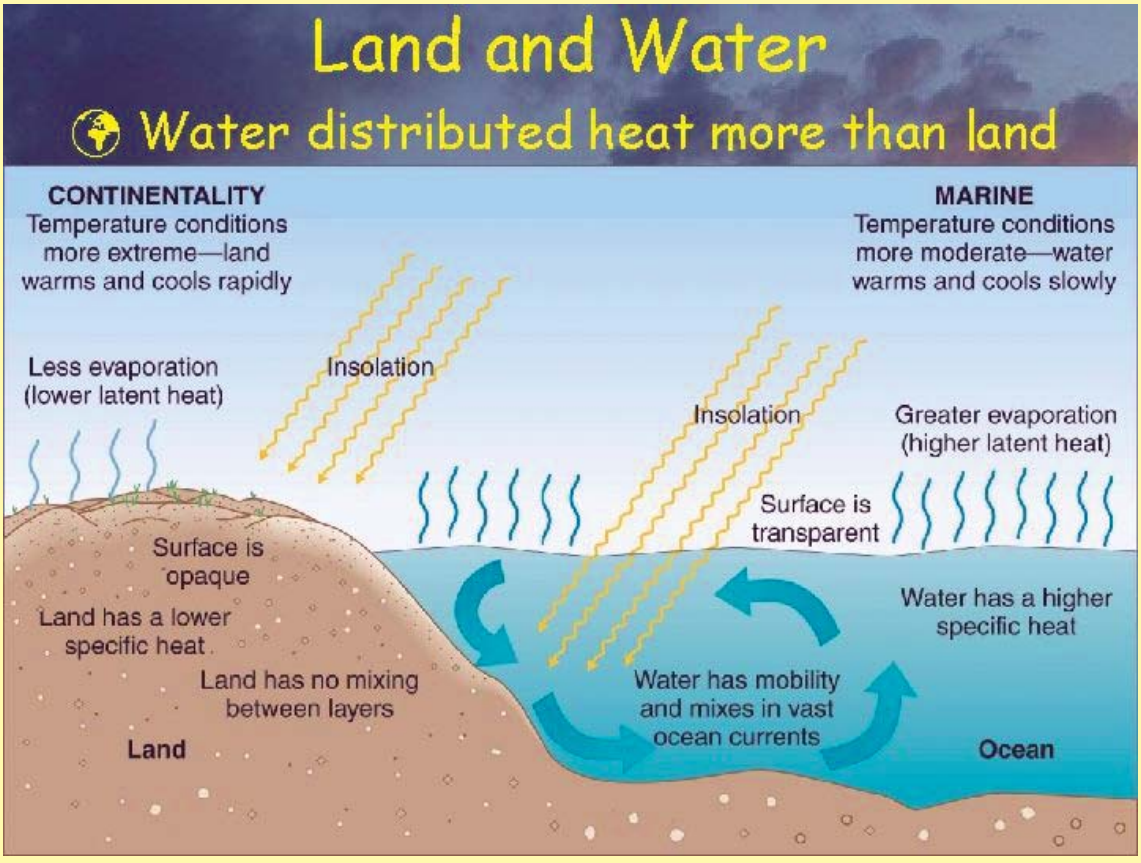
The Institute of Mathematical Sciences, Chennai

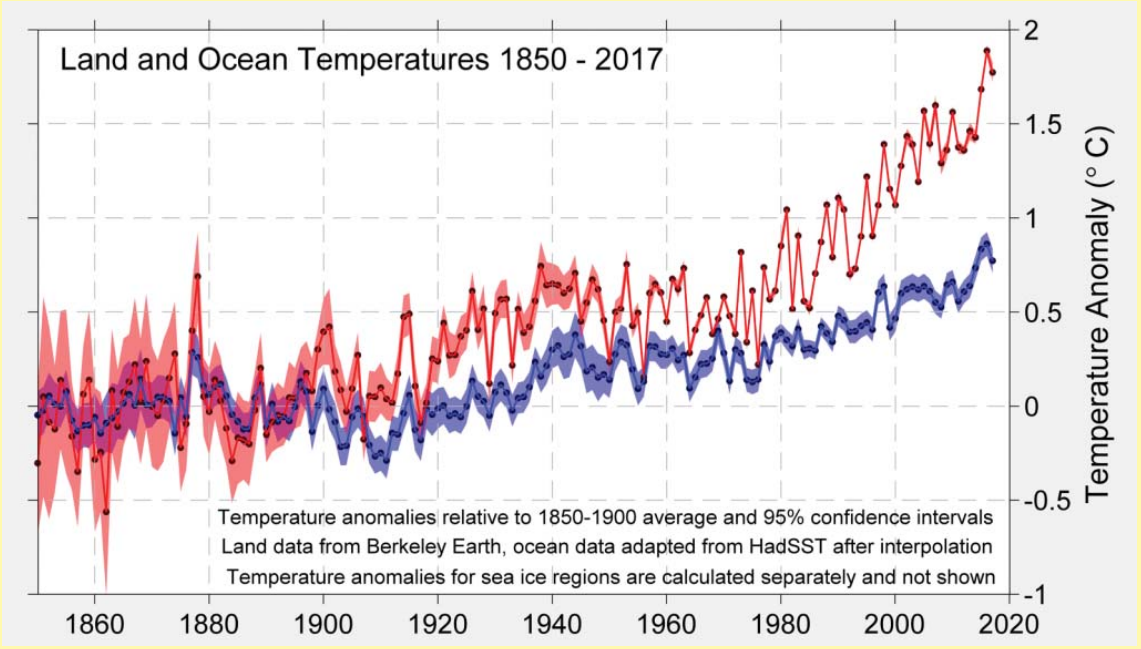
Who hasn't enjoyed a proper thunderstorm? The rain pouring down in buckets, the flash of lightning and the rolling sound of thunder. Both thunder and lightning are associated with thunderstorms. But what causes them to form in the first place?

The Earth is heated up by the Sun during the day. The land gets very hot while water (in the sea and lakes) does not heat up as much. You may have noticed this if you live on the coast, like in Chennai. In the day time, you will burn your feet if you try and walk on the sand, but the moment you reach the sea and put your feet in the water, it is deliciously cool. (Do you know why that is so? See the box.)

Humans and climate change

Last year, global temperatures were 0.95C warmer than the 20th century average. Human activity is responsible for around 100% of this warming. But this temperature rise is not uniform across the





Earth. The increase in temperature over land areas is almost twice as much as over the oceans (1.75C over land and 0.77C over water). Hence the continents are warming more rapidly than the oceans.

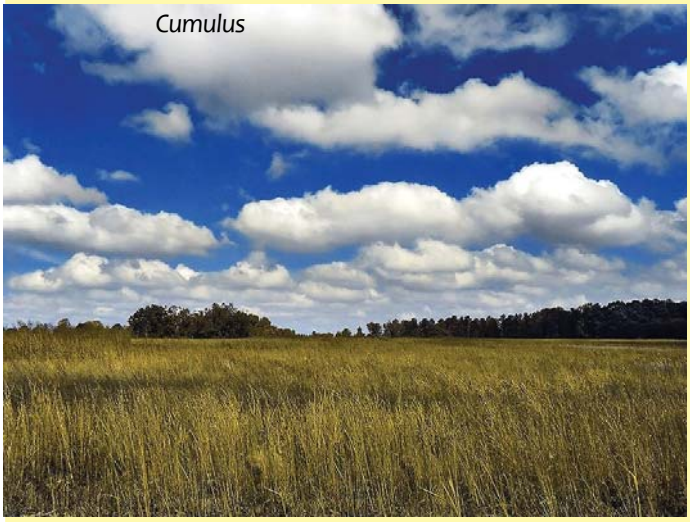
Climate and weather

While global warming is a sign of *climate* change, the heating and cooling of the land and sea have always been there. The daily (or short-term) changes over a region of the Earth determine the *weather* in that region. Stormy weather, for instance, is something locals in Chennai come to expect during the North-Eastern Monsoon that sets in about

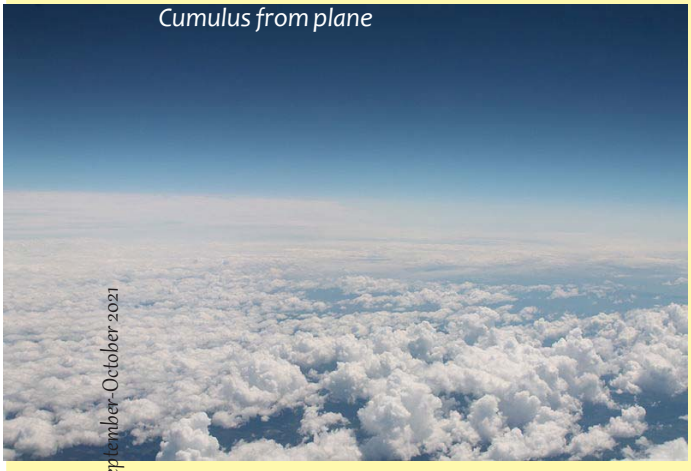
Why water does not heat up as much as land

Metals get hot very fast, but water does not. This is because of a property called specific heat. This is the amount of heat to be given to unit mass of a substance to increase its temperature by 1C. For instance, if you give 450 Joules of heat energy to 1 kg of iron, its temperature will increase by 1 degree, but to achieve the same for 1 kg of water, you need to give 4200 Joules, almost 10 times the heat. Because the specific heat of water is so high, the temperature of water in the sea hardly changes by a few degrees through the day. But sand gets very hot easily. Similarly, at night, sand (land) also loses heat easily and becomes colder than water.

Apart from this property, there are also other factors. For instance, water is light and transparent, while land is not, so land absorbs more solar radiation. Also, texture matters. A tar road is hotter than a grass lawn because the rough surface of the road absorbs more heat. In fact, sometimes it gets so hot that the tar melts! Finally, there is a complex relation between temperature and the amount of moisture in the air.



Cumulus



Cumulus from plane

October every year.

How storms and rain form

We already saw that land gains and loses heat quickly over the day compared to water. Since the air is thinner as you go higher above Earth's surface into the lower atmosphere (called the **troposphere**), the temperature also decreases with height.

Cumulus clouds

During the day, the air is warmer and water evaporates. The moist hot air rises and forms clouds called *cumulus* clouds.

Climate change and the role of oceans

At night, after the Sun has set, sand and soil lose their heat much faster. But it turns out that Earth's oceans are more important than the land as far as the weather is concerned. For one, the oceans cover more than two-thirds of the Earth's surface. They also absorb more sunlight and store more heat. Additionally the Sun's rays penetrate the oceans to a depth of many meters, but only heat up the top layer of the sand or soil. Since water has to lose more energy than the sand (dry land) in order for the temperature to decrease, the oceans retain heat longer.

These are white fluffy clouds, generally seen low down in the sky (about 2,000 m high). If you have been in a plane and seen them from above, they will look like cotton balls.

Cumulo-nimbus clouds

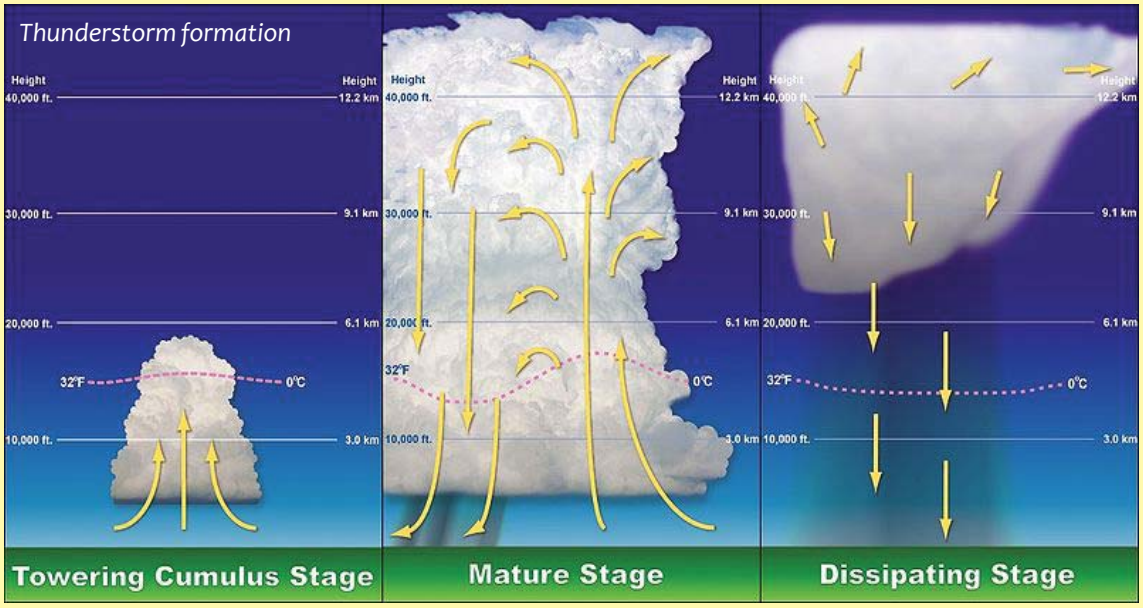
If the sun is hot enough, it can drive these cumulus clouds very high until they reach the upper end of the troposphere (called the **tropopause**). These are the rain-bearing clouds. The air flow inside them is complex, with warm air rising and cool air descending on air currents called *drafts*. The moisture in the cool air has now frozen to ice. The interaction of these two different motions (so that they sort of rub against one another) causes electricity to be generated — actually the bottom of the cloud becomes charged.

Thunder and lightning

Typically, the atmosphere acts as an

Cumulonimbus

insulator and so the charges just stay in the clouds. But at some point the insulation breaks down (just like in a spark) and the charges flow between two clouds or from the clouds to the ground in the form of **lightning**. The streams of charge cause the surrounding air to become super-heated to 25,000C. This causes the air to cool by expanding so suddenly that the air further away is compressed and causes a shock wave. The crackling of air during the discharge is heard as **thunder**. Typically, this happens in the afternoon, when the hot noon sun drives the moist warm air upwards



Tornado_lightning

to form these clouds. You may have noticed how often it rains in the afternoon of a hot day.

These cumulo-nimbus clouds not only generate lightning and thunder, they cause even tornadoes and hail.

Sometimes the thunder lasts a really long time. This is because as the cloud discharges to the ground, more charges from the ground reach up to meet the discharge. So there are several "forks" of lightning and each of these channels create thunder.

So when you listen to thunder, you'll first hear the thunder created by that portion of the lightning channel that is closest to you. As you continue to listen, you'll hear the sound created from the portions of the channel farther and farther away. Typically, a sharp crack or click will indicate that the lightning channel was very close. If the thunder sounds more like a rumble, the lightning was far away. The loud boom that you sometimes hear is created by the main lightning channel as it reaches the ground.

Types of Lightning

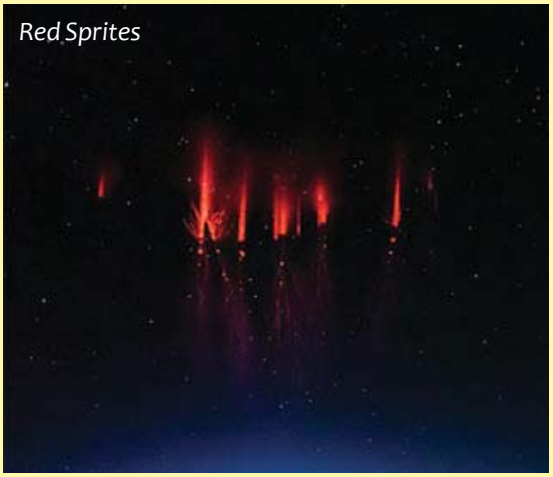
Lightning is not just a big bolt from the clouds to the ground, although that is the most commonly observed one. But there are other exotic types of lightning as well.

Distance of storm

How far away is your storm? You must know that light travels very fast indeed (at 300,000 km/s) while sounds travel a million times more slowly, at about 330 m/s. So you will always see the lightning before you hear the thunder that accompanies it. The lightning reaches our eyes almost instantaneously.

A general rule of thumb to know how far off a bolt of lightning is when you hear thunder, if you count the number of seconds between the flash of lightning and the sound of thunder, and then divide by 3, you'll get the distance in miles to the lightning: 3 seconds = 1 km, 9 seconds = 3 km, 0 seconds = very close.Thunder can be heard from a storm as far as 15 km away.


Blue Jets


Red Sprites

One of the most sought after is **ball lightning**, where the lightning looks like a ball, but this is possibly not really lightning.

Blue Jets

One of the most exciting ones is the blue jet lightning. Although it had been seen for a long time, it was not known how blue jets formed, until scientists looked for a blue jet from above the clouds using the **International Space Station**. They spotted one in February 2019. It appeared above a storm over the Pacific Ocean near Australia.

A flash of bright blue light started off the jet. It started at the top of the cloud (about 16 km above the ground) and rose to 52 km, high into the **stratosphere** (the next layer above the troposphere). Its speed was such that it lasted only half a second.

Why was it so short and why was it blue? asked the scientists. We know that llightning forms when electricity flows between two oppositely charged parts of clouds (or from cloud to ground). When these two regions are very close, say, about a km apart, a very short but very powerful surge of current could be produced. Since the energy was very high, it produced a blue flash. As the jet travelled out into the stratosphere, it heated the air which begins to glow. Now, the stratosphere has mostly nitrogen gas and this glows blue, giving blue jet lightning.

Red Sprites

Another strange lightning that is visible only above the clouds is a burst of red light that seems to hang in the air. They are called red sprites. A *sprite* is a fictional elf or fairy, almost a ghost. The red sprites were so called because they were so hard to see, above the clouds, although they can be 50 km high! Also, they last just milliseconds. But they were caught at last, by scientists who went up in planes with high speed cameras to try and photograph them.

Understanding blue jets better and red sprites will help us understand the physical and chemical composition of Earth's upper atmmosphere. Would you want to be in a plane, photographing lightning at night, when there is a storm outside?! If so, perhaps this is the career for you!

Sources: Science News for Students, Smithsonian, NOAA, Wikipedia

Seasons from the Sun

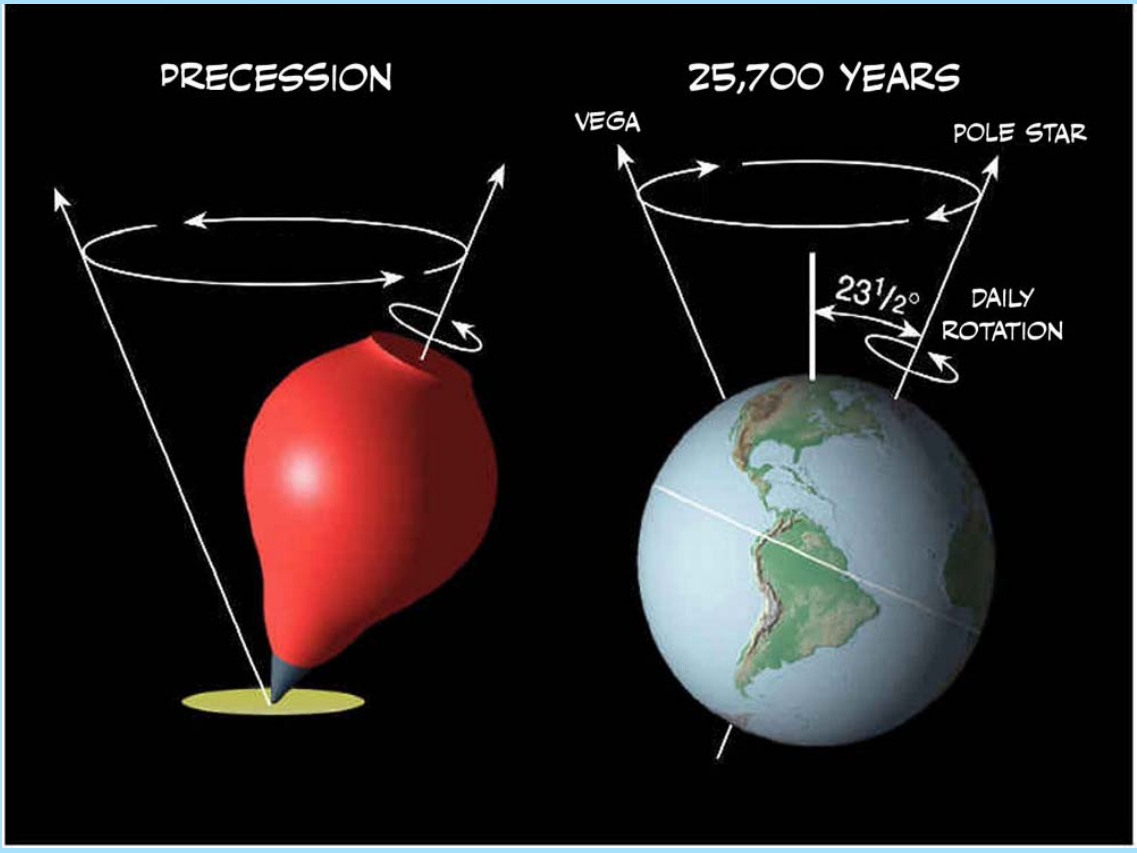
Kamal Lodaya,
Bengaluru

This is the seventh of a series about calendar makers from history.

Earlier articles talked about **lunar** calendars based on *phases* of the Moon, *seasonal* calendars based on seasonal happenings (such as rains or river flooding which were important for farmers) and *intercalary* calendars whose years were seasonal but whose months were based on the Moon's phases.

There are several calendars in India, using different Eras.

The Earth's axis is tilted relative to the plane of its orbit and it's this tilt, which gives us our seasons. No tilt would give no seasons, but the tilt of the Earth oscillates from 22.1 degrees to 24.5 degrees and back again over 41,040 years. When the Earth is more highly tilted we experience more extreme seasons, hotter summers and colder winters. Right now we're almost exactly in the middle of the cycle with an axial tilt of roughly 23.4 degrees. This variation in the rotation of Earth is called *precession*, like a top whose axis keeps shifting slightly as it spins. This makes the solstices (longest and shortest days) shift to an earlier date every year, which becomes noticeable over centuries. To fix this, a *leap day* was introduced to the seasonal year every four years by the Egyptians, and later by **Julius Caesar** of Italy helped by an astronomer called



Kali Yuga 5122				
Month	Days	Duration	Sankranti	Festivals
Chittirai	31	30:22:26:48	14 Apr 3am	Cheiraoba, Meshadi, Bihu
Vaikasi	31	31:10:05:12	15 May 1am	
Aani	32	31:15:28:24	15 Jun 11am	
Aadi	31	31:11:24:24	17 Jul 2am	Dakshinayana, Navroz
Aavani	31	31:00:26:48	17 Aug 2pm	Simhadi, Onam
Purattaasi	31	30:10:35:36	17 Sep 2pm	
Aippasi	30	29:21:26:24	18 Oct 1am	
Karthikai	29	29:11:46:00	16 Nov 10pm	
Margazhi	29	29:07:37:36	16 Dec 10am	Lohri
Thai	30	29:10:45:12	14 Jan 5pm	Maghabihu, Pongal, Uttarayana
Masi	30	29:19:41:12	13 Feb 4am	
Panguni	30	30:08:29:00.56	15 Mar 0am	Jamshedinavroz

Sosigenes.

Seasonal calendar, 6th century CE

In earlier articles, we mentioned the Indian **National** calendar of 1957 CE, following the *Shalivahana Shaka Era* which began in the year 78 CE. It uses a leap day every four years, when the month of *Chaitra* has 31 rather than 30 days. This follows the idea of Sosigenes, in which the month of February has 29 rather than 28 days.

A related Indian **Nirayana** calendar is ahead by three weeks, beginning on 14 April rather than 22 March. In this, it is the month of *Phalguna* which has a leap day.

The **Tamil** seasonal calendar, based on the Sun, was described by the *Sangam* poet **Nakkirar** around the 3rd century CE. In 499 CE, the Indian astronomer **Aryabhata**, an *Ashmaka* (likely from the Godavari valley) who lived in **Kusumapura** (Patna in Bihar), introduced the *Kaliyuga Era*. He declared the Tamil calendar beginning with *Chaitra* (*Chittirai*) that year to be 3600 KE. His seasonal calendar is used in Kerala and Tamil Nadu.

Aryabhata was a mathematician. He wanted to *calculate* the seasonal months, *without* using a leap day. If the Sun moves by 360 degrees during a year (actually it is Earth going around the Sun, but keep Earth fixed for convenience), then moving by 30 degrees is a seasonal month. This can be roughly determined by which of 27 *nakshatras* is highest in the sky at midnight, hence opposite to the Sun. The Sun will move by 2 1/4 nakshatras every seasonal month, if we think of nakshatras as covering parts of the Sun's path, rather than as just stars.

Here is how these ideas work, roughly speaking. When the Sun travels in the sky from *Revati nakshatra* (star) in **Meena rashi** (constellation) to *Ashwini nakshatra* in **Mesha rashi**, this is called Mesha *sankranti*, and the *Chitra nakshatra* in **Kanya rashi** is exactly opposite and highest in the sky at midnight. The seasonal month is called **Chaitra** or **Chittirai** after the opposite nakshatra. Thirty degrees after Mesha comes **Vrishabha rashi** and one can find out when the Vrishabha *sankranti* takes place.

Duration of seasons

It turns out that the Sun's speed through the sky is not the same. In the **table** are observations of the lengths of months from earlier years, which

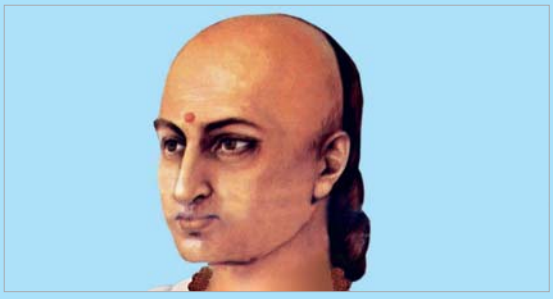
Numbers and calculation

Do you find Aryabhata's calendar easier or Julius Caesar's? As seen in the last issue of ***JM***, the Indians had developed arithmetic calculations that we learn in school, by the time of Aryabhata. They were delighted to use their new knowledge at every possible opportunity.

Aryabhata knew the Roman calendar, because one of Varahamihira's five texts was the *Romaka Siddhanta*, known in India since 2nd century CE. One can imagine Aryabhata thinking: 31,28,31,30,..., why do days in months have to be in this arbitrary fashion? Why have months like July and August, arbitrarily named after emperors, when they can be named after stars for a sensible reason? Why not just calculate the days in every month?

Little is known about him, yet Aryabhata's work appears scientifically minded. Some historians think he taught at the university in **Nalanda**, Bihar. Arithmetic calculations were not then taught in primary schools like they are today. Keeping track of the exact time of *sankrantis* from year to year and sunrises or sunsets from month to month was not easy.

This goes back to 575 CE, when **Varahamihira** compiled all the calendars known to him in his **Panchasiddhanta** (meaning "five texts"). He combined earlier Hindu and Jain calendars based on the Moon with Aryabhata's calculations of the Kaliyuga calendar. Aryabhata's and Varahamihira's calendars were taken up by *jyotishis* who made *panchangs* (publicly available calendars). Varahamihira's grandfather, father and son, as well as he himself, were jyotishis.



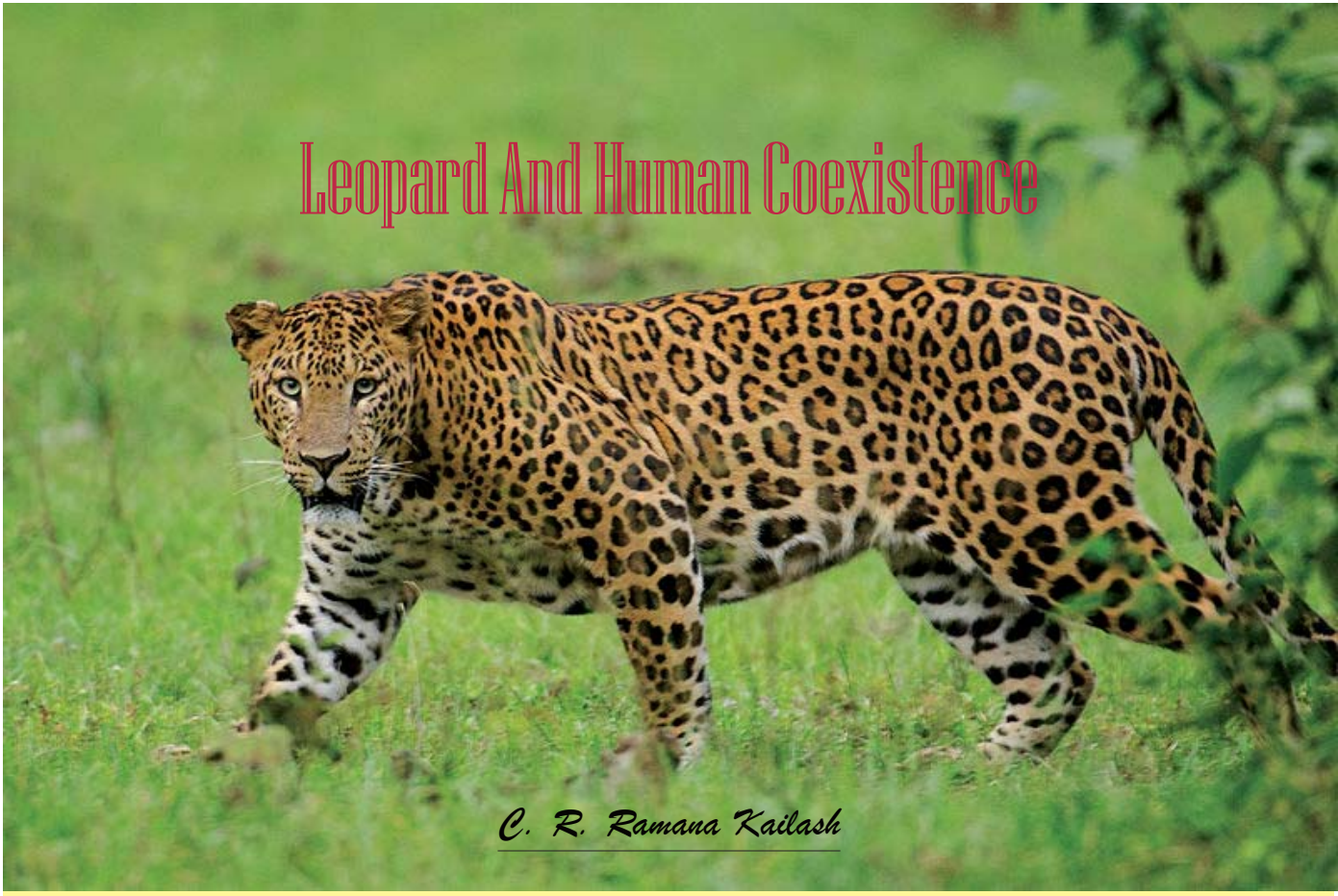
were compiled in texts like the *Surya Siddhanta*, attributed by 6th century polymath **Varahamihira** of Ujjain to **Laatadeva** (which suggests a person from the Narmada valley). It was updated to the *Vakya* version several centuries later. The second last column of the table is written in units of days, hours, minutes and seconds for our convenience. The last column gives festivals determined by this calendar.

Now if you know what time Mesha *sankranti* was (about 3 AM on 14th April) this year, you can just add up from the table and calculate the other sankrantis. So, in the Tamil calendar this year, **Karthikai** seasonal month will begin on 17 November and not on 16 November, since the *sankranti* time is at night. You can see that **Aani** seasonal month this year had 32 days! If you know how the festivals at the end of the table are connected to the calendar, you can find out their dates yourself. If you add all the durations in the third column of the table, you will find that one year lasts 365:06:12:36.56 (days:hours:mins:seconds) and so the next Sankranti is on 14 Apr at 9am the next year

Isn't this all wrong? If you ask any one, they will tell you that this year *Deepavali*, falling on the *amavasya* (New Moon) of **Karthikai** *lunar* month, is on 4th November. This is nowhere near the seasonal month of **Karthikai** shown in the table! This is because we also have months determined by the Moon.

*The story continues in the next issue of **JM**.*

Leopard And Human Coexistence



C. R. Ramana Kailash

Leopards are one of the most adaptive big cats in the world. They live from frigid regions Of Russia to hot and humid rainforests of Indonesia; from Arabian deserts to African savannah.

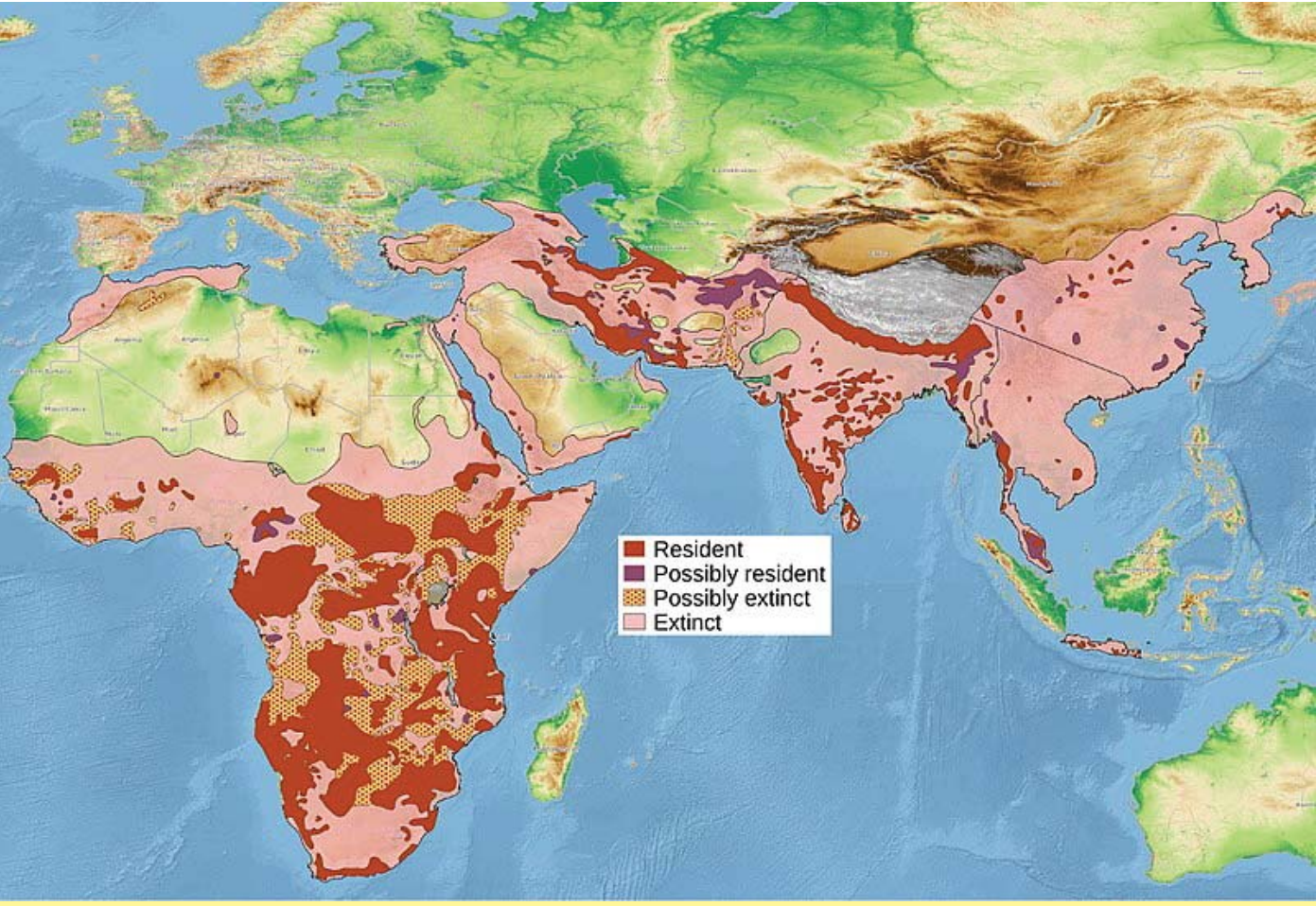
While big cats around the world struggle to survive the pressure exerted by humans, a subspecies of leopard had managed to survive in the concrete jungles of one of the busiest cities in the world; the Indian leopard. But it doesn't mean that these leopards thrive in urban regions. For last two decades, human-leopard conflict has risen rapidly. This causes loss on both sides, humans and leopards conflict each other for habitat. Leopards have started to encroach the cities and villages of India as we, humans destroyed their habitat.

Further, human's tolerance towards leopards has decreased in the past few years. This results in conflict: humans poison leopards as they kill their livestock and leopards attack humans. A few leopards turn into man-eaters, worsening the situation. Nearly 200 leopards are killed in India by villagers annually.

Maharashtra, Uttarkhand, Northern parts of Bengal, Gujarat and Himachal Pradesh are the states facing severe leopard- human conflict.

Leopard-Human conflicts in India

Urban leopards are increasing all over India, especially in one of the busiest cities of Asia, Mumbai. The Sanjay Gandhi National Park lies beyond the bustling chawls and apartments of Mumbai. This 103



sq.km forest is sandwiched by the city, with no corridor to connect with other forests. This forest could be sustainable for three male leopards, but nearly 60 leopards live in the park, causing territorial fights among leopards.

Lack of prey and less area has pushed these crafty feline to adapt to the suburbs of Mumbai. Thousands of stray dogs and other domestic animals roamed in the Mumbai roads; leopards soon adapted to the bustling urban environment, hunting dogs and pigs. Inevitably, leopard-human conflict started becoming intense. Even though most leopards preyed on dogs and other animals for most of the time, a few leopards turned man-eaters, especially preying on small children.

Sustainability

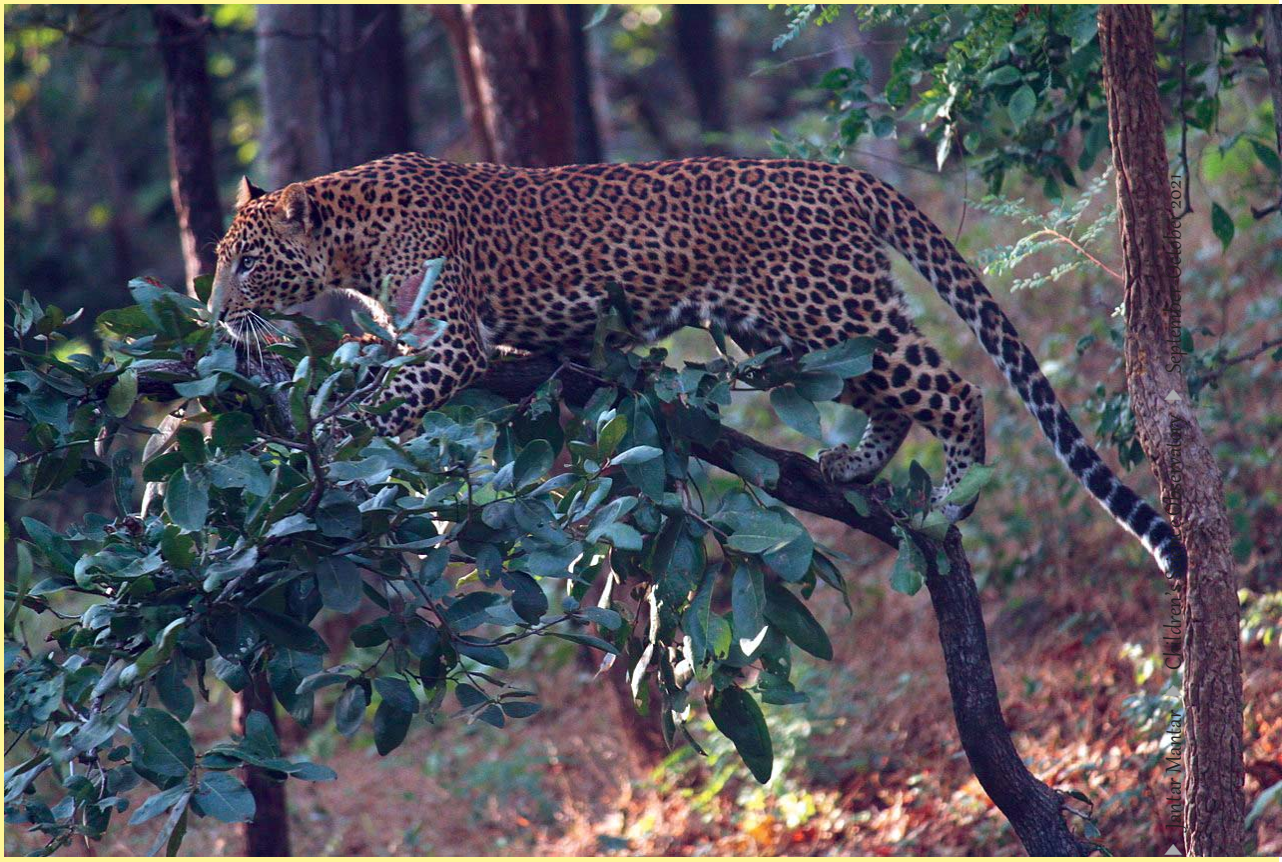
What does sustainability mean in the context of leopard habitats? Leopards are very fast creatures and like to inhabit scrub jungle with small prey that they can catch easily because of being able to chase them down in the open jungle. Typically, leopards live to about 20 years in the wild. So, sustainable means that there should be enough prey and area available for the population living there. Moreover, they should be able to live there undisturbed, without disturbance from humans.

Selfie in Mumbai

Soon, man-eater leopards were captured and a campaign titled 'Living with Leopards' was conducted all over Mumbai. Awareness had led to coexistence of both species; conflict between humans and leopards has decreased considerably. But leopards still roam in the nights of Mumbai.

Prey animals of leopards in Mumbai are not owned by people, they are feral animals. But in rural India, leopards attack livestock of farmers which are major money yielders for farmers; this intensifies the conflict. Farmers poison leopards, dozens of leopards die in India because of poisoning, annually. A few leopards still see humans as their prey; vast farms provide a good cover for these felines to hunt.

Once, leopards all over India preyed on humans. But elimination of man-eaters by game hunters like **Jim Corbett** and **Kenneth Anderson** had resulted in leopards developing a fear towards humans. Today, leopards are killed by villagers considering



▲ Jantar Mantar | Children's Science Revelry | September - October 2021

them as pests. In few instances, villagers beat leopards to death. It is leopards that are in danger now.

Jawai-a solution for the conflict

While conflict between humans and leopards are increasing all over India, villagers of **Jawai** in **Rajasthan** figured out how to coexist with India's most feared predator. Located in the north western part of India, this small village adjoins a large, thorny forest in rocky outcrops of the Aravalli range; this thorny bush forest serves as home for 50 leopards. **Rabari** tribes, a semi nomadic herders, and shepherds live in these villages. Vast pastures of land serve as grazing field. Leopards frequently hunt their precious livestock but they have a mutual relationship with these animals as the state government gives compensation to them.

Many shepherd in Jawai work as part-time tourist guides as Jawai forests draw hundreds of tourists. Money from tourism is additional income for the villagers. People here consider leopards as sacred; the villagers also welcome leopard's presence in their field as leopards drive out *Neelgai*, *deer* and other herbivores. Leopards in turn seem to consider humans not as a threat. Not even a single attack has happened in the Jawai hills for past one century. People here work as a community to save these magnificent predators.

Even though a similar scenario may not be practical all over India, mutual understanding, tourism and awareness can be the key factors to help in conservation of leopards. We can't teach a leopard to avoid humans; but we can teach a human to tolerate leopards. Reducing urbanization in the vicinity of forests, maximizing forest cover and spreading awareness about

Facts about leopards

- The leopard is the smallest of the big cats, with the male being almost 50% larger than the female.
- Leopards are a near threatened species in India.
- Leopards are very fast and can run at up to 60 km/h!
- They can leap 6 metres forward through the air and jump almost 3 metres high! It uses its curled tail to maintain balance during the jump.
- Leopards can see seven times better in the dark than humans. Being nocturnal animals, they are more active at night and spend their days resting, camouflaged in the trees or hiding in caves.
- Due to their resemblance to the shape of a rose, the spots of a leopard are called rosettes and each individual leopard has a unique rosette pattern. Difference in the rosettes shape and colour can also be observed in different regions.
- The tongues of all felines, from house pets to leopards, are covered with tiny barbs or hooks, giving them a rough texture. These microscopic projections face toward the cat's throat, and are the tools that help to groom its coat. In the wild, these hooks help to tear the flesh off the bones of the big cat's prey!

leopard conservation will be the last hope for peaceful coexistence between the two species.

Sources: Wildlifesos.org, Wikipedia

Puzzles to puzzle you

1. Find the birthday

When asked about his birthday, a man said:

"The day before yesterday I was only 25 and next year I will turn 28."

This is true only one day in a year - when was he born?

2. Ordered times

Mari saw that his oven digital clock was showing 01:23, and noticed that each number was one higher than the number to its left.

He wondered: of all the different clock times from 00:00 to 23:59 in a 24-hour clock, how many are like that? And what exactly are those clock times?

Can you help him out?

3. Mathematical grandmother

Mimi asked her Granny how old she was. Rather than giving a straight answer, she replied:

"I have 6 children, and there are 4 years between each one and the next. I had my first child (your Uncle Pethu) when I was 19. Now the youngest one (your Auntie Janaki) is 19 herself. That's all I'm telling you!"

How old is Mimi's Granny?

Adapted from www.mathsisfun.com

Answers on page 35

On the move

Kamal Lodaya,
Bangalore

Fifty years ago, travelling from Guwahati to Jorhat on NH37, our bus broke down in Kaziranga National Park in the afternoon. The highway runs through the southern side of the Park, separating it from the hills of Karbi Anglong further south. The park is about 13 km from north to south.

We were terrified. In those days there was no traffic on the road in this region in the absence of daylight. The driver told us we had to leave the place. The reason was that the animals in Kaziranga migrate across the road— Elephants, rhinoceroses, wild buffaloes, tigers, leopards— in search of food.

Apparently elephants find the bamboo in the tea gardens on the hills more tasty. When it rains they prefer to move from the waterlogged northern side along the Brahmaputra river to the drier south. But if they are thirsty they are more likely to find water in the north.

Well, nothing dramatic happened. Another bus came along. At our driver's request, everybody from our bus (including the crew) were accommodated on the other bus and taken to Jorhat. The mechanics came to repair our abandoned bus the next day.

●●●

From the late 1990s onwards, elephant herds, said to be displaced by the Subansiri dam project in Arunachal Pradesh, appeared on the fertile *chaporis* (islands) of the Brahmaputra river (Majuli is the biggest), where crops like sugarcane were grown. This was the first time that elephants were found swimming across a river to forage for food. The numbers grew to nearly 150 since the herd seemed to accept new members, unlike most herds

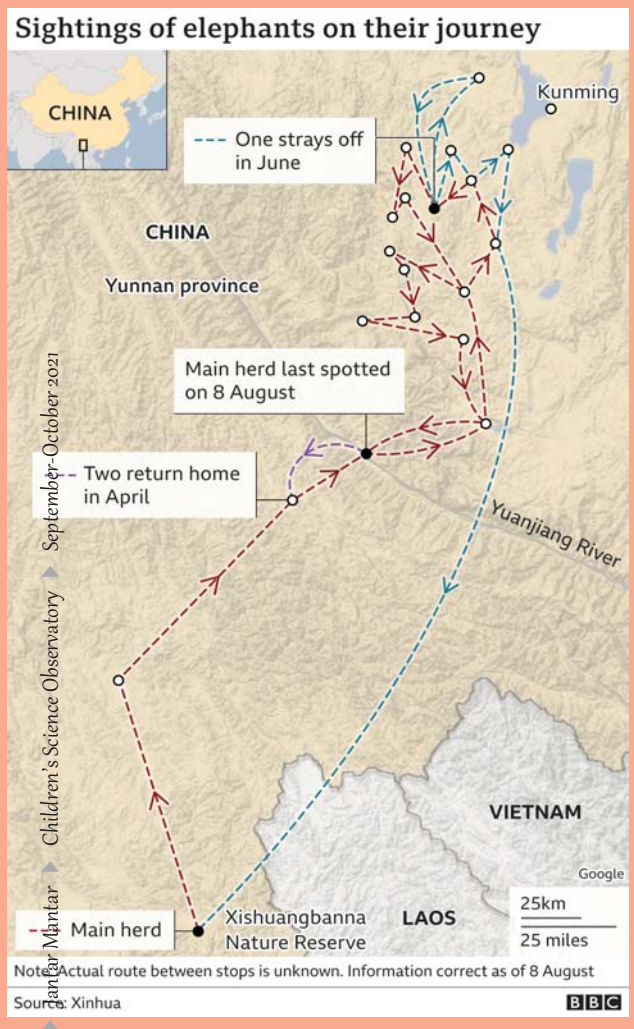
seen so far. A determined effort was made to drive them to Kaziranga National Park, but some of the elephants broke away and returned to the islands, whose crops they seemed to enjoy more. I lost track of what happened to them, but some of the herd still moved across the northern bank of the Brahmaputra two years ago.

●●●

I was reminded of my childhood memory when I read of the wandering elephants of Xishuangbanna, a bio reserve in southwest China. The Mekong river runs from Tibet through Yunnan and Xishuangbanna to Laos. **Xishuangbanna** (or Sibsong panna) means "twelve districts", more precisely "twelve township rice-fields", in the Thai (Dai) language of the **Lao** (Lyu) people living in this region. It is a prefecture in the province of Yunnan in China. Yunnan is the only Chinese province where elephants are found in the wild.

A Chinese prefecture is like a district, a province would be like a state. China also has city-prefectures which are cities with surounding rural areas. Xishuangbanna prefecture is about the size of the Indian state of Mizoram with a similar population. Yunnan is a mountainous province the size of all seven of India's northeastern states, Sikkim, Bhutan and West Bengal put together, at around the same latitudes. Its population density is similar to that of Manipur or Mizoram, so it has as many people as Odisha which only has 40 per cent of its area.

Humans and elephants have lived in India and China for a long time. For example, remains of our early ancestor *Homo erectus* have been found in Yunnan (dated to 17 lakh years ago) and in Madhya Pradesh (dated to 5 lakh years ago). The Xishuangbanna elephants belong to the same species as the Indian elephant, also found in Southeast Asia. Chinese elephant remains in Yunnan seem to be from a different species of Asian elephant, now extinct.



Jantar Mantar Children's Science Observatory September-October 2021

●●●

In March 2020 a herd of 15 elephants (six adult females, three adult males and juveniles) started marching north from Xishuangbanna, no one knows why. When they came near human habitations, they raided crops, wandered down streets, and broke into kitchens. In April 2021 two elephants decided to turn back home. Another male strayed in June, and officials eventually tranquilised and transported him home as they were worried that he would not survive alone.

More than a year later, in June 2021 they had travelled 500 kilometres northwards and were within a few days' walk of the city-prefecture of Kunming, capital of Yunnan, with the population of Bengaluru or Chennai.

Chinese authorities were terrified of what the elephants might do if they reached a major city. They focussed on trying to lure them back south using food bait and physical barriers. Bamboo, maize, pineapples, bananas and sugarcane have been used, in case you wondered. Lines of trucks have been used as roadblocks. Their tactics worked, they turned back and by mid-July were being diverted around Yuxi, a smaller city-prefecture with the population of Indore or Bhopal. The Red river runs from Tibet through Yunnan and Yuxi to Vietnam. By the beginning of August, they had crossed the bridge over the Yuanjiang river and were about 200 km from home.

One cannot let wild elephants become too dependent on human-provided food.

The elephants also need to feel safe, it is not only food that matters to them. If they feel unsafe they may become aggressive.

Experts like **Becky Shu Chen** of the London Zoo and **Raman Sukumar** of Bangalore feel it is unrealistic to expect that the elephants will walk back all the way to Xishuangbanna, and a "holding area" should be found where they have food and security, while a new habitat plan is chalked out. One young male who broke away from the herd was tranquillized and transported back to the reserve. Trying to tranquillize a herd is dangerous, it is not clear what the rest will do if one of them falls down.

To monitor the elephants, the Chinese have used drone cameras. Their pictures and movies have gone viral all over the world. In China tracking the wandering elephants is among the most popular items on social media.

One picture of the entire herd sleeping is very unusual, they must have been really exhausted. Because elephant herds don't all lie down and go to sleep as seen in the picture. This makes them too vulnerable to danger, for an elephant to get up and stand upright takes time. At least some adults doze as they lean against a tree or an anthill.

But even if they return to the Xishuangbanna National Nature Reserve, there is no guarantee that they will not wander again. The big question this situation raises is how to handle the conflict between growing human needs and the needs of wildlife. Send your ideas to *Jantar Mantar*. If you come up with a clever plan we will send it to the authorities in China.

Images from:
WTI, Daily Mail,
Owliverspost.com

Do You Know?

1. I read that the earth's core is almost as hot as the sun. Why does it not melt the planet?

2. Where would a compass point to if I were at the North Pole?

3. Will all our jobs be taken by robots in the future?

4. Is groundwater always clean?

5. Are red worms also earthworms?

Answers to last issue's Do You Know?

1. We hear of global warming and ice melt in the Arctic. When will all the ice in the Arctic be fully gone?

ANSWER: This is a question that many are asking. As we hear more about global warming, and read of icemelt in the Arctic, there is natural concern among the general public as well as people in Governments. As ice keeps melting in the Arctic, when will it all be gone?

As we will see, this is actually not the right question to ask, as this assumes that sea-ice loss is irreversible. Ice keeps re-forming, so we need not consider that it will be "gone". The right question to ask is:

how much more sea ice we are willing to lose?

What is usually call ice loss in the Arctic is loss of *summer ice*, measured in September. We monitor summer ice in September because that is the time of year with the least amount of sea ice in the Arctic Ocean. Historically, the Arctic Ocean was covered by ice year-round, but today this area is about half of what it used to be.

So we should ask: when are we likely to see ice-free Septembers in the Arctic? The most recent IPCC report (Intergovernmental Panel on Climate Change) gives what is likely to be a conservative estimate: it states that if global temperatures increase by two degrees C, ice-free Septembers will at happen once every decade. Several scientists point out that the observed relationship between sea-ice decline and global warming is much larger than that seen in the climate models (including those used by IPCC). Compensating for this, they assert with certainty that ice-free conditions will occur *every* summer at a global warming of 2 degrees C.

The probability of ice-free summers is greatly reduced if the warming is kept to below 1.5 degrees Celsius. But this seems unlikely as of now.

To understand more, we need to see that ice loss is a function of natural climate variability and warming caused by increased atmospheric carbon dioxide (CO_2) concentrations due to human activity. Every metric ton of CO_2 added to the atmosphere causes another three square meters of September sea ice to disappear. Currently we add 35 to 40 billion metric tons of CO_2 each year. When we will have added another 800 billion metric tons, September sea-ice will disappear in the Arctic. Will this be in 20 years, or less? Remember that these are statements based on models, and there is a variety of climate models. The predictions vary widely, from 2 years to 20 years.

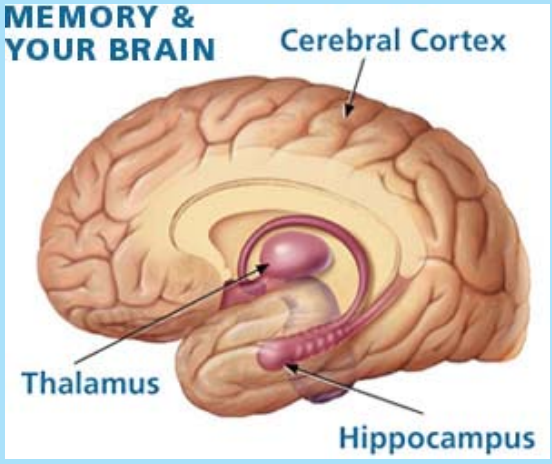
What is worse is that it does not stop there. With another 1,800 billion metric tons of CO_2 added, the Arctic will likely have no ice from July through October.

So what we need to do is to discuss ways in which we can limit the amount of additional CO_2 in the atmosphere in order to preserve summer ice cover in the Arctic.

2. Why do we forget so many things but never forget how to ride a bicycle?

ANSWER: Many adults tell you this: they used to ride a bicycle during childhood; never even touched a bicycle for a decade after they started working; but then suddenly, when they had an opportunity to ride a bike, all they had to do was hop on, it came to them naturally!

When the same person is unable to recall where s/he kept the bicycle key afterwards! Or s/he tells you, there used to



be a restaurant at that corner until last year, what was its name? How is it that we do not forget the skill to ride a bicycle but forget so much else?

The short answer is that different types of memories are stored in distinct regions of our brains. The kind of memory relating to biking, called procedural memory, resides in basal ganglia, below the cerebral cortex, relatively better protected in the brain's centre. In this region, fewer new nerve cells may be formed in adults and hence there is less re-forming. Therefore, unlike in other areas where there is neurogenesis, or continuous remodelling, fewer memories get erased as well.

Long term memory is of two kinds: **procedural** memory and **declarative** memory. While the former relates to performance (like singing, playing an instrument or riding a bicycle), the latter is related to knowledge. Declarative memory may be factual knowledge (What is the capital of Uttarakhand?) or consist of recollections (What did you do on your 10th birthday?). For both of these you are aware that you know (or not) and can communicate this to others. Declarative knowledge involves interpretation and the brain does a great deal of "modelling" (to decide what to remember) in memory of facts and recollections. This is the neurogenesis we referred to.

How do scientists know this? In a famous study of an epilectic patient called Henry Gustav Molaison, they found some of this. Large parts of his hippocampus (in his brain) had been removed during a surgery. The operation was successful and the number of his epilectic seizures ("fits") reduced, but Molaison had also lost many memories from before the surgery, and could not form new memories. As his hand-eye coordination improved, doctors could make him learn — for instance, to draw and reproduce an image. But he could never remember drawing the image. Basically they saw that he could develop procedural but not declarative memories.

By now neuroscientists know that procedural memory is more resistant to loss and trauma (due to major injuries). So it does seem that memories of sequences of actions, responsible for performing actions, are more stable than that of recollections.

3. Can one lose weight only by exercising, or is dieting also needed?

ANSWER: Many advertisements by soft-drink manufacturers seem to suggest that you need not worry so much about calories and dieting as about exercising. Of course, this is good for them since those drinks add many calories. But is this true at all?

According to many diet and behaviour experts, any such claim is false. They say that working out is not, by itself, very effective for weight loss. There is no data saying that if you exercise so many hours a week at some particular level of intensity you lose so many grams, independent of what you eat. On the contrary all data seem to refute this.

Regular exercising is important, since it keeps people focused on their health and it keeps them psychologically stable as well. However, exercise increases appetite and people often just make up for whatever they burnt off by exercising.

On the other hand, people who diet tend to restrict themselves overly, which often leads to overeating when they do eat.

Often cutting out some kind of food makes that food more desirable. To lose weight, you have to change your behaviour for the rest of your life, so the change should be sustainable.

Doctors say weight loss is like training to run marathons, not training to run a sprint race. It is about making regular, sustainable diet changes. You should not change your eating pattern drastically, but make small changes that are easy to sustain and work up to dropping about 300 calories per day.

Fundamentally exercising is good in multiple ways and it is also helps to burn off calories. But it cannot make up for diet control.

4. Who invented soap?

ANSWER: The timeline in the Box shows how the making and use of soap goes back at least 5000 years ago to the **Sumer** region, now in **Iraq**.

Soap originally seems to have been used primarily for the treatment of ailments. One Sumerian text dating back to 2200 BC describes a form of soap being used to wash a person with some type of skin condition. Exactly what the physicians believed this would do is unclear, but the idea that soap had medical benefits was accepted by many ancient civilisations.

The primary cleaning agent in ancient India was taken from soap nuts also known as soap berries (from the plant *Sapindus saponaria*). The literal translation of Sapindus is sap = soap and indus = India. In other words, soap from India!

This nut was used in ancient China as well and its usage spread from India to Middle Asia and then Europe. Soap nuts are boiled to soften them up, and then crushed to filter out the essence which contains the all-important cleansing chemicals. It lathers but in small quantities. Ancient India also used *shikai* or *shikakai* (a variant of the **acacia** plant) as a hair and body cleanser.

As early as 3000 years ago during the **Zhou Dynasty**, the Chinese discovered that

Time line of soap

3000 BC Sumerians use soap solutions made from ashes and water.

2800 BC The Babylonians record the basic method of making soap.

1500 BC The Ebers papyrus shows that Egyptians produced a soap-like substance.

1200 to 200 BC The Greeks and Romans use public baths but do not use soap.

79 AD An entire soap factory of this period found among the ruins of Pompeii.

200 AD Roman baths use soap regularly.

700 AD Arabs produce the first solid soaps.

800 AD Soap making processes in Italy and Spain.

1200 AD Fragrances in soap; Italy and France lead in soap making.

1500 AD European processes use vegetable oil rather than animal fats.

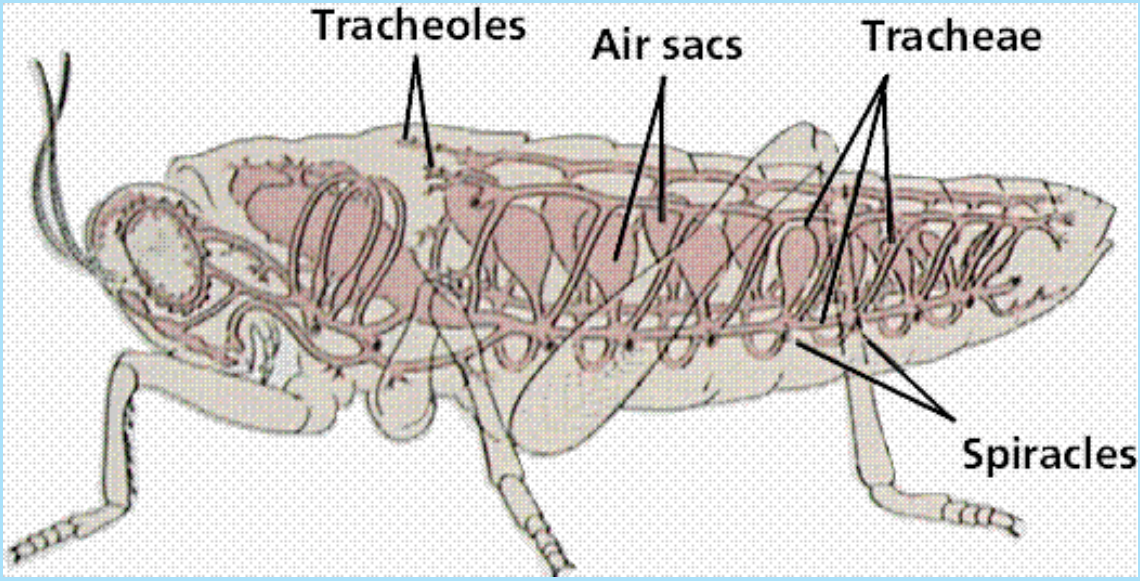
1791 First commercial soap making by Nicholas Leblanc and Michael Chevreul.

using ashes of certain plants could be used to remove grease. This method was improved upon in subsequent dynasties using and mixing these ashes with crushed sea shells, as well as discovering a naturally-occurring form of saponin which was a useful and effective cleaning agent.

When mixed with water, certain tadpole-like molecules in soap form spherical structures called "micelles" around any droplets of germy dirt or oil, with their water-hating ("hydrophobic") tails pointed inwards and their water-loving ("hydrophilic") heads pointed outwards. The outside of the micelle is soluble and so it washes away, along with any grime trapped in the middle.

5. How do ants breathe?

ANSWER: For human beings, the diaphragm plays a major role in breathing. It actively pumps air in and out of our lungs. Try this: open your mouth and throat, but hold your diaphragm and chest absolutely still. Actually, even now, though you think you are holding your breath, some oxygen does manage to find its way into your lungs



by the random diffusion of air molecules. But that is not enough to keep up with what your body needs and you gasp.

If you didn't have a diaphragm, you would need a much smaller body, or more than one throat. Ants have both.

Some species of ants have nine or ten pairs of openings, called **spiracles**, along the side of their body. Each spiracle is connected to a very finely branching series of tubes called **tracheae**. This seems similar to our lungs, but insects do not use blood to carry oxygen from the tracheae to the rest of the body. Instead, the tracheae spread throughout the body and each branch ends in a little bag with a moist end-wall that touches directly against the membrane of a cell.

An ant's movement helps the oxygen to circulate through the trachea, with the released carbon dioxide exiting through them as well.

This system works well only in tiny animals. Once the body grows beyond a centimetre or two, the tracheae are simply too long for air to be able to diffuse along them fast enough. What do the larger insects do then? They supplement the passive breathing system by flexing their abdomens to pump air along the tracheae.

For ant-sized insects, though, the trachea work just fine. In fact, scientists have found that many insects this size actually have to close their spiracles periodically to avoid getting too much oxygen!

An extra fact about ants: they are as old as the dinosaurs! Scientists have found that ants first rose during the Cretaceous period around 130 million years ago. They have survived the Cretaceous-Tertiary extinction that killed the dinosaurs as well as the ice age.

Compiled from various sources

Science News

Headlines

- *Are vaccines needed for those who got Covid and recovered?*
- *A beautiful flower turns out to be a carnivore!*
- *Jupiter superheats its atmosphere*

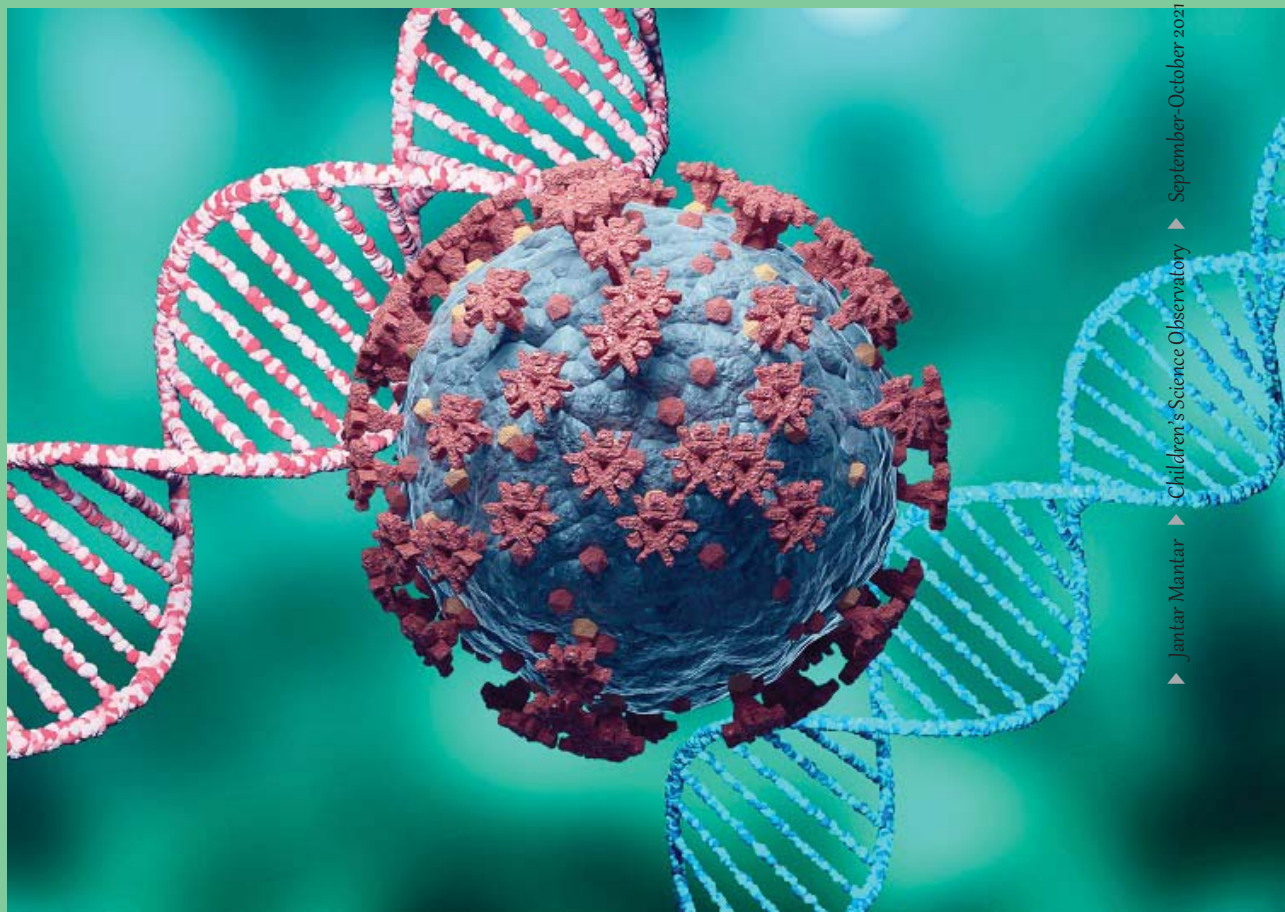
Read more below.

• Are vaccines needed for those who got Covid and recovered?

In India, large numbers of people seem to have been already infected by the SARS-2 coronavirus and have recovered. (The picture shows the schematic of the virus, with 2 DNA strands in the background). Many such people wonder whether they need to get vaccinated. It is true that once you have been infected, you have some antibodies in the system. Some laboratory studies (as opposed to tests among the general population) show that even one dose of vaccine may be sufficient to protect people who have already had Covid. Yet, vaccines give you extra protection, so vaccination is recommended for everyone.

This is mainly because we do not precisely know how long immunity lasts after an infection. Studies have shown that antibodies are present in the blood for at least eight months after getting sick, but some recovered patients have gotten reinfected. The **Delta variant**, which has caused much havoc in India, seems to spread among not only those already infected, but also among those vaccinated. So the extra layer of protection is recommended.

Antibodies are not the only part of the



immune response that benefit from the vaccine, although the immune proteins are crucial to prevent infection. Vaccines help patients to reach high levels of a subset of immune cells called T cells, according to studies. T cells help coordinate and ramp up the immune response when a person is exposed to the virus again.

A study in Kentucky, USA, showed that who had recovered from a coronavirus infection but were not vaccinated were around twice as likely to get infected again as their vaccinated counterparts. People who had got only one dose, or had got the second dose less than two weeks ago, were 1.5 times as likely to be reinfected as fully vaccinated people. So all this suggests is that full vaccination is the best option.

Another study showed that those who have got one round of vaccine but also got Covid and recovered (in whichever order) had more antibodies than those who had only got one or two rounds of vaccine but never got Covid, and also than those who had recovered but did not get vaccinated.

What about new variants? Will the vaccines help against yet-to-be-seen variants as well? One recent experiment offers even more evidence of vaccine-induced antibodies' ability to recognize emerging variants. Antibodies from recovered patients who had been vaccinated stopped a version of coronavirus with 20 changes in its spike protein. (Current "variants of concern" like beta and delta have around 10 spike mutations.) The spike protein acts as a key to unlock and infect cells, but even with all the changes, antibodies still prevented the virus from infecting cells, researchers reported recently. (This study has not yet been reviewed by other scientists, so it is not "official". In science, results are accepted only after "peer review" by other scientists.)

• A beautiful flower turns out to be a carnivore!

A recent report in the *Proceedings of the National Academy of Sciences*, a prestigous science journal from the USA, says that a beautiful wildflower is actually a carnivore.

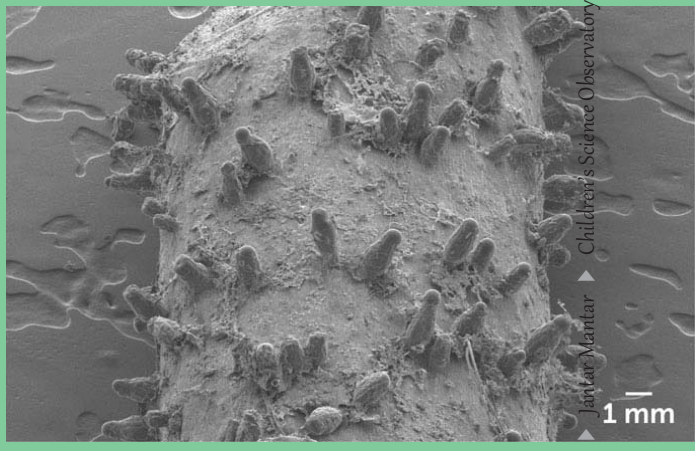
The wildflower, **Triantha occidentalis**, growing in Cypress Provincial Park in British Columbia, Canada, has sticky hairs on its stem that it uses to trap and digest small insects. Scientists have known about T. occidentalis since the 19th century, but its taste for insects has gone undetected until now.

Many noncarnivorous plants use sticky hairs to defend against pests. But T. occidentalis has qualities that some meat-eating plants share: a love of bright, nutrient-poor habitats which are marshy, and the absence of a gene that fine-tunes how plants get energy from light. Together, those features felt like pieces of a jigsaw puzzle to scientists. To solve the puzzle, they needed to know if the wildflower pulls nutrients from insect corpses.

The team attached fruit flies fed with nitrogen-15, an isotope that can be used to track changes in nitrogen levels, to the flowering stems of T. occidentalis plants. Over half of the wildflowers' nitrogen came from the fruit flies, the team found. Those levels are comparable to known carnivorous plants. What is more, the wildflowers' sticky hairs oozed phosphatase, a digestive enzyme that many carnivorous plants secrete to consume prey.

T. occidentalis' sticky hairs seen in

picture and zoomed under an electron microscope) might also hint at how some meat-eating plants evolved. In nutrient-poor soils, it may have been advantageous for some plants to co-opt hairs for this.



Jantar Mantar ▲ Children's Science Observatory

• Jupiter superheats its atmosphere

Jupiter's upper atmosphere is hundreds of degrees warmer than expected. Scientists have been puzzled about this for decades. A recent study suggests that the culprit is the planet's intense **auroras**. We know the Earth's auroras, the northern and southern lights, formed when the solar wind disturbs Earth's magnetosphere. It appears Jupiter has them too.

Jupiter's magnetic field lines (shown blue in the picture) direct charged particles in the solar wind toward the planet's poles, generating auroras (white) similar to Earth's. High-altitude winds then carry heat (red) from the auroras toward Jupiter's equator, warming the planet's upper atmosphere, as shown in this artist's illustration, which overlays a visible light

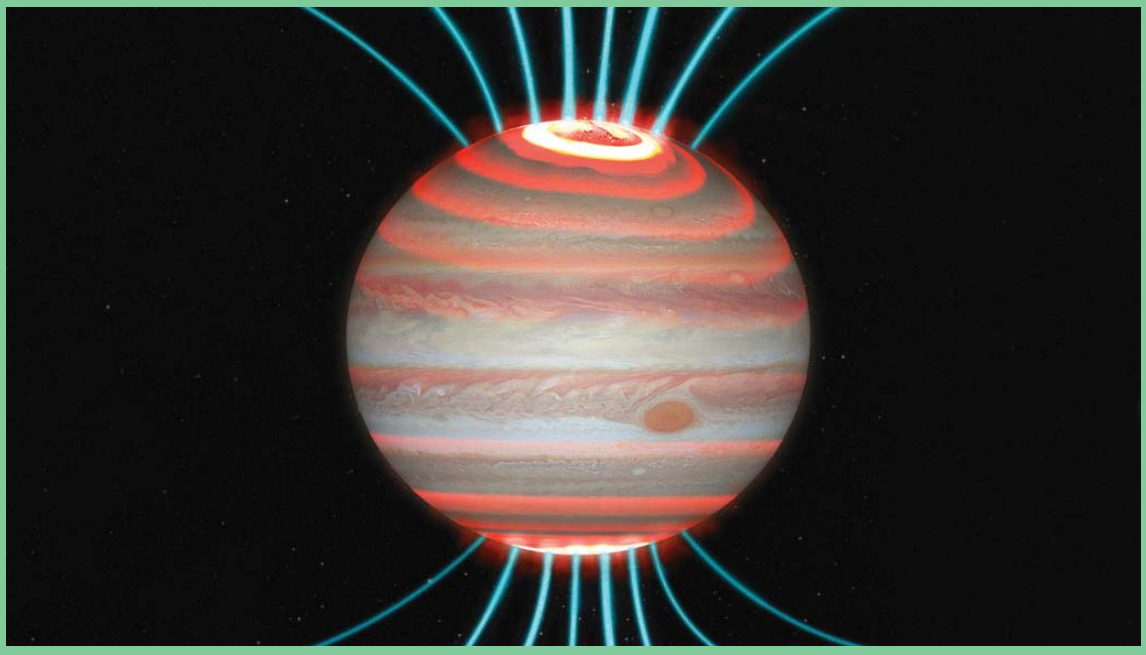


image of the planet.

Jupiter's orbit is roughly 778 million kilometers from the sun. Since the sun's illumination is so feeble there, it gets less than 4 percent of the energy per square metre that hits the Earth's atmosphere. So we would expect the temperature of the upper atmosphere to be about –73 degrees Celsius. Instead we find that the region several hundred kilometers above Jupiter's cloud tops has an average temperature of about 426 degrees C.

Scientists noticed this almost 40 years ago and many theories have been proposed. Recently, the 10 metre telescope in Hawaii has given valuable data that may explain this phenomenon. (Interestingly, do you know where this telescope is placed? It sits on top of the dormant Mauna Kea volcano!)

The study, reported in the journal *Nature*, in August 2021, found infrared emissions from Jupiter that contained positively charged Hydrogen molecules. These molecules are created when charged particles in the solar wind, among other sources, slam into the planet's atmosphere at a speed of hundreds or thousands of kilometers per second, painting auroras at its poles.

The team measured the intensities of these molecules and prepared a heat map, which shows a maximum temperature of 725 degrees Celsius at the poles, which drops to about 325 degrees Celsius near the equator (of Jupiter). This is used to explain that Jupiter's auroras are the source of heat in the upper atmosphere and that winds disperse that heat from its polar regions.

Scientists add that these ideas are preliminary and that more detailed simulations of Jupiter's atmospheric circulation will be needed to get more precise answers.

Source including images: https://www.sciencenews.org

Indian Scientists who changed the world

Shreya Pareek

Science is an important part of our everyday life, even more so than we notice. From our fancy gadgets to the technologies we can't live without, from our humble light bulb to the space explorations, it is all a gift of science and technology.

I wonder what we would be doing if none of these things were invented? How often do we take out the time to think about those extraordinary minds who made life easier for us? Here is a series on Indian scientists whose path-breaking achievements led to the international progress of Science. In this issue, we continue with **Homi J. Bhabha**.

Born on October 30, 1909 in Bombay, Homi Jehangir Bhabha played an important role in the development of Quantum Theory as applied to collisions of high energy particles. Bhabha worked at the prestigious **Cavendish Laboratory** for his thesis work towards getting a doctoral degree. For instance, **James Chadwick** had just discovered the *neutron* (which is found in atomic nuclei along with *protons*). **Cockcroft** and **Walton** were learning how to accelerate particles to collide them at high energies, and *positrons* (the anti-particle of electrons) were being studied here.

The underlying theory and calculation of collisions of electrons and positrons was worked out by Bhabha and today this is known as *Bhabha scattering*, after him. Bhabha also worked on *cosmic rays* and their composition. These are high energy particles (mostly protons) that hit Earth from outer space. Their origins are still a mystery even today.

Just before the outbreak of the second world war, Bhabha was visiting India. War broke out, and Bhabha did not return to England. Instead, in 1939, he joined **Sir C V Raman's** group at the Indian Institute of Science, Bangalore.

He was convinced of the importance of nuclear physics and he soon started the Tata Institute of Fundamental Research in Bombay in 1945, just after the war ended. He also lobbied Prime Minister **Jawaharlal Nehru** to establish the Atomic Energy Commission in 1948. He worked on both cosmic rays and nuclear weapons/ nuclear energy at this time.

He was convinced that nuclear power was the solution for energy-starved India. He served as President of the **United Nations Conference** on the *Peaceful Uses of Atomic Energy* in Geneva, Switzerland in 1955. At the same time, he continued to lobby for nuclear weapons. He was a member of Indian government's Scientific Advisory Committee and was involved in setting up an independent organisation for space research. He was also keen on music and arts.

He died in a plane crash in France (on the french Alpine mountains), while on his way to Vienna to attend a meeting of the International Atomic Energy Agency on 24 Jan, 1966.

He left behind a legacy which included investment in basic science research in India, as well as development of nuclear energy and nuclear weapons programme. He also believed that the development of nuclear power would help alleviate poverty in India. •

Interview with a passionate bird watcher

My journey into birding:

Angeline Mano, Salem Ornithological Foundation

Tricolored Munia

JM: *When did you first get interested in bird watching?*

AM: My mother was the one who sowed the seeds of birding in me during my school days. She used to show me birds around us, tell their names and some behaviour. Another reason for my interest toward birds was because of my mum's habit of feeding them by placing water and grains at the backyard. Crows, Mynas and few other species visited and used to feed on grains. Watching those feeding their young made me to think more about it.

Since childhood, I have always had a great love for nature. My grandmother's place is a village near *Tamirabarani River* and I used to watch the black waterbirds (later I knew them as **Cormorants**) with delight. As days passed, enjoying the sounds of birds was becoming a habit. On January 12, 2018, my parents bought me a camera and I started photographing birds.

JM: *How did you find out the names of the birds you saw?*

AM: As I didn't have proper guidance to birding, finding the names of birds was a task on its own. One day I just simply captured a colourful bird and sent it to one of my college seniors who had immense love for birding. Tamil Selvan told me that it was a **Coppersmith Barbet** (*Psilopogon haemacephalus*). It got the name as coppersmith because of its metallic call. He further gave me an introduction to birding, taught me bird names, interesting behaviours and suggested some books. I was in awe of the fact that there's plenty to know about birds and there started my journey into birding. After this, my love for birding grew exponentially as I began to watch more and videographing their beauty.

Coppersmith Barbet

A few weeks later, Tamil Selvan explained me about **eBird**, an international platform to document and monitor birds. I registered at once and I regularly contribute data and upload images as well.

JM: What are some high points of your journey?

AM: One day from my balcony, I was so thrilled to see a Purple Sunbird (*Cinnyris asiaticus*) going near the nest of Scaly-breasted Munia Lonchura punctulata and they became noisy. Mommy Scaly-breasted

Rufous Treepie

Munia and Daddy Scaly-breasted Munia were guarding their nest. Later I found that there were juveniles in the nest.

On October 2018, I visited Kannankurichi (Mookaneri) Lake with Tamil Selvan. I saw many species including Little Cormorants Microcarbo niger, White-breasted Waterhen Amaurornis phoenicurus, Little Grebe Tachybaptus ruficollis, Indian Pond Heron Ardeola grayii, Asian Koel Eudynamys scolopaceus, Striated Heron Butorides striata, Tricolored Munia Lonchura malacca. That was a great new experience for me. I was glad I took my best companion **Nikon D3400** to click those birds.

JM: *Can you give an example of how difficult and intense, but extremely rewarding, bird watching can be?*

AM: As I became so passionate in birding, even the small call of birds was so sharp to my ears. One day as I returned home from college, I heard a different call which I hadn't heard before. So, I took my camera and went searching for the bird but couldn't find it. I returned disappointed and few minutes later I heard the same call from backyard. This time, I just got a glimpse of its tail. To get a good view, I literally climbed the wall and clicked the bird and referred the book to know its name. It was a Rufous Treepie (*Dendrocitta vagabunda)*. That was an awesome and thrilling moment! These days, every time when I just hear the calls, I am unable to ignore it and I start to bird.

JM: *What is the central appeal of bird watching?*

AM: Birding is a feeling that cannot be expressed in words. When I am birding, I just forget myself and never take my eyes from it. Watching them doing cute things gives a great relaxation and bliss to mind and heart. What I love about birds is how they behave, because just by observing them we can understand lot of things in life. Birds connect us to nature. In future, I will show people how to conserve the natural world and I really hope that birding and birds will help me to do this. I also strongly recommend everyone irrespective of their age, to take up birding as a hobby and fly with them!

JM: *Thank you so much for sharing your passion with us.*

Answers to Puzzles to Puzzle You

1. Find the birthday

He was born on December 31st and spoke about it on January 1st. How do we see this?

He said: `The day before yesterday I was only 25...'. So on Dec 30 and Dec 31, he will be 25 and 26 years old respectively. So when he spoke (Jan 1 this year), he was 26. Then he said: ` '...next year I will turn 28'. So on Dec 31 (this year), he will be 27 and on Dec 31 (next year), 28.

2. Ordered times:

The possibilities are 01:23, 12:34, and 23:45.

3. Mathematical Grandmother

Mimi's Granny is 58 years old. Let's see why:

First child born: Granny is 19

Second child born: Granny is 23 (19 + 4)

Third child born: Granny is 27 (23 + 4)

Fourth child born: Granny is 31 (27 + 4)

Fifth child born: Granny is 35 (31 + 4)

Sixth child born: Granny is 39 (35 + 4)

Sixth child is 19 now: Granny is 58 (39 + 19)

Publisher
S.Subramani
TNSF, Chennai 600 086
Typeset at
Fineline
Design, Illustrations and Layout
Basheer
Rajeswari
Printed at
Sri Murugan Printers,
7/1, Boobegam 3rd St, Anna salai,
Chepauk, Chennai - 600 002.

Annual subscription Rs. 90/-. Life Subscription Rs. 900/-
Bank Details: Jantar Mantar, Indian Overseas Bank, Dr. RK Salai Branch, Chennai - 600004
AC No: 029101000031081 IFSC Code: IOBA0000291

Registered with Registrar of Newspapers for India under No. TNENG/2001/04429

Published by S.Subramani Published at 245, Avvai Shanmugam Salai, Gopalapuram, Chennai-600 086 Printed by P.S.Kumaresan, Printed at SRI MURUGAN PRINTERS, No.7/1, BooBegum 3rd Street, Chepauk, Anna Salai, Chennai-600 002.
Owned by Tamil Nadu Science Forum, Editor: Dr. D. Indumathi