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Monsoon Blues: Are We Prepared?

... think scientifically, act scientifically... think scientifically, act scientifically... think scientifically, act...

Valuable snapshots on citizen science

Dr. R. Gopichandran

The objective of this editorial is to help science and technology communicators take note of some recent analyses about the concept of citizen science. The eight references provide invaluable insights on the spread and depth of the dynamics of engagement with stakeholders through targeted communication in this context.

The citizen science approach arguably optimises interactions and mutually reinforcing learning between scientists and citizens with an eye/propensity for scientific observations. Clarke[1] presents an excellent overview of initiatives in ecology, technology and policy interfaces and research areas regarding outcomes and roles of stakeholders that need special attention. Land & Water Australia[2] re-emphasises hands-on approach of citizen science to gather evidences and investigate to assist decision making. Wiggins & Crowston[3] define a typology of interventions based on the expected outcomes. The European Commission[4] recognises this unique interface in its strategic planning over the present decade only to strengthen the policy interface of science and society. An essential element of this coming together is the democratic engagement process substantiated with evidence based decision making. These are captured in a unique snapshot presented by the UNEP[5], the UK Environmental Observation Framework[6], the European Commission[7] and the framework of public participation in scientific research by Cooper[8] only to help understand the ubiquitous and comparable contexts of engagement across the world, unmindful of geographic and political boundaries. These could pertain even to the need to tackle environmental consequences of natural or artificially induced disasters.

It is important to recognise that this paradigm of engagement is significantly more broad based than theme-specific top-down approaches to stimulate and reinforce scientific temper in citizens. A real-life connect with natural phenomena with observations and empirical evidences could reinforce and probably expedite outcomes of such engagement initiatives.

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Monsoon Blues: Are We Prepared?

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For the last two months or so the entire country has been in a state of uncertainty. The India Meteorological Department and various other agencies are working overtime to give accurate predictions about the monsoon. For some time some experts have been suggesting that the monsoon could be affected by El Niño this year. There was another opinion too that El Niño was not going to affect Indian monsoon to a large extent. Historically, it has been found that the years with El Niño bring less than normal rains in the country. Data for 126 years (1880-2005) compiled by Skymet, a private weather forecaster, show that in about 90 per cent of all El Nino years there were below-normal rains and in 65 per cent of El Nino years there were droughts. If we take the period of last one decade, during the years 2004, 2009, 2012 there were El Niño events and India had less than normal rains (79 to 92%). The years 2004 and 2009 saw drought-like conditions. But the tragedy is that except the meteorologists and a few scientists no one did take the issue seriously. Also, another group of experts which did not give much importance to El Niño argued that in 2013 when there was nothing like El Niño several areas of Maharashtra suffered drought, Marathwada region was one of them. In all 15 of the 35 districts had to be declared drought hit. About 11,000 villages were affected.

A Himalayan stream in Ladakh is almost totally free of pollution.

It is difficult to comment whether El Niño would show its impact on Indian monsoon this year or not. But one thing is certain that so far there have been deficient rains in large parts of the country. Of course, there have been fluctuations. A strong probability is that even if the monsoon conditions improve, deficiency will remain in several areas and is likely to show its direct impact on agriculture. *Kharif* crops will be affected the most. Last year the *kharif* output was 128.07 million tonnes. Initially, the Government was anticipating a rise in production to 129.37 million tonnes for the current year. But chances are very low that the target can be met. Estimates suggest that there will be reduction to the extent of 7% in output this year.

Misconceptions and misinformation about water

Are we ready to face the reduced rains and possible drought-like conditions? The answer seems to be "No", because there does not seem to be any large-scale preparations on these lines. Our thinking is still skewed. The text books, even at highest levels, generally talk about the fact that about 70% Earth's surface is covered by water. Obviously the oceans hold huge quantities of water. But we generally tend to forget that out of the total water present on Earth, about 97.5% is saline, containing high concentrations of various salts, mainly sodium chloride. Only about 2.5% is not saline. It is called "fresh water" and only this kind of water can be directly consumed by us and most of the organisms on Earth. Certainly, fresh water contains some salts, but in very small concentrations without which we would suffer from mineral deficiency.

Another issue is that out of the total fresh water on Earth, around 68.9% is locked up in the glaciers and about 30.8% is groundwater. Only about 0.3% is available

In the plains, heavy deposit of silt and sediments often shrink a river to a fraction of its original size.

Agriculture on hill slopes often leads to soil erosion and silting of rivers downstream.

in the rivers, lakes, ponds, streams and other surface sources. This fraction has to meet the demand of humans and all land organisms. Importance of water can be easily understood by the fact that most animals, including humans, have to regularly drink water to remain alive. Similarly, insufficient water in soil leads to drooping of plants and if the condition persists for long, death of the plants.

Weed being removed from a lake. The weeds slowly kill the water body. Weeds appear on account of pollution of the lake.

Not enough water to meet our needs

If we look at the overall scenario, we find that only 0.007% of the total water present on Earth is available to meet all the requirements of more than 7.1 billion people living on Earth and also of the other organisms living outside the oceans. Apart from direct consumption, water is required by humans for producing food, for dilution and treatment of wastes, and to keep the environment in healthy condition. Food production consumes huge quantities of water. It may surprise many that water needed to produce the average diet of an affluent individual may work out to about 4,000 litres per day in terms of food production and processing. There is a water cost embedded in the transportation of food as well. The oil burnt in trucks, railway engines, aircrafts, ships, etc., also have a water component for drilling, refining, etc. As an example, a litre of petrol takes about 13 litres of water to produce. Most industrial activities also need water for their operations. It is needed as ingredients, solvents, carriers of materials and quite often as a coolant for machines. We also need water for washing, cleaning etc.

Dead plant materials on floor in a forest allow rainwater to slowly seep into the ground helping in groundwater recharge and also protect the soil from erosion.

Over-utilisation of water sources

The total quantity of water on Earth has remained almost constant since eternity. Only its form has been changing and at times it accumulates more in certain components of the hydrological cycle. The tragedy is that we have trained ourselves to consider water as a renewable resource. There is no doubt that the environmental processes try to keep it renewable. But there is a limit to that. Rains come year after year and the rivers and reservoirs tend to be full. This general principle is true to large extent except when there are droughts. But the situation with the underground reservoirs is different. When we pump out more water on day-to-day basis, the reservoirs are unable to replenish. Practically, we are mining water which should be left for the future generations. Rains cannot replenish those reservoirs fast. The result is that the water tables are falling with passage of time. With every passing year more and more areas are experiencing groundwater shortages. Similar situation is there in case of large numbers of rivers, lakes, ponds, etc. We are extracting more water than what these water bodies receive. The result is that these water bodies are shrinking and many of them dry up immediately after the rainy season or snowfall is over.

Wastage of water

The tragedy is that wherever water is available in sufficient quantity, generally there is large-scale misuse and wastage. This explains why during the last century global water use has grown at more than double the rate of population growth. It is estimated that world over during the last 50 years water withdrawals from the ground have risen three times. Reasons are many. One is our changing lifestyle and food habits. As stated above, food production requires huge quantities of water. About 95% of our water footprint is hidden in the food we eat, energy we use, products we buy, and services we utilise. The water footprint of our electricity use is based on the way power is generated. Presently most of our energy requirements are being met through thermal or hydroelectric routes. If we use energy-star appliances and adopt other energy-efficiency measures we can reduce our water footprint substantially along with reduced electricity bills. Our water footprint would be even less if we use alternative energy sources such as wind and solar energy. Leaking taps often lead to wastage of up to 50 litres of clean water in every household, which can be avoided.

Little of the total water consumed in households – about 5% – runs through toilets, taps, and garden hoses at home. But this water is important. Reasons are many. First of all the water is of good quality and is generally treated before being supplied. Obtaining that water and processing of the same consumes energy. Secondly, the water is supplied to households through pipelines, which again entails consumption of energy for pumping. Thirdly, in many places the supplied water is not from local resources. They are transported from large distances, which again consume energy. Fourthly, there is loss in transit, which means more pressure on the sources of water. It is a universal phenomenon, but percentage of water loss in municipal supplies in India is quite high compared to world standards. For example, about 25% of available water in our metro cities is lost due to leakages.

Precipitation and utilisation of water received

In India, most of the rainfall takes place during a few weeks of the year. About 75% of it is confined to the monsoon season – June through September. For the rest of the year, there is no or little precipitation. But the tragedy is that a large percentage of the water so received is lost; it flows into rivers and to the oceans or just evaporates. It is not effectively captured. Estimated average rainfall in the country is about 1,170 mm with wide variation from one region to another. Estimates suggest that the total precipitation in India is about 4,000 billion cubic metres (bcm), out of which only 1,869 bcm remains available for use and about 1,123 bcm of which is utilisable. The World Bank has issued warning that India will exhaust its fresh water by 2050. Even if it may not be 100% true, looking at the trend it can be concluded that the situation will certainly be serious if corrective measures are not adopted.

For large areas of the country groundwater is the major source of water for irrigation, drinking, industrial operations and other needs. It is true for urban as well as rural India. Estimates suggest that the total static groundwater available in India is about 10,812 bcm. The average groundwater recharge rate of India's river basins is about 260 m^3/day. Estimates suggest that about 432 bcm of groundwater is replenished annually through rain and river drainage. With growing demands for irrigation and also for industrial and domestic purposes, groundwater is increasingly being pumped from lower levels and at much faster pace than precipitation can replenish. As a result in most of the areas, water tables are dipping with each passing year.

Water and agriculture

For India agriculture is extremely important. Although the country's farm sector accounts for only around 14 percent of the economy, two-thirds of the country's 1.2 billion people depends on agriculture for livelihood. Another important point is that more than half of the country's arable land needs the summer rains. A third dimension is that India needs to keep boosting its agricultural production to meet the demand of its growing population. Our head count is expected to hit 9.7 billion by 2050. With improvements in financial conditions, the demand for food per capita is also rising. No doubt with Green Revolution and extensive imports we have been able to meet the demands in one way or the other. It is a matter of pride that among Asian countries, India has the largest arable land. It accounts for about 39 per cent of Asia's arable land. Only USA has more arable land than India. The result is that water consumption for agriculture is very high and it is growing every year resulting in depletion of the water sources.

Streams flowing downhill slopes near Cherrapunjee in Meghalaya mostly dry up after the rains are over.

But the tragedy is that large quantities of precious water are wasted during irrigation. Over-irrigation is common. Also, there are seepages and leakages at different stages of irrigation, resulting in over-exploitation of water resources. Over-irrigation also leads to degradation of arable land on account of flooding and increase in soil salinity and also wastage of energy as well. In several states power is subsidised for agriculture, which indirectly encourages over-irrigation. Till recently diesel was heavily subsidised. That too resulted in over-irrigation. This fact is obvious from the fact that as per the assessment of the National Commission for Integrated Water Resources Development (NCIWRD), about 83% of available water in the country is used for irrigation. The remaining 17% meets the rest of the demands in domestic, industrial and other sectors.

In India we find a peculiar situation as far as water resources is concerned. For example, water-intensive crops like rice, cotton, sugarcane, etc., are extensively grown in areas which do not have sufficient water. Marathwada is a drought-prone area. Still we find sugarcane being cultivated on large scale in the area. Not only is sugarcane grown here, it is also processed in the area bringing further pressure on the scanty water sources. Farmers and industrialists who are influential in one way or the other often over-utilise the available water, leaving the weaker section deprived. Their crops generally fail and in the absence of institutional supports they get deeper and deeper into debt traps, which often lead to suicides

The irony is, despite so much of water and other resources being pumped into agricultural sector, a significant part of the agricultural produce often goes waste. Food wastage is a global problem. It is estimated that about one-third of the total food produced globally goes waste. Although India stands at seventh place in the table of food wasting nations, still it is very important as large numbers of persons in the country are unable to get adequate food and nutrition. Government of India's estimate suggests that food materials worth about Rs.50,000 crores are lost every year. Loss of food does not mean loss of food alone. Apart from other resources, it also means wastage of precious water used for irrigation and other related activities.

Dwindling water resources

The United Nations has confirmed that by 2025, about 1.8 billion people will live in areas beset with water scarcity and two-thirds of the world's population will be living in water-stressed regions. Climate change will also play its own role. Climate change and rise in Earth's temperature can lead to more hardships. Rains are likely to become uncertain. Water will evaporate much faster from soil, lakes, rivers, ponds, etc. Most of the glaciers and mountain snow caps all over the world are already showing shrinking trends. The problem will further aggravate. A recent report says that glaciers in Nepal Himalayas have shrunk by about 24% in the past three decades or so. The situation in

Indian Himalayas is not much different. It is important to remember that the Himalayan glaciers feed seven great Asian rivers.

Another consequence of climate change is that extreme rainfall events will be more frequent. There will be heavy downpour or unexpected dry patches. As a consequence, there are possibilities of crop loss both on account of shortage of water and on account of flooding. Variety of crops including wheat, tea, etc., will get affected. There is possibility of major drop in wheat and tea production in this part of the world. We need not reemphasise the importance of wheat as a staple crop for India and also China. Tea is a major exchange earner for India and several other countries in the region. Even coconut production may be adversely affected by long dry spells.

Role played by forests and vegetation

Forests and other vegetation areas play important role in underground storage of rain water. The vegetation protects the land against compaction. Also, movement of water on the vegetated surface is slow. These factors help water to percolate down. That is why in areas affected by deforestation and vegetation clearance, the groundwater reservoirs suffer depletion. Presence of forests and vegetation is helpful in one more way. It also helps reduce floods and soil erosion.

The tragedy is that country's forest cover is highly inadequate. Our 1988 National Forest Policy targeted 33% of land under forest cover. In 2002 the Policy was revised. The year 2012 was identified to achieve the goal. But today we have only about 23.7% of the land area classified as forests. Only about half of it is good quality forest. Rest is barren land, wasteland, or under encroachments. Generally, it is claimed that compensatory forestation is done to take care of the deforestation. But truth of such claims is questionable. Quite often compensatory forestation is done only on paper. Even if it is done, there is none to take care of the forested areas. As a result the survival rate remains very low. Also, the quality and functioning of the forested areas cannot match natural forests.

An extreme example of the impact of deforestation can be observed in Cherrapunjee. The place has remained in history books for decades as the world's wettest place. It has long record of maximum rainfall year after year. Now an adjacent area in the same State has surpassed Cherrapunjee. Large-scale deforestation and rocky barrenness in the area on account of large-scale mining have resulted in this kind of situation.

Waste in a large drain such as this finally flows into the Yamuna River. Unless drains are diverted and only treated waste water let into the river no river cleaning project can succeed.

Conclusion

It is obvious that our water resources are already overstretched and the monsoon this year has so far been deficient. There is some hope that the situation will improve around the end of monsoon season. If it does not materialise, agriculture will be badly affected, availability of drinking water will be reduced, and water for industries may not be sufficient and so on. Also, we need to realise that water availability and its quality are closely related to health status. Lack of adequate water availability for day to day requirements is an important factor in making living conditions unhygienic. A related development is that on account of overuse and our callousness most water sources in the country are contaminated by sewage, industrial effluents and agricultural runoffs. According to the Central Pollution Control Board, water in half of Indian rivers is not suitable for drinking. Even groundwater is not safe in most parts of the country. Till recently people could use groundwater without any fear, but now the situation has changed on account of contamination and pollution. The result is that infectious diseases continue to be serious threat for the entire population, especially in case of children. Studies by the Government and UNICEF indicate that a major cause of mortality for children below five years is a group of diseases related to contaminated water and lack of sanitation. That explains why over 21% of the country's diseases are water-related.

The tragedy is that even with this kind of grave situation we are not showing adequate concerns towards the looming danger. Millions of rupees have been put in for cleaning up rivers like Ganga, Yamuna, etc., but with no positive results. Similarly, not even 1% of municipal water supply comes from desalination. Undoubtedly, desalination is energy intensive. But we need to consider the indirect costs of water shortages. Whenever there is scanty rain or shortage of water, rain water harvesting is discussed. But nothing substantial comes out.

Only if a small fraction of Government fund is utilised honestly for creation of infrastructure to capture and store rain water, things can improve in no time and that will not be a temporary solution. Decades back the Jaigarh Fort (near Jaipur) was built on the top a hill. There was no source of water on the hill. The ruler got canals and covered tanks constructed to capture and store rain water. Till today the system is functional and it is meeting all the needs of residents of the Fort and the visitors to the Fort. Jaigarh Fort is well known for the "Jaiwaan", the largest canon on the Earth. But very little is talked about the innovative rainwater harvesting system, which is fully functional. We need to emulate such examples.

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The Siberian crane

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Tallest of all flying birds, cranes are one of the most handsome avifaunal creatures on Earth. For example, Indian Sarus crane (*Grus antigone*) may measure more than 1.5 metres in height. They stand tall and upright on their two feet, and if you get a chance, they may walk beside you with the elegance of an English gentleman.

Cranes belong to order Gruiformes and family Gruidae. There are altogether 15 species on the planet found on five of the seven continents (Table 1). Antarctica and South America are devoid of any crane species.

The Siberian crane

A critically endangered species, Siberian cranes, are the ones which cover the longest migratory distances, among all the different species of cranes. They are characterised by white plumage with black primaries. An adult individual is devoid of feathers on its fore-crown, face and side of head (Fig. 2), which bear red colour. The bill is dark, long and pointed. The eyes are reddish and the legs are pinkish in colour.

There are two known populations of Siberian cranes today: An eastern population and a western population. The eastern population breeds in north-east of Siberia and spends the winter season around the Yangtze River in China, whereas the western population breeds around Ob River located east of Ural Mountains in Russia and winters along Caspian Sea in Iran.

Fig 1. Tall and upright poise of cranes

A central population of Siberian cranes was also known earlier which used to breed in Western Siberia and later visited India to spend the harsh winter months. In India, these birds used to winter, primarily, in and around the marshy areas of Keoladeo National Park (KNP), situated in Bharatpur district of Rajasthan. The selection of KNP in India for wintering by Siberian cranes was attributed to the wide availability of plants such as *Cyperus rotundus*, *Scirpus tuberosus*, *Eleocharis dulcis*, *Nymphaea* spp., and *Scirpus littoralis* in these marshy lands. During their stay at KNP, these birds feed mainly on tubers and rhizomes of these plants.

However, there was a drastic decline in the number of Siberian cranes visiting KNP over the years. From 200 birds in 1964, their numbers crashed to 100 in 1967. In 1993 only five birds were sighted and none in 1994 and 1995. In 1996, there was a kind of re-appearance, as four visitors were reportedly sighted. As per the information available from International Crane Foundation, the last documented sighting of Siberian Crane in India was way back in 2002.

Table 1 Different species of cranes

Common name	Scientific name
Black crowned crane	*Balearica pavonina*
Gray crowned crane	*Balearica regulorum*
Wattled crane	*Bugeranus carunculatus*
Blue crane	*Anthropoides paradisea*
Demoiselle crane	*Anthropoides virgo*
Siberian crane	*Grus leucogeranus*
Sandhill crane	*Grus canadensis*
White naped crane	*Grus vipio*
Sarus crane	*Grus antigone*
Brolga	*Grus rubicunda*
Eurasian crane	*Grus grus*
Hooded crane	*Grus monacha*
Black-necked crane	*Grus nigricollis*
Red-crowned crane	*Grus japonensis*
Whooping crane	*Grus americana*

Threats to the Siberian crane

Siberian cranes are most habitat-specific, among the crane species. They completely depend on wetlands for different stages of their life. Habitat degradation, therefore, is considered as one of the prime reasons for their decline worldwide. Hunting of these birds during their arduous migratory journey is also believed to be contributing substantially to their decline.

The 5,000 km (approx.) journey of the central flock of Siberian cranes starts from wetlands of Kunowat river in western Siberia and continuing over the Russian Federation, Kazakhastan, Uzbekistan, Turkmenistan, Afghanistan and Pakistan, finally terminates at KNP, in Bharatpur, Rajasthan (Fig. 4). Throughout their migratory route, they are

Fig. 2: A Siberian crane pictured at Patna zoo

suspected to be in danger of being hunted, except in India where wildlife has a better protection. Besides the above mentioned two factors, infection due to a virus known as HPAI (highly pathogenic avian influenza) is also considered to be a potential threat to Siberian cranes.

Fig. 3: Migratory route of three populations of the Siberian crane (Source: International Crane Foundation)

Conservation efforts

Conservation efforts to protect Siberian cranes worldwide broadly involve two strategies: To save the extant eastern and western populations and to revive the central population.

International Crane Foundation (ICF) is one of the major organisations working globally towards conservation and protection of critically endangered Siberian cranes. ICF initiated Siberian Crane Wetland Project (SCWP) with grants from Global Environmental Facility (GEF) in 2003. SCWP was carried out in collaboration with UNEP (United Nations Environmental Programme), CMS (Convention on Migratory Species) and the governments of People's Republic of China, Islamic Republic of Iran, Republic of Kazakhstan, and Russian Federation. Attempts have also been made to artificially re-introduce captive-bred Siberian chicks into the central population, though with little success so far.

The success of conservation efforts depend upon three factors: complete ban on hunting along the migration corridor, protection of the wetlands which serve as habitat and raising public awareness.

Conclusion

The Siberian crane is considered to be an 'Umbrella species'. A species is said to be an umbrella species when its habitat requirements are broad enough to include an entire ecosystem. Thus, protecting an umbrella species would require protection of its complete habitat, which in turn would provide conservation and protection benefits to all other species thriving on and around that habitat. In the case of Siberian cranes, the migratory routes followed by their different populations are also used by a number of other migratory birds which also include 32 endangered species. Thus, conserving and protecting the Siberian crane would indeed offer conservation services to many other critical species. Besides, this white avian angel is also a symbol of high moral values and good fortune. Therefore, saving this for our future generations will help impart good moral values to our human successors.

Fig. 4: Migration route of Siberian cranes to India (Source: International Crane Foundation)

(This article is based on material drawn from various journals web sites.)

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Save the Great Indian Bustard

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According to an estimate, the population of the Great Indian Bustard in its entire distribution range in India has reduced to around 200 individuals. Thus this giant avian fauna is standing on the verge of extinction

The Great Indian Bustard is a large terrestrial bird found in India and Pakistan. It is one of the largest flying bird species found in the world. The scientific name of Great Indian Bustard is *Ardeotis nigriceps* (Family – Otididae) and is locally known by various names in various states. The names popularly used are *Maldhok*, *Yerbhoot*, *Ghorad, Godawan*, *Tuqdar*, *Sohan chidia*, etc.

When the 'National Bird' of India was under consideration, the Great Indian Bustard was a proposed candidate and was strongly supported by the Indian Ornithologist Salim Ali, but dropped in favour of the 'Indian peafowl' with at least one reason being the potential for being misspelt. The Great Indian Bustard is a state bird of Rajasthan.

Due to drastic reduction in population the Great Indian Bustard has been listed as Critically Endangered Species by International Union for Conservation of Nature and Natural Resources (IUCN) in the Red List of Threatened species. In 2011, *Birdlife International* also reclassified this avian species from 'Endangered' to 'Critically endangered'. Critically endangered species are those species which are facing extremely high risk of extinction in the wild in immediate future.

Features of the Great Indian Bustard

The Great Indian Bustard is a large cursorial bird (one that is adapted specifically to run) with a long neck and long bare legs similar to that of the ostrich. It stands at about metre in height. The Great Indian Bustard is easily distinguished by its black crown on the forehead contrasting with the pale neck and head. The body is brownish and the wings are marked with black, brown and grey. The male is about 1.1 – 1.20 m in length with body weight ranging between 8 – 18 kg. The female is smaller (9.2 m in length) than the male with a body weight ranging between 3.5 – 6.75 kg. The male is deep sandy buff coloured and during the breeding season has a black breast band. The crown of head is black and crested and is puffed up by displaying males. In the female the head and neck are not pure white and the breast band is either rudimentary, broken or absent. Males have a well-developed throat pouch right below the tongue which helps in producing the deep resonant booming mating call to attract females that can be heard up to a distance of 500 m. The Great Indian Bustard is devoid of preen glands that secrete oil and hence cannot oil its feathers. Instead it is covered with powder down feathers, which produce a dust that acts on the feathers to make them more waterproof and along with dust bathing helps to keep the feathers clean.

Great Indian Bustard hidden amidst grassland (Courtesy: www.thehindu.com)

Male and female Bustards generally move in separate unisexual flocks. The flock size varies from 3 to 10 birds. The bird carries out its roosting on the ground. All the birds in a flock rest together and a few of them are watchful for any impending danger. Night roosting is done in open while during day they prefer thick grass or shade of bush. The bird has excellent eyesight and hearing powers and is capable of hiding when danger threatens.

Great Indian Bustard is largely a silent bird, but when threatened produces a barking sound *'hook'* and therefore it is also known as *'Hookna'* in some parts of Northern India. It is known in some other parts as *Gaganbher* or *Gurayin* for the resemblance of other calls to thunder or roar of a tiger.

Distribution, habitat, ecology and behaviour

The species was formerly widespread in arid and semi-arid grasslands of India and Pakistan. However, today it is rare due to serious decline in population. The individuals are scattered in the grasslands of the states of Rajasthan, Gujarat, Maharashtra, Andhra Pradesh, Karnataka, and Madhya Pradesh in India. Some birds are found in Pakistan, mainly in summer. The bird prefers arid and semi-arid grasslands with thorn scrub, tall grass interspersed with cultivation. The bird avoids irrigated areas. The Great Indian Bustard is an opportunistic omnivore, feeding on berries of *Ziziphus* spp., seeds of grasses, insects (grasshoppers, locust and beetles), scorpions, rats, and lizards. In cultivated areas they feed on crops such as exposed groundnut, millets, pods of legumes, and wheat grains. The chick mainly feeds on insects. Like other desert fauna, it is facultative drinker (drinks regularly when water is available but can survive without water for long dry spells).

The Great Indian Bustard breeds

between March and September when the fluffy white feathers of the male are inflated and displayed. Territorial fights between males involve strutting next to each other, leaping against each other with legs against each other and landing down to lock the opponents head under their neck. The Great Indian Bustard is known for fantastic courtship display. The male selects the most prominent spot (display spot) in its territory and spends most of the time there. During early morning and late evening, it stands at the display spot and starts to display (courtship) to attract females. The male struts along with its head held back as much as possible its tail cocked, wings drooping down and the pouch of the throat inflated. On inflation the pouch looks like a balloon. It stands in the same position for a few minutes and to further highlight the effect it produces a deep moaning calls. The display may last up to three or four hours and the bird may call hundreds of times. The male may engage in display up to 45 times a day. The purpose of this lengthy exercise is to attract the females for mating and also to advertise to other males to leave its territory. The female moves from one territory to another in search of a male of her choice.

When the female is attracted and ready for mating, it walks and flies towards the displaying male. After mating, the female selects some secluded spot to lay her egg, usually under a bush from where it can have a good view of the surroundings. The female lays a single, or very rarely, two pale olive-brown eggs in a nest situated on open grounds and incubate it for 27 days. Within 24 hours of laying the egg, the mother takes it from the nest to an area with adequate vegetation cover to check predators like, jackal, fox, crow, mongoose, and monitor lizard from getting at the egg or the chick. Females may use a distraction display that involves flying zigzag with dangling legs. Since males are polygamous, they take no part in incubation or caring of young. Only the females are involved in incubation and care of young. Generally the chick feeds on grasshoppers, beetles, and small lizards.

Courtship display by male Bustard (Courtesy: orientalbirdimages.org)

Threats to survival

A study of mitochondrial DNA in 2011 in 63 samples from five Indian states revealed a very low genetic diversity indicating a historical population reduction. The effective population size estimated from the diversity of mitochondrial DNA was fewer than 1,000 birds, and likely about 500 during the period 2006-2010, when samples were collected. Attempts to breed Great Indian Bustard in captivity have failed.

Postage stamp issued by Indian Postal Department in 1980 to draw attention on dwindling population of Great Indian Bustard (Courtesy: indiapicks.com)

Loss of habitat and poaching are the two major threats to the survival of Great Indian Bustard. In addition, the slow breeding nature of bird is also a threat to their declining population. Grazing cattle are also source of disturbance to the incubating female Bustard. On observing the cattle and herdsmen coming very close, the bird moves off the egg leaving it unattended for a long time in the scorching Sun, often resulting in the death of the embryo.

Despite being adapted to survive harsh conditions the Great Indian Bustard has disappeared from almost 90% of their former range owing to loss of habitat and poaching and the calculation indicates that the species has declined at a rate equivalent to 82% over 47 years. Their present population in India is estimated to be around 200 individuals with maximum concentration (around 100 individuals) in the Desert National Park near Jaisalmer, Rajasthan. However, in 19th century, flocks of more than 20 to 30 individuals were a common sight in the Indian grasslands of arid and semi-arid zones.

The grasslands in which they inhabit have been destroyed due to over-grazing, agricultural conversions, and urbanisation and many have been opened up for construction of roads resulting in fragmentation of habitats. The Sokhliya region of Ajmer district in Rajasthan has been known for the population of Great Indian Bustards, but the opening of the area for mining has led to habitat loss of this bird. This has resulted in sharp decline in Bustard population of the region. In Sokhliya region the estimated population of Great Indian Bustard in year 1990 was 72 individuals, which has dropped to 24 individuals in the year 2004. However, in February 2012 only 2 individuals of Great Indian Bustard were recorded from the region.

Spread of the Indira Gandhi canal in the desert state of Rajasthan has resulted in an increased area under agriculture leading to alteration of the bird's habitat. This in turn has led to the disappearance of the species from the region. At Ranibennur Blackbuck

Sanctuary (Karnataka) habitat changes have influenced the population of the blackbuck and the Great Indian Bustard. In the 1950s the scrub forest was replaced with *Eucalyptus* plantations. These helped wildlife when trees were short but after their extensive growth they made the adjoining grassland less favourable for the Bustards.

The Bustard Sanctuary in Maharashtra has only nine birds. The latest bird census in Gujarat has revealed that in entire state only 48 Great Indian Bustards are left.

Inflated gular pouch of the throat of hanging like balloon in front of the legs in male Bustard (Courtesy: greatindianbustardgodawan.blogspot.com)

The Great Indian Bustard is hunted for sport and meat since the time of British rule in India. It was one of the topmost game birds in India. Great Indian Bustards are still hunted in Thar Desert, though they are protected under Indian law. The bird is listed in Schedule 1 of the Wildlife Act of India, 1972 and international trade is prohibited by its listing in Appendix 1 of the Convention on International Trade in Endangered Species (CITES) of wild flora and fauna.

Conservation of the Great Indian Bustard

The position of the Great Indian Bustard has always been precarious. However, emphasis on its protection was initiated soon after India gained independence. In 1952, the Indian Board of Wildlife placed this bird on the fully protected list of endangered birds and all State Governments accepted the recommendation. A number of protected areas have been set up in distribution range of the bird to ensure its conservation. The most important one includes Naliya in Kutch region of Gujarat, Rollapadu in Andhra Pradesh, Bustard Sanctuary in Maharashtra, and Desert National Park in Rajasthan.

Despite of conservation measures the population of the Great Indian Bustard has declined sharply. They have disappeared even from their several protected areas. Great Indian Bustard have totally vanished from former Sanctuaries like Karera and Ghatigaon in Madhya Pradesh, Rannibenur in Karnataka and Sorasan in Rajasthan.

The protection of grasslands is inevitable for the conservation of this magnificent bird. Over-grazing , which is the main cause of grassland destruction in arid and semi-arid regions due to surplus cattle population, needs to be avoided in the bird's habitat and all possible firm efforts should be made to prevent the alteration of the bird's habitat from developmental activities. Since biology of the Great Indian Bustard is largely unknown, a proper biological investigation is also necessary to conserve the bird. Strict enforcement of Wildlife (Protection) Act and CITES can also be helpful in conservation of this giant species of bird. There is also need to launch Project Bustard in India to save this highly threatened bird.

Conclusion

Thus it can be concluded that the Great Indian Bustard is standing on the verge of extinction chiefly due to habitat degradation and ruthless poaching. The population of this giant bird in its entire distribution range has declined to serious extent. Therefore protection and conservation of this critically endangered species is need of the hour otherwise it may be gone extinct at any time in the future.

Dr. Arvind Singh is MSc. and Ph.D in Botany with area of specialization in Ecology. He is an active Researcher having more than forty Research Publications in journals of International and National repute.

Green energy options for India

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Energy is a basic requirement for economic development in almost all major sectors of any country – agriculture, industry, transport, commerce and housing. With steady increase in population the consumption of energy has also been steadily rising. India's current electricity demand is 1,27,165 Megawatts (MW). But the availability is around 1,14,686 MW. This leaves the country with electricity generation deficit of 12,479 MW. At present, 65% of the electricity generated in the country comes from thermal energy - mainly by burning fossil fuels. However, apart from the problem of supplying huge amounts of fossil fuels to the generation plants, there is now growing concern about the harmful effects of burning fossil fuels on the environment and human health. There is now increasing interest in developing renewable energy sources such as solar and wind energy.

Sustainable development has been defined as development that meets the needs of present without compromising the future. For India, renewable energy is the only long-term solution to the existing energy crisis and is the key to future energy, food, environment and economic security. Renewable energy is the energy produced by natural resources like Sun, wind, water, biomass (including agricultural residues, animal dung, biodegradable waste from cities and crop residues), geothermal energy (hot dry rocks, natural geysers, hot springs), and ocean energy (waves and tides).

Present scenario

At present India's installed power capacity is 2,48,510 MW (May 2014) with renewable energy contributing 30,939 MW or 12.45%. of which 71% is wind power, 15% small hydro, 13% biomass, and 4.5 % solar power. By 2030 power generation from renewable sources is estimated to grow to 14%. Consequently, India will benefit in a big way by reducing carbon emissions. In 2009, India was responsible for emitting 1,700 million tons of carbon. If the above projections come true, by 2050, it will be reduced to mere 426 million tons, which will be a great achievement for a thickly populated developing country.

However, to focus on the main areas of solar, wind, and biomass, it is necessary to understand current scenarios and future potentials including the challenges in the renewable energy sector. There is a need of conducting awareness generation programs on energy efficiency policies and technology options amongst energy producers, consumers, industries, infrastructure services, and also the household sector.

Benefits of renewable energy

No doubt, the renewable sector is a challenging and capital hungry sector. Even though it enjoyed substantial progress in 2012, the market in general is still struggling to balance the potential benefits of green power with the challenges of managing the regulation, integration and cost. Considering the benefits of energy efficiency, Government of India enacted the most important step towards renewable energy route, Energy Conservation Act, 2011, in October 2011, aimed at institutionalising and strengthening delivery mechanism for energy efficiency programs in the country. Unfortunately, no targets have been achieved so far.

The task that is staring at us can be solved only if each one of us contributes towards this cause. In India 1,15,000 million tons of

solid waste is generated by households and industries annually, which occupies landfills and these dumping yards give rise to water, land and air pollution. Waste generation in India is expected to increase rapidly in future. As more people migrate to urban areas and as income increases, consumption is likely to rise, as would waste generation. In India solid waste usually contains 51% organics and 17.5% recyclables. If the solid waste thrown away from every house is managed properly, it can be used to generate electricity. In general, 100 tons of raw solid waste with 50-60% organics can generate about 1-1.5MW power and 1,15,000 million tons has the potential to generate huge amounts of power. The residue after power generation can also be used to produce compost and organic fertiliser. The idea is not new, but the initial momentum that was gained has been lost due to lack of continuous supply of segregated waste. As individuals, we should start segregating waste into different categories before putting it in the garbage bin.

Biomass, which is an eco-friendly source of production of electricity, also holds considerable promise for India. It is estimated that with the present utilisation pattern of crop residues, the amount of surplus biomass materials is about 150 million tons, which could generate about 16,000 MW of power

Development of solar/wind power does not lead to cutting down of trees. Like solar energy harvested by solar panels, trees also harvest solar energy and also reduce CO_2 concentration in the air, which is a natural mechanism and which should not be disturbed.

Our building and construction codes should ensure that roof tops are designed to accommodate micro-solar or micro-wind installations. The finance and banking community need to step forward to make these solutions more attractive for consumers. A bolder initiative between industry and the Government in this regard needs to be undertaken. Renewable approach will provide a commercially viable solution rather than just a green and exotic option and will also find wider public willingness and political acceptance.

In order to bring about a sustainable transformation in social attitudes and value systems in favour of energy efficiency, school children and the teaching community need to be motivated. Panchayats need to be involved in electricity distribution at the village level and creating mass awareness about the use of biomass for meeting energy needs.

Often renewable energy is considered "far more expensive." There has already been a decline of 30% in initial capital cost of solar solutions over the last 2 years with a substantial improvement in efficiencies. We often make the folly of comparing the cost of renewable energy with that of large grid-connected coal-based plants and then moan about the huge subsidy burden that renewable energy has to be given. There is no planning to address seasonal peak demands like in summers, except that of frequent load shedding. India has to reduce its dependency on imported fossil fuels (coal and oil) because it makes the economy acutely vulnerable to global energy prices and exchange rate fluctuations. Elimination of subsidy on diesel and kerosene for the purpose of power generation will enhance the attractiveness of renewable energy solutions.

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Letter to the editor

Of science and scientists

I have enjoyed very much the article 'Of Science and Scientists' by Pradeep Kumar Basu (Dream 2047, June 2014). With reference to the incident where Landau challenged Einstein, as mentioned in the article, I would like to add that Landau was fortunate in the sense that Einstein was open-minded enough to admit his own fault and pay due credit to Landau for pointing out the mistake.

In another instance, Subramanian Chandrasekhar, then a research student, who later won the Nobel Prize in Physics in 1983, was not so fortunate during the presentation of his newly proposed theory on late stages of stellar evolution. In the case of Landau, Einstein was the speaker and Landau was in the audience while in the case of Chandrasekhar, he was the speaker and the renowned astrophysicist Arthur Eddington was in the audience. On that day, Eddington could not accept Chandrasekhar's theoretical argument and in fact tore apart and even ridiculed young Chandrasekhar in front of the audience. But, later it was proved that Chandra was right. In fact, on that occasion Eddington lost his rationality and became a victim of dogmatism.

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Pomegranate: a panacea fruit!

Pomegranate has been known for generations for its multifarious medicinal properties. The article by Ravendra Singh nicely brought to light the medicinal chemistry of this fruit (Dream 2047, May 2014). It appears it is a remedy for many diseases – a panacea by itself! For combating the widespread dengue fever, we Keralites bank on this devaphala, as this fruit is known in locally. However, its prohibitive cost is a negative aspect. Government should do everything to promote its cultivation and distribution throughout the country. Kudos to the Dream 2047 team for publishing such an informative article.

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Mystery of Dark Matter

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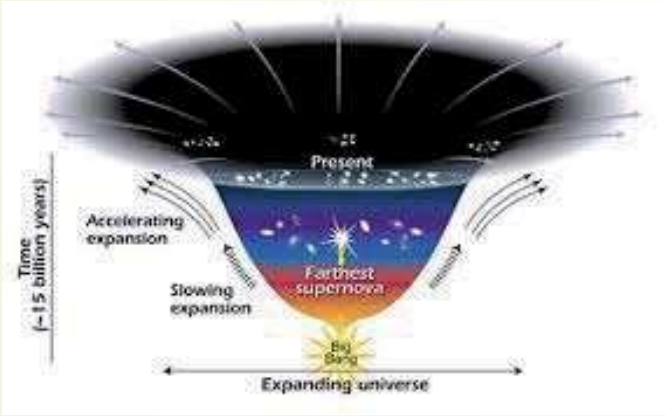
Space has attracted humans for ages. Early sky watchers had tried to explain the goings on in the sky in an effort to understand the universe. Modern day astronomers continue the process to explore it more and more. This tireless effort of astronomers has succeeded in unveiling many mysteries of universe, but at the same time these successes have raised many new questions yet to be explained.

In the beginning of ninth decade of last century scientists were convinced that the energy density of universe is large enough to stop the ongoing expansion of the universe in distant future. But in 1998, during a study of 1-A type supernova the Hubble Space Telescope observed something that was incompatible with such a possibility. It found that the speed of expansion of universe is in fact speeding up rather than slowing down. This discovery amazed the scientists. In order to explain this phenomenon when they put these observations into the theories of the Big Bang, they found that the ordinary "seeable" energy and matter comprise only 5% of the universe. It was found that rest 95% is made of forms of matter and energy which are unfamiliar to us. Calculations revealed that 70% of the universe is in the form of energy and 25% is in the form of matter that we cannot see. These forms of energy and matter were called dark energy and dark matter, respectively.

Dark matter is that form of matter which is unfamiliar to us till now. Since this form neither absorbs nor radiates any type of electromagnetic radiation, it cannot be "seen" directly through any telescope. The idea of dark matter goes back to 1932 when the Dutch scientist John Oort found that the motions of stars in the Milky Way were faster than predicted by calculations. To solve this discrepancy he conceptualised a form of matter that cannot be seen. In 1933, during explanation of observed faster speed of galaxies in Coma cluster in comparison to the calculations, Swiss astronomer Fritz Zwicky found that the amount of this "vanished matter" should be at least hundred times that of normally observed matter. He coined the term "Dark matter" for this kind of matter.



Accelarating Universe

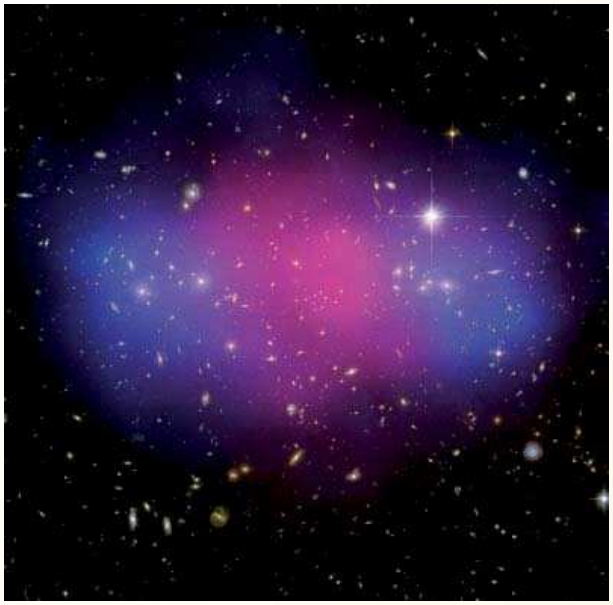
In the 1950s and 1960s, in course of study of rotation of spiral galaxies, astronomers discovered a perplexing phenomenon. They observed that the rotational speed of stars at the centre of Milky was equal to that of stars situated at the edges of the galaxy. This was contradictory to the normal behaviour where stars at the edges should be moving faster than the stars near the centre of the Milky Way. In 1970, American astronomer Vera Rubin confirmed the generality of this phenomenon after studying many galaxies including Andromeda. The implications of all these observations pointed to the fact that either there is a fundamental fault in our understanding of gravitation and rotation, which is very unlikely as these laws have been tested numerous times over centuries, or there exists some invisible matter in the galaxies and galaxy clusters which is responsible for these observed effects.

These observations inspired astronomers to explore the farthest corners of the universe in search of existence of dark matter and its characteristics. The scientists concentrated on the large clusters of galaxies (containing fifty to thousands of galaxies in a single cluster) glued together by gravitational force in the hope that they would find heated gases that probably could not be seen in previous observations and could provide the answer to the question of missing or dark matter. Gigantic clouds of super-heated gases were indeed found when X-ray telescopes were focussed on those clusters. Here Chandra X-ray telescope (named after the Indian Noel laureate S. Chandrashekhar) contributed significantly. But the calculation of hot gas pressure of these clusters revealed that the mass of the clusters should be at least five to six times the combined mass of all the stars and gases present in these clusters, or else there would not be enough gravitation to prevent the escape of these heated gases. These observations and calculations provided several clues about the existence of dark matter. Models simulated by various computational programs predict that dark matter should be woven with ordinary matter in the entire universe.

Collision of Galaxies

Structure of dark matter

Although the prospects of existence of dark matter have got a boost in a number of astronomical



Collision of two galaxies in Bullet Cluster observed by Chandra Obseravatory

observations in the last few decades, the identification of the structure of this matter is the biggest unresolved enigma of astronomy. As this matter does not interact with electromagnetic radiation at all the confirmation of its existence and study of its virtues could only be studied indirectly by reading its gravitational effects on ordinary matter, energy and large structures in the universe. As a result, till now we only know which constituents it does not contain rather which constituents it should be comprised of. According to initial theories, dark matter could be made of black holes, neutron stars, faded old white dwarfs and brown dwarfs, which are invisible but made of ordinary matters collectively known as MACHOs. But the data from observations show the quantity of this "non-illuminated" matter to be too meagre to fulfill the 25% predicted by theory.

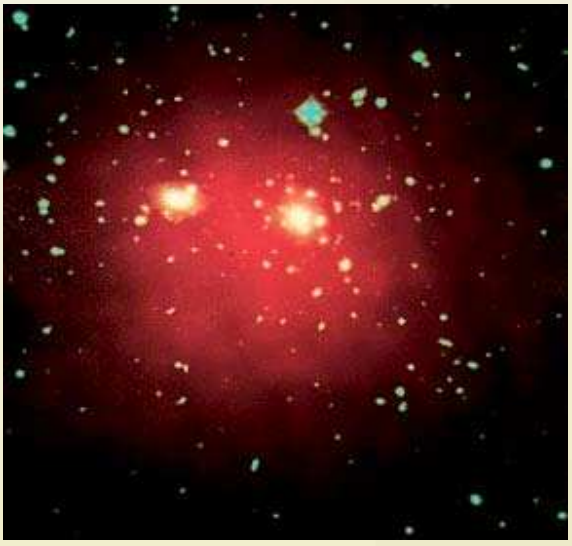
Again, dark matter could not be dark clouds of ordinary matter fabricated of baryon particles, as in this case they would be capable to absorb electromagnetic radiation passing through the clouds. Dark matter could also not be antimatter because then we would be getting large number of gamma rays characteristic of matter-antimatter annihilation. In addition the possibility of galaxy-sized gigantic black holes being dark matter is eliminated due to non-observation of sufficient number of a special phenomenon called "gravitational lensing", which confirms the existence of these black holes.

Considering all these facts the most prospective constituents of dark matter could be non-baryonic particles excluding the commonly known ones. Among these, neutalino (one of the WIMPs), axions, and sterile neutrino are the most probable.

Historically these particles could further be divided into three groups:

(i) Cold dark matter is the lead candidate of being dark matter which very simply explains most of the astronomical observations. Due to non-relativistic speed of its constituent particles, this matter is called "cold" dark matter. Cold dark matter was hypothesised in 1984 by American scientists Joel R. Primack, George Blumenthal, and Sandra Moore Faber with UK scientist Martin Rees to explain the creation of clusters. This theory beautifully explains the current situation of galaxies in the universe, nature of relic microwaves generated during Big Bang and many other phenomena.

(a) The possible candidates of cold dark matters include: Axions, which are very light particles and are one of the prominent candidates of being cold dark matter. Its mass should lie in between 10^{-6} to 1eV and electric charge should be zero. (In particle physics mass in measured in electron volt and one electron volt is equal to 1.783×10^{-36} kilogram). Many theories predict the existence of axion particles but yet to be verified experimentally.



Coma Cluster

(b) MACHO, which is the acronym of massive (astrophysical) compact halo objects, could be a form of cold dark matter. It includes compact bodies like black holes, white dwarfs, brown dwarfs, neutron stars and non-illuminated planets with natural satellites. But experts opine that the total amount of all of these objects may constitute a very small part of dark matter.

(c) WIMPs, weakly interacting massive particles. Their mass should be more than that of all the particles of standard model. Despite having the maximum probability of existence in theory these particles could not be detected till date.

Unfortunately, cold dark matter theory is not a complete theory. According to it the density distribution of dark matter halos should be much more peaked than what is observed in the rotation curves of galaxies. Additionally, cold dark matter predicts larger numbers of small dwarf galaxies (about one thousandth the mass of the Milky Way) than are observed.

(ii) Hot dark matter comprises dark matter particles which travel at relativistic speed. According to the special theory of relativity these particles should possess zero or very light mass resulting in possessing high energy and should have been distributed isotropically in the universe. This theory precisely explains the origin of super clusters, which had made it the most popular theory of dark matter in the 1980s, but its inability to explain how individual galaxies formed from the Big Bang and many related phenomena led to the gradual fading in its popularity and now-a-days mixed hot and cold dark matter theory is being used in its place. Neutrino particles could be a real example of hot dark matter.

(iii) Warm dark matter is a concept lying in between those of hot and cold matter which is increasingly gaining popularity as a topic of active research since last decade. This theory is capable of explaining the evolution of galaxies like cold dark matter theory as well as the observations found in super clusters. Moreover, it is also better in calculating the actual number of dwarf galaxies which is one of the major problems of cold dark matter theory. As a result

many scientists have started treating it as the most likely dark matter theory. But this theory too is not flawless. Till now there is no particle in particle physics having mass in the prescribed domain of warm dark matter (300 eV to 3'000 eV) .Consequently some particles have been hypothesised that could be warm dark matter. Photino, gravitino and sterile neutrino are prominent among the proposed warm dark matter particles.

Photinos are predicted to be charge-less and be ten to hundred times heavier than protons. The possibility of existence of these particles was proposed by scientists J.R. Bond and M.S. Turner together in 1982. .

Gravitinos were proposed in 1982. The maximum mass of these particles should be 1 TeV.

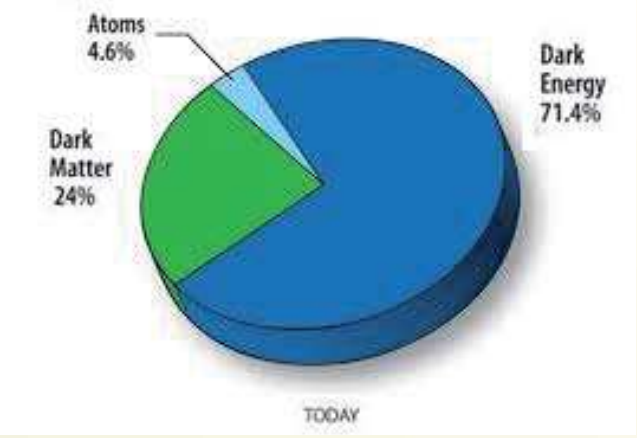
Sterile neutrinos are slow and heavier form of normal neutrino particles. Unlike normal neutrinos these particles remain unaffected by weak forces also. Their mass should lie in the range of kilo eV to giga eV.

Apart from these three types of dark matter, mixed dark matter was also conceptualised in the 1980s to resolve the problems of hot dark matter , but due to its inherent problems this theory cold never get wide recognition and with the advent of dark energy theory it was completely abandoned.

Experiments to confirm dark matter hypothesis

If the dark matter of our galaxy is made of WIMPs then thousands of these particles should be passing through every square centimetre area of the Earth. Based on this concept, a number of experiments are either running or proposed which could be classified in following ways depending upon their characteristics.

Direct detection method: In this method detectors explore dark matter scattered from the collision of atomic nuclei**.** These experiments are in general carried out in underground laboratories to minimise interference from cosmic rays. The Soudan mine; the SNOLAB underground laboratory at Sudbury, Ontario (Canada); the Gran Sasso National Laboratory (Italy); the Canfranc Underground Laboratory (Spain); the Boulby Underground Laboratory (UK); and the Deep Underground Science and Engineering Laboratory, South Dakota (US) are leading names among all the underground laboratories. Cryogenic detection or noble gas fluid detection techniques are used in these laboratories. In the former technique the detectors working below 100 millikelvin (mK) temperature identify particles catching the heat generated due to collision of particles with the atoms of the absorbers like germanium. The CDMS, CREST and EURECA experiments are based on this technique. On the other hand the detectors based on the second technique detect scintillating light emerging due to collision of particles in the noble gas fluids like xenon or argon. ZEPLIN, XENON and LUX are famous experiments based on this technique.



Distribution in Universe

Indirect detection method: These methods are based upon detection of the particles produced due to annihilation and decay of WIMPs. If WIMPS are "Majorana" particles (Majorana particles are antiparticles of themselves) then two WIMPs could annihilate one-another to generate gamma rays or particle-antiparticle pairs of standard model. If WIMPs are unstable particles then they could decay to produce standard model particles. So, by observing emanating gamma rays, anti-protons and positrons from likely high-density areas of dark matter their existence could be proved indirectly. EGRET gamma ray telescope, PAMELA (Payload for Antimatter Matter Exploration and Light-nuclei Astrophysics) experiment (launched 2006) and Fermi gamma ray space telescope are searching for dark matter on these very concepts. Again, there exists a high probability of decay of energy due to collision of sufficient number of WIMPS passing through the Sun or Earth with the atoms of normal matter. Consequently, the density of these particles could rise to a sufficient proportion in the core of the Sun or Earth which could further radiate signals in the form of high-energy neutrinos produced due to their decay. It could be the best indirect proof of existence of WIMPs. High-energy neutrino telescopes such as AMANDA, IceCube and ANTARES are searching for this signal.

Indications till now

PAMELA has detected larger number of signals of positrons which is more than anticipation. These additional positrons could be due to annihilation of dark matter, but there is also strong possibility that they might be originating form pulsars. This experiment has not recorded any additional amount of anti-protons.

In 2009, the scientists from CDMS project have informed two such events which could be caused by WIMPs with 77% probability.

In 2011 CREST project scientist presented proof of 67 such collision where the probability of any known particle or contamination is less than one in ten thousand. There is a reasonable chance that a good number of these collisions might have caused by WIMPS or other unknown particles.

Alternative theories

Although dark matter theory presents widely recognised explanation of many observations related to galaxies and clusters, the possible existence of dark matter particles has gave rise to many alternative theories which do not require presence of unseen matter. Among these theories, the modified laws of gravitation are worth mentioning which are at variance with the established theories of gravitation proposed by Newton and Einstein in order to explain various astronomical phenomena.

But all these alternative theories are in various stages of development and none of them is currently in a position to replace the current dark matter theory which still remains the best explanation to all these astronomical phenomena.

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ASTRONOMICAL TELESCOPE MAKING WORKSHOP

05 - 16 January 2015

An excellent opportunity to learn telescope making and initiate observational astronomy:

A. The workshop is primarily aimed to attract professionals, amateurs and enthusiasts who would like to gain a firsthand experience in the nitty-gritty of telescope making under expert supervision under one roof.

B. Successfully enrolled participants will be trained to make their own five inch (5") Newtonian reflectors with alt-azimuth mounts primarily from locally available material.

C. There is a provision for just 25 teams on a first come first served basis. Each team should consist of maximum two members preferably, not below the age of 17 years.

D. The last date of registration is October 31, 2014.

Workshop attractions: Participants will .....

I. Grind, polish glass blanks, test their own-hand-made mirrors and fabricate the dobsonian alt-azimuth mount using predominantly locally available materials. This is to impart and enhance skills to secure precise curvature, focal length and the reflecting surface.

II. Learn through night sky observations, practical sessions on how to use telescope, lectures on elementary astronomy, tips on astrophotography, interactions with eminent astronomers from various research institutions and many more.

III. All teams at the workshop will become part of a country-wide network. They will receive regular e-mail updates on astronomy activities, night sky events, and other special events including seminars/workshops/training sessions.

Registration details:

1) Each participant will have to pay a fee of ₹10,000.
2) If a team of two members comes together, the team have to remit a sum of ₹ 12,000. The members of the team should mutually agree to share the telescope for use.
3) Payments have to be made through a Demand Draft of any nationalized bank. The draft of required amount has to be made in favor of 'Jawaharlal Nehru Memorial Fund', payable at Allahabad, UP.
4) This fee amount is meant to cover the cost of materials that will be used to make the telescope and a working lunch over the days of the workshop.
5) Participants will have to meet their own travel, lodging & boarding expenses. However, assistance may be provided to locate a suitable accommodation depending on the requirement and the budget of the participants.
6) Only online registration is allowed at www.vigyanprasar.gov.in. List of selected participants will be displayed after deposit of registration amount.

Confirm your participation at the earliest.

Venue
Jawahar Planetarium
Anand Bhawan, Allahabad

Last Date of Registration
31 October 2014

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Uterine fibroids— Symptoms and diagnosis

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Uterine fibroids are extremely common benign tumours of the uterus. They occur during childbearing years, and are non-cancerous growths which develop from muscle cells in a woman's womb. Growing into a tight bundle or mass, they can be single or multiple, and may be as small as seedlings or as large as a football and reach up to the rib cage. They are noncancerous, aren't associated with an increased risk of uterine cancer and almost never develop into cancer.

The growth patterns of uterine fibroids vary — they may grow slowly or rapidly, or they may remain the same size. Some fibroids go through growth spurts, and some may shrink on their own. Many fibroids that have been present during pregnancy shrink or disappear after pregnancy, as the uterus goes back to a normal size.

Who gets uterine fibroids?

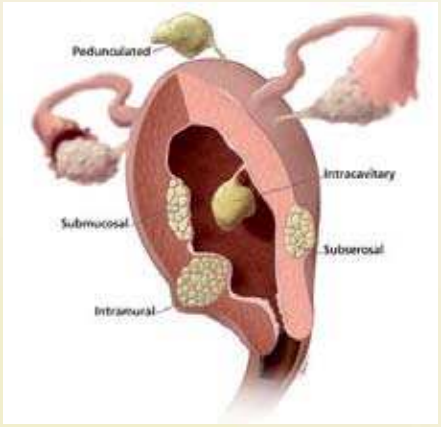
More than 40 per cent women have uterine fibroids sometime during their lives. Most remain unaware of them because they cause no symptoms. Often, a doctor may discover fibroids incidentally during a pelvic exam or prenatal ultrasound.

No one knows what causes uterine fibroids, but their growth seems to depend on estrogen, the female hormone. Uterine fibroids don't develop until after puberty, and usually after age 30. Uterine fibroids tend to shrink or disappear after menopause, when estrogen levels fall.

Several factors may influence development of uterine fibroids:

Early menstruation

Women whose first period was before age 10 are more likely to have uterine fibroids



Pregnancy

Women who have had children are less likely to get fibroids.

Birth control pills

Women taking birth control pills are less likely to develop significant uterine fibroids.

Family history

Women whose mothers and sisters have uterine fibroids are more likely to have them.

What are the symptoms?

In most women, uterine fibroids do not cause any symptoms. When women do experience symptoms from uterine fibroids, they can include:

- Prolonged menstrual periods (7 days or longer)
- Heavy bleeding during periods
- Bloating or fullness in the belly or pelvis
- Pain in the lower belly or pelvis
- Frequent urination
- Difficulty emptying your bladder
- Constipation
- Backache or leg pains
- Pain during intercourse

Rarely, a fibroid can cause acute pain when it outgrows its blood supply. Deprived of blood flow, the fibroid begins to die. Byproducts from a degenerating fibroid can seep into surrounding tissue, causing pain and, rarely, fever.

A fibroid that hangs by a stalk inside or outside the uterus—pedunculated fibroid—can trigger pain by twisting on its stalk and cutting off its blood supply.

The location, size and number of a fibroid may also influence the signs and symptoms:

Submucosal fibroids

Fibroids that grow into the inner cavity of the uterus are called submucosal fibroids. They are more likely to cause prolonged, heavy menstrual bleeding and are sometimes a problem for women attempting pregnancy.

Subserosal fibroids

Fibroids that project to the outside of the uterus are called subserosal fibroids. They can sometimes press on the urinary bladder, causing urinary symptoms. If fibroids bulge from the back of the uterus, they occasionally can press either on the rectum, causing a pressure sensation, or on the spinal nerves, causing backache.

Intramural fibroids

Some fibroids grow within the muscular uterine wall. They are called intramural fibroids. If large enough, they can distort the shape of the uterus and cause prolonged, heavy periods, as well as pain and pressure.

Meddling with fertility and pregnancy

Fibroids usually do not interfere with conception and pregnancy. However, some fibroids can occasionally interfere with fertility and pregnancy. Submucosal fibroids may prevent implantation and growth of an embryo. Rarely, they may also cause multiple miscarriages.

Very rarely, fibroids may also distort or block the fallopian tubes, or interfere with the passage of sperm from cervix to fallopian tubes. In all such cases, it may be best to remove the fibroids before attempting pregnancy.

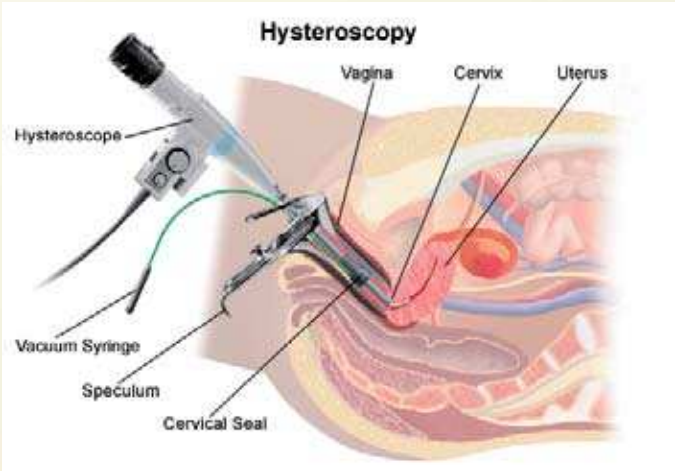
When to see a doctor

You should see a doctor, preferably a gynecologist, if you have:

- Overly heavy or painful periods
- Spotting or bleeding between periods
- Pelvic pain that doesn't go away
- Pain consistently with intercourse
- Enlarged uterus and abdomen
- Difficulty emptying your bladder

Although uterine fibroids usually aren't dangerous, they can cause discomfort and may lead to complications such as anaemia from heavy blood loss.

You must, however, seek quick medical care if you have severe vaginal bleeding or sharp pelvic pain that comes on suddenly. This could mean a complication which may need immediate medical attention.



Diagnosing fibroids

A gynecologist can easily feel moderate and large-sized uterine fibroids during a manual pelvic examination. However, s/he may suggest a specific imaging test to confirm the presence of uterine fibroids.

Ultrasound

A pelvic ultrasound examination is the simplest test to obtain good three-dimensional images of the uterus. It can help in mapping and measuring the uterine fibroids.

An ultrasound device uses sound waves to pick out finer details of the abdominal and pelvic organs. The examination is carried out by a specialist doctor (a radiologist) or technician.

The uterus can be imaged in two ways. In a trans-abdominal ultrasound, the doctor moves a hand-held ultrasound device called the transducer over the abdomen, and obtains images of different organs by focussing the sound waves on them. In contrast, in a transvaginal ultrasound, the doctor uses a thick pencil-like probe and places it inside the vagina to get close up images of the uterus.

Hysterosalpingography

The gynecologist may also recommend a hysterosalpingography (HSG) if infertility is a concern. This special test uses a contrast dye to outline the uterine cavity and fallopian tubes on X-ray images. The test is carried out a week or until ten days after you have had your menstrual period.

After you lie on your back as directed by the doctor, s/he may inject a local anesthetic into the cervix after cleaning it. Next, an instrument called a cannula will be inserted into the cervix. The doctor will push a liquid contrast through the cannula, which will flow into the uterus and fallopian tubes. You would be asked to change positions several times so that the doctor can capture certain images. You may feel some pain and cramping as the dye moves through the fallopian tubes.

Once the required X-rays have been taken, the cannula will be removed. You will be prescribed appropriate medications for pain and infection prevention and discharged.

Hysteroscopy

For performing a hysteroscopy, the gynecologist inserts a small, lighted telescope called a hysteroscope through your cervix into the uterus. S/he then injects saline into your uterus, thus, expanding the uterine cavity. This allows her to examine the walls of your uterus and the openings of your fallopian tubes.

Magnetic resonance imaging (MRI)

When an ultrasound examination fails to clinch the diagnosis or the doctor has a special treatment plan, s/he may ask for a specialised imaging study, like the MRI. This test can show the size and location of fibroids, identify their blood supply and help determine appropriate treatment options.

Lab tests

If you're experiencing abnormal vaginal bleeding, your doctor may order other tests to investigate potential causes. These might include a complete blood count (CBC) to determine if you have anaemia because of chronic blood loss and other blood tests to rule out bleeding disorders or thyroid problems.

(Next month: Treatment options in uterine fibroids)

Recent developments in science and technology

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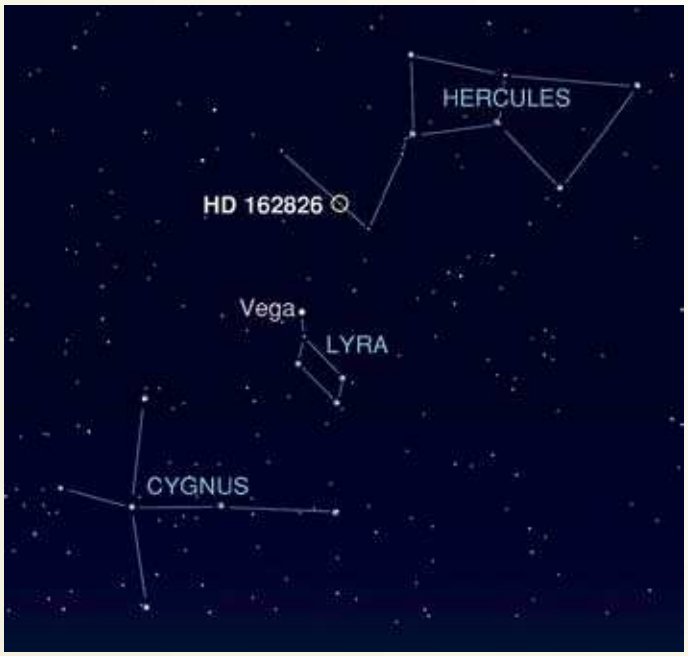
Sun's sibling discovered

Our Sun has been shining for more than 4.57 billion years. It is known that the Sun and the planets of the Solar System formed out of a massive cloud of gas and dust known as the solar nebula. The Sun was born when the cloud contracted due to gravity and the temperature at its core reached 10 million degrees Celsius due to compression, triggering nuclear fusion. After the Sun was formed, the left-over matter of the cloud condensed around it in discrete lumps due to gravitational contraction to form the planets. But recently, astronomers have made an exciting discovery – they have identified a star that they say is a "sibling" or sister of our Sun, formed out of the same cloud of gas and dust as our Sun at the same time. The discovery was made by a team of researchers, led by Ivan Ramirez from the University of Texas at Austin, USA. Known as HD 162826, in the constellation of Hercules, the star is about 4.6 billion years old, and a bit warmer, brighter and 15 percent more massive than our Sun (*Astrophysical Journal*, 1 June 2014 | doi:10.1088/0004-637X/787/2/154).



Star HD 162826 is not visible to the unaided eye, but can be seen with low-power binoculars. It is in the constellation Hercules, and appears not far from the bright star Vega in the night sky. (Credit: Ivan Ramirez/Tim Jones/McDonald Observatory)

According to astronomers, stars like our Sun are not formed singly, but are formed in groups. Evidence for this can be found throughout the Milky Way; for example, in the Trapezium Cluster – a tight open cluster of stars in the heart of the Orion Nebula in the constellation of Orion. But after formation, the stars usually drift away, as the motions of other stars and relentless tug of the Galaxy's gravity tear the group apart. Typically, star formation results in the formation of an "open cluster" – a group of young stars that have formed from the same gas cloud. Open clusters only last for a few hundred millions years, their stars spreading out throughout the Galaxy over time. The Sun itself is about 4.57 billion years old, so it has had plenty of time to move away from its siblings. At present, HD 162826 is located 110 light-years away from the Sun in the constellation Hercules. The star is not visible to the unaided eye, but can be seen easily with low-power binoculars, not far from the bright star Vega.

The team made the discovery after closely studying 30 possible candidates found by several groups around the world looking for solar siblings. Ramirez's team studied 23 of these stars in depth with the Harlan J. Smith Telescope at McDonald Observatory in Texas, USA. The other seven stars, which are visible only from the Southern Hemisphere, were studied with the Clay Magellan Telescope at Las Campanas Observatory in Chile. In all of these observations high-resolution spectroscopy was used to get a deep understanding of the chemical make-ups of the stars. The chemical composition of HD 162826 matches that of the Sun.

But there were also other criteria which helped the team pin down HD 162826 as Sun's sibling. In addition to chemical analysis, the researchers also included information about the stars' orbits – where they had been and where they are going in their paths around the centre of the Milky Way galaxy. Combining information on both chemical makeup and dynamics of the candidates narrowed the field down to one: HD 162826.

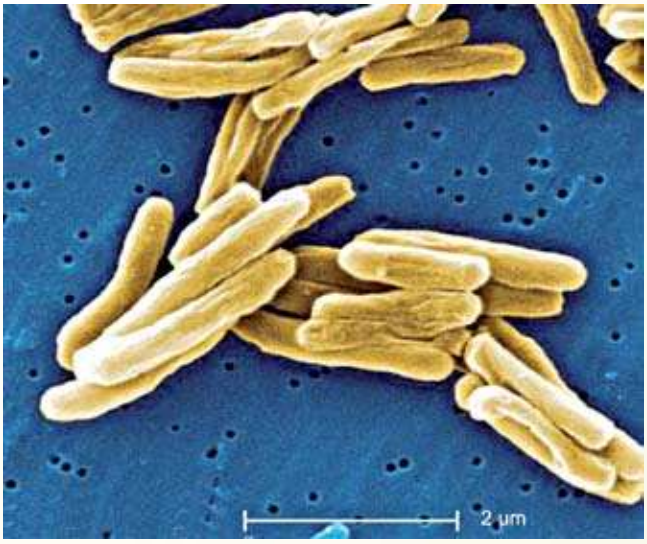
The researchers hope more siblings of the Sun could be identified in future using the technique they have used. Once many more solar siblings have been identified, astronomers will be one step closer to knowing where and how the Sun formed and will be able to identify the birthplace of our Solar System.

New drug for MDR-TB

Tuberculosis, or TB as it is commonly known, is widespread in India. According to the World Health Organisation (WHO), India harbours the largest number of TB cases, with an estimated figure of 2.2 million out of a global incidence of 8.7 million cases. It is estimated that about 40% of the Indian population is infected with TB bacteria, the vast majority of whom have latent rather than active TB.

India's Revised National TB Control Programme is the largest TB Control Programme in the world, placing more than 100,000 patients on treatment every month. The WHO-recommended Directly Observed Treatment, Short Course (DOTS) strategy was launched in 1997 after pilot testing from 1993-1996. Since then DOTS has been widely advocated.

Rifampicin and related drugs are important antibiotics used effectively to treat TB, but it takes about six months of treatment to cure the disease. However, two forms of tuberculosis, referred to as "multi-drug-resistant," or MDR, and "extensively drug-resistant", or XDR, have become resistant to rifampicin, mainly due to the



Electron micrograph of Mycobacterium tuberculosis, which causes TB. (Credit: Centres for Disease Control and Prevention)

lapses in treatment, especially with patients failing to complete the course of treatment. Bacteria that cause MDR and XDR TB are resistant to most of the common drugs used for treating the disease and is therefore very difficult to treat with antibiotics like rifampicin that had been quite effective in the past.

According to WHO's global tuberculosis report for 2013, India has the world's largest number of MDR-TB patients, with an estimated 64,000 cases among notified patients with lung tuberculosis. There is therefore urgent need to accelerate the capacity for diagnosis and treatment of these patients. According to the report, while the number of people diagnosed with MDR-TB through rapid diagnostic tests had increased by 40 per cent worldwide during 2012, three out of four MDR-TB cases still remain undiagnosed.

It is therefore welcome news that a team of scientists of the University of Delhi and Oregon State University, USA have managed to modify a precursor to an existing anti-TB drug, an important first step towards developing new drugs that can be used against MDR and XDR TB. By modifying a precursor of rifampicin called 24-desmethylrifamycin, the researchers have developed a new compound called 24-desmethylrifampicin that has much better antibacterial activity than rifampicin against multi-drug-resistant strains of *Micobacterium tuberculosis*, the bacterium that causes TB. In lab trials on MDR TB strains, use of 24-desmethylrifampicin as part of a cocktail of drugs used to combat the disease showed far more potent anti-bacterial activity than rifampicin (*Journal of Biological Chemistry*, 12 June 2014, doi: 10.1074/jbc.M114.572636).

The researchers used a combination of genetic modification of the bacterium *Amycolatopsis mediterranei* S699 (which is the source of rifamycin-B, a precursor of rifampicin) and synthetic drug development to create the new compound, which so far has only been developed in laboratory. According to them, the combined genetic-synthetic strategy used in the study has opened up new avenues for generating more rifamycin analogues. Further development and testing will be necessary before it is ready for human use, they said.

Chimpanzees have been found to prefer Indian music to Western pop music.

Chimpanzees prefer Indian music to Western pop

In many respects chimpanzees are the closest relatives of humans, with about 97 per cent of our genes matching with those of chimpanzees. They also possess many behavioural attributes similar to ours. Although they cannot speak, some chimpanzees are known to be able to communicate using the sign language used by hearing-impaired humans. A recent study has found that chimpanzees also love music, but only of certain kinds. If given the choice they like Indian classical music more than Western pop music. In fact, they prefer silence to Western pop music! The study was conducted by researchers of Emory University, Georgia, USA.

Sixteen adult chimpanzees in two groups were used in the experiment at the Yerkes National Primate Research Centre at Emory University. The chimpanzees were housed in two outdoor enclosures and were given the opportunity to listen to Indian, African or Japanese music playing on a portable stereo near their outdoor enclosure. Another portable stereo not playing any music was placed at a different spot near the enclosure to rule out if the reaction of the animals was associated with an object rather than the music.

The enclosures were divided into four zones, with Zone1 closest to the source of music and Zone 4 furthest from it. The zones and playback volume were chosen so that the music would be clearly audible in Zone 1 and barely audible in Zone 4.

The chimpanzees were exposed to music for 40 minutes each morning over 12 consecutive days. The different types of music were played at the same volume but in random order. Each day, researchers observed the chimps and recorded their location every two minutes. They also videotaped the activity in the enclosure. The behaviour of the chimpanzees when the music was played was compared to their behaviour with no music. At the end of the study it was found that the

chimpanzees prefer silence to music from the West, but like to listen to different rhythms of music from India and Africa (*Journal of Experimental Psychology: Animal Learning and Cognition*, 23 June 2014 | doi: 10.1037/xan0000032).

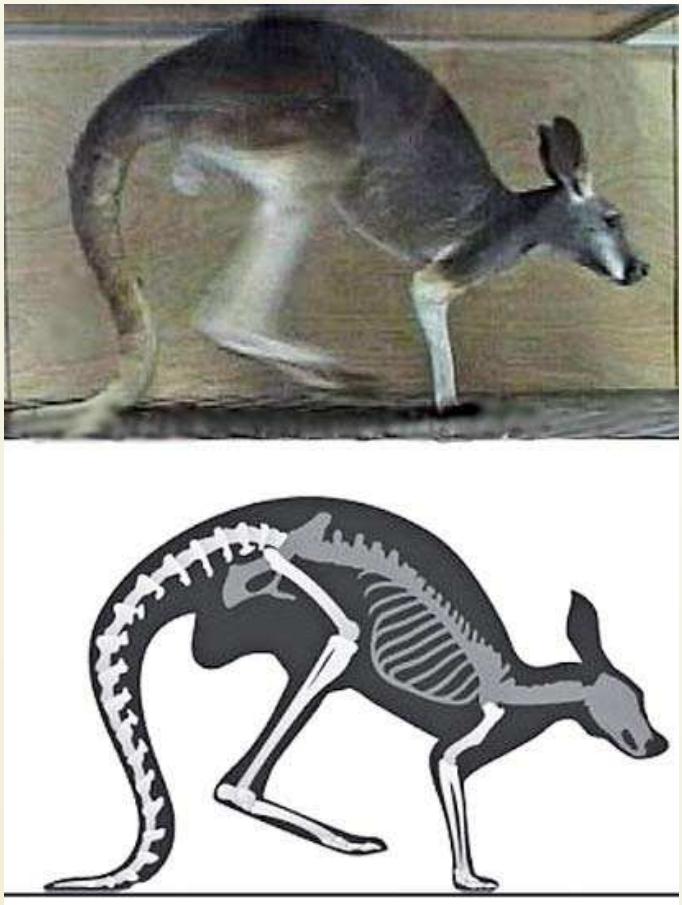
According to the researchers, the objective of the study was not to find a preference for music of different cultures. Recordings of cultural music from India, Africa and Japan were used to pinpoint specific acoustic properties of beats and rhythm. When Indian classical and African music was played near their large outdoor enclosures, the chimpanzees spent significantly more time in Zone 1 where they could best hear the music. In contrast, when Japanese music was played, they were mostly found in Zone 4 where it was more difficult or impossible to hear the music; in other words, they avoided listening to the music.

According to the researchers, the main difference between the types of music played was in the pattern of beats. The researchers say the response of the chimpanzees could be due to the different rhythmic patterns. "Chimpanzees may perceive the strong, predictable rhythmic patterns as threatening, as chimpanzee dominance displays commonly incorporate repeated rhythmic sounds such as stomping, clapping and banging objects," says co-author Frans de Waal. The Indian and African music in the experiment had extreme ratios of strong to weak beats, whereas the Japanese music had regular strong beats, which is also typical of Western music. Additionally, both the Indian and African music had considerable melodic elements compared to Japanese music.

"Chimpanzees displaying a preference for music over silence is compelling evidence that our shared evolutionary histories may include favouring sounds outside of both humans' and chimpanzees' immediate survival cues," says lead author Morgan Mingle.

The kangaroo's 'fifth' leg

Kangaroos are marsupials – mammals of which the females have a pouch containing the teats where the young are fed and carried. They are only found in Australia. Kangaroos have powerful hind legs and short forelimbs. They also have a long and well-built tail. Kangaroos are mostly seen hopping around, often covering more than nine metres in a single leap. As they hop, the long tail whips up and down, helping the animal control the angle of its body. Kangaroos can travel at speeds up to 20 kilometres per hour.



Scientists from Colorado, Sydney and Canada discovered that a red kangaroo's tail provide as much driving force as their front and hind legs combined. Pictured is the tail skeletal structure with corresponding photo of a red kangaroo. (Credit: Heather More/Simon Fraser University, Canada)

Kangaroos also spend a lot of time in a slow, hunched-over walk, moving at a leisurely 6 kilometres an hour or less as they graze and socialise. The animals primarily eat green vegetation, particularly fresh grass, which makes up 75 per cent to 95 per cent of their diet. When foraging for food, these usually majestic creatures look ungainly and awkward as they attempt to balance their heavy bodies.

It was long believed that kangaroos use their long tails for balancing only. Scientists have long known that a slowly walking kangaroo plants its tail on the ground to act as a crutch while its hind legs are off the ground. But recent research by a team of scientists from the University of Colorado, Boulder, USA, Simon Fraser University in Burnaby, Canada, and the University of New South Wales in Sydney, Australia, has shown that the animal uses its tail as a powerful 'fifth' leg. It turns out that while grazing the tail provides the animal as much propulsive force as their front and hind legs combined. When grazing, kangaroos move both hind feet forward together while using their tails and front limbs to support their bodies. In fact, when a kangaroo is walking, it uses its tail just like a leg. The kangaroo tail has more than 20 vertebrae, taking on the role of our foot, calf, and thigh bones. The researchers found that a kangaroo moves its tails as much as a human moves one of their legs. No other animal is known to employ its tail this way (*Biological Letters*, 2 July 2014 | doi: 10.1098/rsbl.2014.0381).

For the study, the researchers videotaped five red kangaroos – the largest of the kangaroo species in Australia – that were bred in captivity and had been trained to walk forward on a force-measuring platform with Plexiglas sides. The platform's sensors measured vertical, backward and forward forces from the legs and tails of the animals. The kangaroos had been taught that walking forward on the platform would be rewarded with sweet treats. A low ceiling above the platform prevented them from trying to hop. The measurements showed that the tail, far from serving as a mere prop, acts like "a motor to lift and help accelerate the kangaroo's body".

In addition to playing the role of a fifth leg, kangaroo's tail also acts as a springy counterbalance during hopping and boosts balance during fighting – when male kangaroos grab each other by the chests or shoulders, then rear back and kick each other in the stomach in an attempt to assert dominance before courtship. ■