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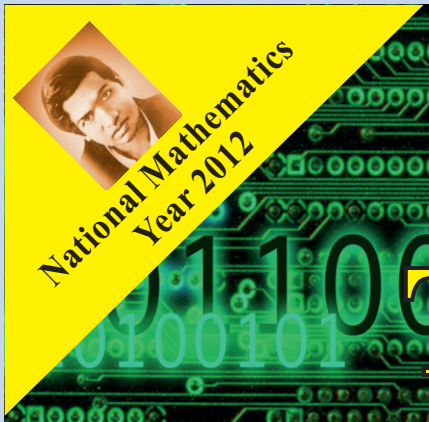

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... think scientifically, act scientifically... think scientifically, act scientifically... think scientifically, act...

Remembering Ruchi Ram Sahni

Dr. Subodh Mahanti

The year 2013 will mark the 150th birth anniversary of Ruchi Ram Sahni who was one of the pioneers who established a tradition of modern science in India. Sahni was a multi-faceted personality. He was a scientist, an innovator, an enthusiastic educationist, a fierce patriot, and a devoted social worker. Sahni's research activities and particularly his pioneering science popularisation efforts remained mostly unknown. He has been referred to mostly in the context of his son, Birbal Sahni—the renowned Indian palaeobotanist. In the early 1990s the National Council for Science and Technology Communication (NCSTC), Department of Science and Technology, Government of India took initiative in making people aware of Sahni's contributions. Narender K. Sehgal, then Head, NCSTC, wrote a two-part article in *NCSTC Communication* (November 1991 and January 1992 issues) on Sahni's science popularisation work. It was Nandan Kudhyadi, a film-maker, who got hold of a copy of the unpublished manuscript of Sahni's autobiography in September 1990 while doing research work for a video programme for NCSTC on Birbal Sahni whose birth centenary was to be celebrated in 1991. Kudhyadi brought the manuscript to Sehgal. Following the initiative taken by Sehgal the edited and abridged version of the manuscript of Sahni's Memoirs was published in 1994 by Vigyan Prasar. The volume was titled *Memoirs of Ruchi Ram Sahni: Pioneer of Science Popularisation in Punjab*.

Ruchi Ram Sahni (RRS) was born on 5 April 1863 at Dera Ismail Khan, a small town and a riverine port on the Indus in the Punjab of undivided India. He got his early education in his hometown and stood first in his middle school examination in the province. He passed high school examination from Lahore under the Calcutta Board, securing a position among top ten. He passed the BA examination from Government College, Lahore in 1884, securing the top position in Punjab University. He joined the Government College, Lahore for his MA degree in physics and chemistry. However, before completing his degree he joined the India Meteorological Department as Assistant Reporter and moved to Kolkata (then Calcutta). While in Kolkata he attended classes at the Presidency College for completing his MA degree. At Kolkata he came in contact with many eminent personalities including J. C. Bose, P. C. Ray, Ashutosh Mookerjee. From Kolkata he moved to Simla, the then headquarters of India Meteorological Department, and worked under Sir H. F. Blanford, FRS, and the first meteorologist who did extensive studies of the Indian rainfall. Sahni was a very keen observer of atmospheric changes and made a remarkable forecasting of a storm in the Bay of Bengal and saved many ships from destruction by sending a timely warning to all the sea ports in the region.

In 1887, Sahni came back to the Government College, Lahore as a member of its faculty. He took active interest in upgrading the standard of science teaching at the college. He demonstrated as many experiments as possible to the students. Realising the dearth of good science books at the college library, he himself built a personal library for the benefit of the students. Sahni helped poor but brilliant students in their pursuit of higher studies and research. Shanti Swaroop Bhatnagar, who later became the founder of the Council of Scientific and Industrial Research (CSIR), was one of his favourite students at Lahore. Sahni managed to get Bhatnagar a scholarship to go abroad for doctoral research.

In 1914, Sahni at the age of 51 left for Europe to conduct investigations in the emerging field of radioactivity. He went to Germany to work in the laboratory of Dr. Kasimir Fazans, an authority in the field of radioactivity. However, he could not continue his work in Fazan's laboratory because the First World War started in Europe. Sahni left Germany and reached England. In England, he worked in the laboratory of Lord Ernest Rutherford at Manchester where Niels Bohr was his research colleague. Sahni undertook the study of alpha scattering in radioactive/cosmic ray emissions. The results of his investigations were communicated by Rutherford himself and they were published in the *Philosophical Magazine*.

One of the major achievements of Sahni was to translate science in the language of the common populace. In this mission he was greatly influenced by the model of the Indian Association for the Cultivation of Science (IACS) was established in 1876 in Kolkata by Mahendralal Sircar. The Punjab Science Institute was established in 1885 in Lahore, Punjab of the undivided India. The idea of establishing an organisation for popularising science at Lahore was first conceived by J. C. Oman of the Government College, Lahore. However it was Sahni who was instrumental in establishing the Punjab Science Institute and he admitted that he was greatly influenced by the example of IACS. He wrote in his *Memoirs*: "the idea of the Institute originated with Professor J. C. Oman of the Government College, when I was yet in the M.A class at the college and before I had proceeded to Calcutta. We used to discuss the need and scope of such an institution. But it was only in the summer of 1885 to say after I returned from Calcutta and explained to Professor Oman what I had

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A Tale of Two Digits

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It was a Friday evening. It was also a relaxed evening for me. There was no rush for the homework to finish for next day's school. I was trying to decipher some puzzles from a book. My Uncle was going through the day's newspaper for the last time.

"Googol, if you have nothing to do now, let's play Botticelli," Uncle told me.

"What type of game a 'Botticelli' is?" I gave a puzzled look at Uncle.

"Botticelli is a guessing game in which players guess the identity of a person based on his or her biographical details using 'yes' or 'no' replies."

"That sounds very interesting though the name of the game is a bit strange!"

"The name was given after Sandro Botticelli who was an Italian painter of the Early Renaissance. The game takes its name to suggest that the famous person has to be at least as famous as Sandro Botticelli. "

"Hmm, I did not know about Botticelli until now; it seems that I might not be very good at this game," I confessed.

"The game of Botticelli has different variants. But the common theme is that one person or team thinks of a famous person, reveals his or her initial letter, and then answers 'yes' or 'no' to different statements allowing other players to guess the identity."

"I got it now, let's play the game."

"Well, we will play it a bit slightly differently. I've written the name of a person on this paper and I'll not give you any hint through the initial. You will tell me the statements, and I will give you a 'yes' or 'no' reply." Uncle explained showing me a folded piece of paper in his hand.

"I understand now," I replied.

"Well, then let's start," my Uncle was quite eager to know how I play the game of Botticelli.

"The gender of the person is male," I said.

"Yes," Uncle replied.

"He is an Indian."

"Yes."

"He is still living with us."

"No."

"During his lifetime, his activities spanned around the post-Independent India."

"No"

"He was involved with struggle for India's independence"

"Yes."

"He was behind the non-violent civil disobedience movement," I tried to focus on a target.

"Yes."

"He led in the Salt Satyagraha, Non-cooperation movement and Quit India movement'

"Yes, I think that you got it now."

"Mahatma Gandhi," I said emphatically.

"Well done, Googol," said Uncle as he showed me the unfolded paper with 'Gandhiji' written on it. I smiled.

"There must be similar games like this one where players have to guess things other than the famous persons,' I was curious to know.

"You are right. There are several flavours of games similar to Botticelli. For example, 'Vermicelli', in which the thing to be guessed is a food; 'Vespucci', in which the thing to be guessed is a place; and 'Webster', a challenging variant in which the thing to be guessed can be any word."

"Oh, that's a good range of games indeed. We can play all those games for a full day!"

"Yes, we may give them a try some day."

"The framing of the statements is crucial to this game and one needs to have a good biographical knowledge too. Only a 'yes' or 'no' answer would lead to the solution, that's quite interesting!"

"Well, here's another thought. Did you realise that at times literature and mathematics converge? Can you tell me the connection of these words with the number system: yes/no, true/false or presence/absence?"

"These are opposites in meaning and representing two states of an event."

"That's a good interpretation, Googol. Mathematically, we can define them as two states of a *binary variable*. In the mathematical world, we can also translate those words into two numeric values, 1 and 0."

"So, the numbers 1 and 0 represent a special type of number system."

"Yes, this is also called *binary number system*," Uncle replied.

"I have heard about the binary numbers, but I do not have a clear idea about what they signify. Please explain this to me."

"Before that, here is a riddle for you. What is the link between Mahatma Gandhi and binary numbers?"

It must be one of those characteristic riddles from Uncle. I was perplexed and did not have a clue.

"Well, here is another clue. The link is hidden in the *Gandhi Jayanti* and *International Day of Non-violence*."

"I know that. Gandhiji's birthday, i.e., the second of October is commemorated as *Gandhi Jayanti* in India and world-wide as the *International Day of Non-violence*."

"And if you write down the date using a date format, what will you get?"

"It will be the second of October, or 2/10."

"Exactly, I hope that you can see the link now. The word 'binary' means the number system is represented by two numeric values and these two numbers are 1 and 0. Moreover, binary representation of 2 is 10. So the date '2/10' in essence captures the concept of binary number."

"Oh yes, I can see the link now. Uncle, please tell me why the binary number system is so important for us."

"The binary numbers form the basis for the operation of computers and all digital circuits. As I mentioned earlier, any number can be represented in a binary number system using different combinations of two numeric symbols, 0 and 1."

"That sounds very interesting – any number can be formed by using only two numeric symbols."

"Tell me, how many symbols do we use in the decimal number system, i.e., the number system that we generally use for writing numbers?" Uncle wanted to know.

"Ten symbols – zero to nine," I answered.

"That's right. The decimal number

system uses ten *symbols* 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 to represent any number. These symbols are called *digits*. This system is used worldwide as the most convenient system to represent numbers. You may remember that we talked about this earlier. Rules for operation of 'zero' were given by Indian mathematician *Brahmagupta* during AD 600. The invention of 'zero' made it possible to write numbers with positional values."

"What is a positional value?" I wanted to know.

Decimal number: 2 3 5
$2 \times 10^2 + 3 \times 10^1 + 5 \times 10^0$
$= 200 + 30 + 5$
$= 235$
Binary number: $(1\ 0\ 1)_B$
$1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$
$= 4 + 0 + 1$
$= (5)_D$

"When we write a decimal number, say 235, then 2, 3 and 5 are not merely symbols. Each position of the number has a *positional value*, for example, the first place has a positional value of 1; the second place has a value of 10; the third place of 100 and so on. The digits are multiplied by the positional values and then added up to represent a number. Hence the number 235 signifies: $2 \times 100 + 3 \times 10 + 5 \times 1 = 235$, " Uncle explained.

"Yes, I got it now, any number in the decimal system can be written according to the positional value of each symbol."

"Now, if you look into the above expression closely, you will notice that all the positional values can be represented as 10^n form, where n is any *positive integer*. Like, $10^0 = 1$, $10^1 = 10$, $10^2 = 100$ and so on. For example, the above expression of 235 can also be written as: $2 \times 10^2 + 3 \times 10^1 + 5 \times 10^0 = 235$."

"Is it due to the fact that there are ten symbols in the decimal number system?"

"That's a good observation, Googol. Yes, you are right. For the decimal number system 10 is called the *base* as there are ten distinct symbols. However, note that n can also be a *negative integer*. When we write a number with decimal point, say 273.45, the positional values at the right hand side of the decimal point will be 10^{-1}, 10^{-2} and so on. Therefore, $273.45 = 2 \times 10^2 + 7 \times 10^1 + 3 \times 10^0 + 4 \times 10^{-1} + 5 \times 10^{-2}$."

"Please explain to me how the binary numbers are formed," I wanted to know.

"In the binary number system, there are only *two symbols* 0 and 1. Or you can say that we use only *two digits* (0 and 1) of the decimal number system. These are called binary digits or bits. Hence, the *base of the binary number system* is 2. The *positional values* are in 2^n form, where n can be *positive or negative integers*. For example, the decimal equivalent of the binary number 101 is: $1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 5$. The decimal equivalent of the binary number 101.11 is: $1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 + 1 \times 2^{-1} + 1 \times 2^{-2} = 5.75$."

Decimal	Binary	Octal	Hexadecimal
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10

"It does not look very difficult! Can we convert a number from the decimal system to the binary system? "

"Yes. For that you have to keep dividing the decimal number by 2 till you get a *quotient* 0. Note, each time you divide a decimal number by 2, you will get the remainder 0 or 1. Now write all the remainder in reverse order and this will give you the binary equivalent of a decimal number. For example, consider a decimal number 12. Now, 12 / 2 = 6 (quotient) and the remainder is 0. Next, divide the quotient 6 by 2. This will be 6 / 2 = 3 and the remainder is 0. Next, 3 / 2 = 1 and the remainder is 1. Next, 1/2 = 0 and the remainder is 1. Now write all the remainders in the reverse order, which is 1100. Therefore the binary equivalent of 12 is 1100."

"I will try to convert a few numbers from the decimal to the binary and also the binary to the decimal system later using the above strategies. Now, please tell me more

	Quotient	Remainder
12/2	6	0
6/2	3	0
3/2	1	1
1/2	0	1
Binary equivalent of 12 is 1100		

on how the binary number system was developed."

"The Indian scholar Pingala (2nd centuries BC) developed the mathematical concepts for describing poetry, and thus presented the first known description of a binary numeral. He used binary numbers in the form of short and long syllables (long syllables is equal to two short syllables), making it similar to the Morse code," Uncle said.

"I have heard that the Morse code is used to transmit information using short and long pulses of sound or light. Does it follow the binary number system?"

"If the information can be coded using two distinct states, it is indeed a binary system. Hence, the Morse code is a binary code."

"Like many other mathematical discoveries, the binary number system was also developed in India – I feel very proud of being Indian."

"That's right. In his Sanskrit classic *Chhanda Sūtra,* Pingala described a method to assign a unique value to each line, something very similar to the binary number system. This is perhaps the oldest description of something similar to the binary number."

"Please tell me what happened after that."

"During the 11th century, the Chinese scholar and philosopher Shao Yong developed a system similar to modern binary number system. Shao Yong's work influenced the German mathematician and philosopher Leibniz in the 17th century in formulating the binary arithmetic."

"Was Shao Yong's work influenced by Pingala's *Chhanda Sūtra*?" I wanted to know.

"It appears that during the 10th century, another Chinese scholar Yang Hsiung developed a number system with the base 3. Shao Yong was influenced by this number system and developed the number system with base 2."

"How did Leibniz develop the binary arithmetic?" I wanted to know.

"Leibniz was aware of the work of Shao Yong on the binary numerals. He noted that the hexagram used by Shao Yong corresponded to the binary numbers from 0 to 111111 and this mapping is one of the major milestones in formulating binary number system. Leibniz also used 0 and 1 as binary numerals."

"How was binary number system introduced in the computer?"

"Computer is based on the digital system. The digital system is based on the binary logic, having two distinct states, TRUE and FALSE. Therefore we can conclude that the binary number system actually triggered the development of computer. "

"It is very interesting – please tell me more on this."

"Any computer system works on the *binary logic* – logic 0 or FALSE and logic 1 or TRUE. Logic 0 and 1 are *two distinct states*, represented by two voltage levels, 0 volt and 5 volts respectively. You can imagine without the binary logic, it would have been very difficult to generate and decipher multiple voltage levels to store and interpret information. Remember, the computer is not a human – it recognises data differently from us. All data in a computer are only recognised by appropriate electrical signals."

"I thought the binary numbers are required for mathematical calculations only. It seems that storing and processing of data also need the binary number system. I am very keen to know more about it. Please explain how the data are stored in a computer. "

"Any data consist of alphabets and numerals, called *alphanumeric* characters. Each of these characters is assigned a distinct numeral value. For example English alphabet 'a' has assigned number 97. Its binary representation is 1100001. Similarly other characters have other distinct values. These binary numbers are stored in the *computer memory*. "

"How are arithmetic operations performed in a computer?" I wanted to know.

"Calculations in a computer are based on the *Boolean algebra* – operations like addition, subtraction, multiplication and division are carried out on the binary numbers," Uncle replied.

George Boole
1815–1864

"Please tell me something about the Boolean algebra.'

"In 1854, the British mathematician George Boole published a landmark paper that described arithmetic operations on the binary numbers. The Boolean algebra is quite similar to the algebra you do on the decimal numbers. "

"Uncle, how does a computer take a decision?"

"As I mentioned earlier, a computer cannot take decisions as a human does. Computers can only check whether a condition is TRUE or FALSE – called logical operation. Based on a series of logical operations, a computer analyses the data and provides an output. "

"What is the logical operation?" I wanted to know.

"In a *logical operation*, a computer verifies some conditions. If the condition is TRUE, it performs some operations, else it performs some other operation. For example, if a is greater than b then add a and b, else (i.e. if a is less than or equal to b), subtract a from b. The entire computer operation is based on the execution of this kind of simple logic."

Claude Shannon
(1916–2001)

"That's very interesting. Please tell me how logical operations are performed."

"Logical operations are also performed using the Boolean algebra. Like algebraic operators (+, –, ×, /) there are *logical operators* 'OR', 'AND', 'NOT', etc."

"It's very interesting. It is clear to me that the development of computer would not have been possible without the binary number system."

"You are right, Googol. In 1937, the American mathematician and electronic engineer Claude Shannon, while working on his thesis at MIT, implemented the Boolean algebra and binary logic using electronic relays and switches. Shannon's thesis essentially founded the practical digital circuit design and eventually the computer was conceptualised. "

"Uncle, I have heard about the octal and hexadecimal number system. Are they related to the binary number system? " I wanted to know.

"The *octal number* system uses base 8 and the *hexadecimal number* system uses base 16. Note that both 8 and 16 can be represented as 2^n, where $n = 3$ in the octal and $n = 4$ in the hexadecimal system. It is therefore clear that both are related to the binary number system."

"If the binary number system is everything for a computer, then what is the need for other number systems?" I wanted to know.

"That's a good question. Let me clarify. We, humans, use decimal system because positional value based on 10^n is easier to comprehend and calculate, and we have 10 distinct symbols. Higher order base will need more distinct symbols; moreover, it would make calculations difficult. A computer system uses the binary number system as it needs only two distinct states (electrical signals) to represent any character. The octal and hexadecimal number systems are just the extensions of binary number system for easier representation of binary numbers, so that we can represent larger binary numbers with smaller octal or hexadecimal numbers."

"That means a computer does not use the octal or hexadecimal number system!"

"Precisely that is the case. These two systems are used only for convenient representation of the binary numbers for our understanding. The binary numbers are easily converted to and from the octal numbers. The *octal number* system has eight distinct symbols 0 to 7. If you look closely, you will note that three binary digits are equivalent to one octal digit. For example, the binary number '110101' is represented as '65' in the octal number system, where 6 = 110 and 5 = 101."

"Please tell me about the hexadecimal number system – I was wondering what 16 different symbols will be in this number system?"

"In the *hexadecimal number* system, 16 distinct symbols are used. These are 0 to 9 and then *A, B, C, D, E* and *F*, with *A* equal to decimal 10, *B* equal to decimal 11 and so on. Here, four binary digits are equal to one

Continued on page 28

An Evergreen Revolution: Myth or reality

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The term "green revolution," coined by William Gaud in October, 1968, refers to a series of research, development, and technology transfer initiatives, occurring between the 1940s and the late 1970s, that increased agriculture production around the world. The origin of agriculture led to domestication of many plant species and it took almost 10,000 years for world food grain production to reach 1 billion tons, in 1960, and only 40 years to reach 2 billion tons, in 2000. This unprecedented increase, which has been named the 'green revolution', resulted from the creation of genetically improved crop varieties, combined with the application of improved agronomic practices. Many of these improvements came along with adverse environmental effects in areas subjected to intensive farming. However, where population pressure is high, there is no option except to produce more food. Productivity must increase, but in ways which are environmentally safe, economically viable and socially sustainable. This approach has been christened 'evergreen revolution'.

Need for an evergreen revolution

The challenge before us is to feed billions of new mouths over the next several decades and save the environment at the same time, without being trapped in a Faustian bargain that threatens freedom from security. The benefits must come from an evergreen revolution. The aim of this new thrust is to lift food production well above the level attained by the green revolution of the 1960s, using technology and regulatory policy more advanced and even safer than now in existence. Exploitative agriculture poses great dangers if carried out with only an immediate profit or production motive. The emerging exploitative farming community in India should become aware of this. Intensive cultivation of land without protection of soil fertility and soil structure would lead, ultimately, to the springing up of deserts. Irrigation without arrangements for drainage would result in soils turning alkaline or saline. Indiscriminate use of pesticides, fungicides and herbicides could cause adverse changes in biological balance as well as lead to an increase in the incidence of cancer and other diseases, through the consumption of toxic residues present in the grains or other edible parts. Unscientific tapping of underground water will lead to the rapid exhaustion of this wonderful capital resource left to us through ages of natural farming. The rapid replacement of numerous locally adapted varieties with one or two high-yielding strains in large contiguous areas would result in the spread of serious diseases capable of wiping out entire crops, as seen prior to the Irish potato famine of 1854 and the Bengal rice famine in 1942. Therefore exploitative agriculture without a proper understanding of the various consequences of every one of the changes introduced into resource efficient and friendly agriculture, and without first building up a proper scientific and training base to sustain it, may only lead us, in the long run, to an era of agricultural disaster rather than one of agricultural prosperity.

How do we achieve this evergreen revolution?

How do we achieve this ever-green revolution, i.e., a balance between human numbers and human capacity to produce food of adequate quantity, quality and variety? The growing damage to the ecological foundations essential for sustainable food security, namely land, water, biodiversity, forests and the atmosphere, is leading to stagnation in yields in green-revolution areas. Climate change may compound such problems with adverse effects on temperature, precipitation, and sea level rise. An analysis of food insecurity indicators in rural India carried out by the M.S. Swaminathan Research Foundation (MSSRF), with support from the World Food Programme (WFP), indicates that the Punjab-Haryana region (India's food basket) may become food-insecure in another 20 years. Indicators used in measuring sustainability of food security are: land degradation and salinisation extent of forest cover, groundwater depletion and the nature of crop rotation. In all of these parameters, Punjab and Haryana occupy low positions. The common rice-wheat rotation has led to displacement of grain and fodder legumes capable of improving soil fertility. The current trend is towards non-sustainable farming resulting from land and water mining. Forewarned is forearmed.

Sustainable agriculture

Sustainable agriculture is an imperative as an alternative agricultural system that addresses many of the constraints faced by resource-poor farmers and at the same time ensures environmental sustainability. It refers to the capacity of agriculture over time to contribute to overall welfare by providing sufficient food and other goods and services in ways that are economically efficient and profitable, socially responsible, and environmentally sound. Using local resources to make initial soil and land improvements can get farmers on a virtuous cycle where rising incomes relieve the constraints to adoption of more resources-intensive sustainable practices. Sustainable agriculture has three principles:

1) Economic sustainability, (2) Environmental sustainability, and (3) Social sustainability.

Sustainable food security

Food security has three major dimensions: (1) Availability of food, which is a function of production; (2) Access to food, which is a function of purchasing power/access to sustainable livelihoods; and (3) Absorption of food in the body, which is determined by access to safe drinking water and non-food factors such as environmental hygiene, primary health care and primary education.

Biotechnology

Considerable advances have been made in the past 25 years, taking advantage of the new genetics tools in medical research, production of vaccines, sero-diagnostics, and pharmaceuticals for human and farm-animal healthcare. The production of novel bioremediation agents; for example, the new Pseudomonas strain for clearing oil spills in

oceans, rivers and lakes developed by Ananda Mohan Chakraborty is also receiving priority attention because of increasing environmental pollution. There has also been substantial progress in agriculture, particularly in crop improvement through molecular-marker-assisted breeding, functional genomics, and recombinant DNA technology. A wide range of crop varieties containing novel genetic combinations are now being cultivated in the United States, Canada, China, Argentina, and several other countries. A cotton variety containing the Bacillus thuringiensis gene (Bt cotton), resistant to the bollworm, is now under cultivation in India. In India cotton is the only genetically modified crop approved for cultivation. The semi-dwarf, short wheat varieties with high yield came from Japan where they were first developed by Dr. Gonjiro Inazuka. Seeds were then taken to the U.S. by Dr. S. C. Salmon, who was with General MacArthur. We got our material from U.S. scientists, particularly from Drs. Norman Borlaug and Orville Vogel, and then developed our own varieties, which triggered the wheat revolution and then the Green Revolution.

Ecotechnology means marrying the best of modern science with the best in traditional wisdom and traditional ecological prudence. We can use biotechnology for bioterrorism, or we can use it for biohappiness. We must try to use all the technologies in this world for biohappiness, which means people have a good life, better health, and better food, as a result of the technology. Ensuring safe and responsible use of biotechnology has to be done by regulatory mechanisms and also by public opinion.

Biovillages

A biovillage involves human-centred development. It has two major components. One aspect is the conservation and improvement of natural resources, particularly soil health, water and biodiversity. The other aspect is improving the income of the farmers higher productivity on farms and value added to primary products. For example, in rice-growing areas, there is a whole series of rice by-products such as rice bran, rice husk, and rice straw. Rice straw can be used, for example, for growing rice-straw mushrooms and it can also be made into paper and board. At the moment we have no biotechnology

Biovillage

crops in these villages. The idea is to use other biological approaches; for example, use of bio fertilisers and bio pesticides. The purpose of biovillages is to convert natural resources into wealth and jobs. Most of the villages in the state of Puducherry are now biovillages. Bangladesh has also started biovillages.

Organic farming

Growing awareness about health and environmental issues associated with the intensive use of chemical inputs has led to interest in alternative forms of agriculture around the world. Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment. According to Codex Alimentarius (FAO/WHO, 1999) – a collection of internationally recognized standards, codes of practice, guidelines and other recommendations relating to foods, food production and food safety – 'organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. In areas of intensive farming system, shifting to organic agriculture decreases yield; the range depends on the intensity of external input use before conversion. In the so-called green revolution areas (irrigated lands), conversion to organic agriculture usually leads to almost identical yields. In traditional rain-fed agriculture (with low external inputs), organic agriculture has shown the potential to increase yields. However, a consortium of microorganisms each capable of performing important functions like nitrogen fixation, phosphorus solubilisation, and/or sequestration of salts and pollutants will be needed for each major agro-climatic and agro-ecological farming system. The other area of research that is essential for sustained high productivity is integrated pest management involving concurrent attention to pests, diseases and weeds. For this purpose, there is need for a biosecurity compact that will help manage not only pests, diseases and weeds, but also invasive alien species and mycotoxins in food. Sanitary and phytosanitary measures and Codex Alimentarius standards of food safety need to be integrated in organic production protocols.

Biopesticides

With primary goals of achieving both food security and livelihood security in perpetuity without degrading the ecological foundations of agriculture, care needs to be taken to develop and use biopesticides and biofertilisers within Integrated Pest and Nutrition Management (IPNM) schedules. In scientific literature, it is well-documented that chemical pesticides are not pro-nature, pro-poor and pro-women. Because they kill several non-target beneficial organisms (e.g., pollinators, predators, parasitic wasps, earthworms, birds, etc.), they are not eco-friendly. The carcinogenic action of pesticide residues and the increased incidence of cancers among the farmers and their family

Organic farming

members in the green revolution belt are well documented. Further, chemical pesticides are becoming increasingly expensive, inflicting costs beyond the means of the resource-poor, marginal and small farmers. Hence, MSSRF has demystified the production of a biopesticide, an egg parasitoid, T. chilonis (Hymenoptera, Trichogrammatidae) and

trained several landless women in over dozens of villages in Tamil Nadu and Puducherry to culture and market these. The Trichogramma, an effective egg parasitoid, lays its eggs on the eggs of cotton bollworm (H. armigera). On hatching, the Trichogramma larvae feed on the egg contents of the bollworm leading to significant reduction in the population of the pest. The biopesticide effectively reduces the damage caused by bollworms to a level that still allows appreciable levels of productivity and profit, leaves no toxic residue to affect non-target organisms (i.e., biodiversity is left intact), and does not increase the incidence of cancers in the exposed workers and members of the farming families. A significant contribution to microbial control of insects was made by Elie Mechnikoff in 1879 and N.A. Krassilnikow in1888, who were the first to document that a fungus called Metarrhizium anisopliae could be mass produced and applied as a microbial insecticide to control the grain and the sugar beet pests. These are some of he most important dimensions of agriculture and sustainability.

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Continued from page 39 **(Remembering Ruchi Ram Sahni)**

seen in the Sircar's institution, that a society under the name of the Punjab Science Institute was actually established…" Sahni organised popular science lectures under the aegis of the Punjab Science Institute for laypersons on topics like "How does the telegraph wire speak", "The common flame", "The water Lahoris drank before 1880", "The pure and impure water", "The toys and their lessons", "Soap making", "Electroplating", "Electricity in the service of man", and "The Punjab and its rivers". He also delivered lectures on latest scientific discoveries namely "X-rays", "Edison's phonograph" and "Wireless telegraphy". According to some estimate Sahni himself delivered more than 500 lectures. He also persuaded many teachers in the colleges to come forward to share the activities of the Institute. Popular science lectures organised by the Punjab Science Institute were not delivered in any special theatre or auditorium. They were delivered in open spaces. The lectures were often accompanied with experimental demonstrations. The audience for these lectures in Lahore consisted of mostly shopkeepers from the surrounding market and office workers, mostly clerks. Lectures were organised in smaller towns and villages on the occasion of festivals and fairs. In 1880s, Sahni demonstrated that the local language Punjabi could be successfully used as a vehicle of scientific ideas. All the expenses for the lectures organised by the Punjab Science Institute were covered by the fees charged for them. There was a direct impact of these popular science lectures on science teaching in schools. The original aim and object of the Punjab Science Institute was the popularisation of all kinds of science. However, later encouragement of technical education and setting up of chemical industries were also included as objectives of the Institute. Pamphlets on the manufacture of soap, indigo and other products of common use were produced for wide circulation. Sahni established a sulphuric acid factory near Lahore which flourished for several years. In this venture he was assisted by Acharya Prafulla Chandra Ray.

Sahni worked hard to improve the quality of science teaching in schools and colleges. On realising that science teaching in schools and colleges was not possible without facilities for repair and manufacturing of simple scientific instruments, he established a workshop as part of the Punjab Science Institute by spending his own savings. The workshop not only repaired and manufactured scientific instruments but it also trained young people enabling them to earn a decent living.

Sahni actively participated in the freedom movement. During the Punjab Enquiry held by the Indian National Congress, following the Jallianwalla Bagh massacre, he had an opportunity to work with leaders like Motilal Nehru, C.R. Das, Pandit Madan Mohan Malviya and others. He relinquished the title, conferred on him by the British Government, during the Khilafat Movement. Throughout his life he fought against British hegemony. He was a pioneer of the social reform movement as well, particularly relating to women.

R. Ramchandran, one of India's best science journalists while reviewing the *Memoirs of Ruchi Ram Sahni* correctly argued why Sahni should be accorded as prominent as a place given to pioneers of modern Indian science as J.C. Bose. P.C. Ray, M.N. Saha, C.V. Raman and S.N. Bose. Ramchandran wrote: "Professor Ruchi Ram Sahni's is not a name that people are likely to recognise—let alone an average Indian, not even someone from the Indian scientific community. Which is indeed a pity. For, this unsung hero of Indian science from the pre-independence era should have been accorded a prominent place in the annals as the likes of P.C. Ray, J.C. Bose (RRS's contemporaries), S.N. Bose, M.N. Saha and C.V. Raman. The late 19th century and the early 20th century truly constituted a period of Indian "renaissance"—in arts, literature, and science—to which RRS belonged. It was a period of cultural and intellectual ferment which threw up remarkable men and women who dedicated themselves to building a progressive and self-reliant independent India. However, the unfortunate fact of history is that while the circumstances and the manner of evolution of post-independent India made some better known and remembered, others like RRS were forgotten. RRS was a chemist by training but his historic contribution is not in the field of research and discovery—and maybe that is why he is not as well-known as the others of his time—but in popularising science among the common people. In that respect his contributions were unique. Though the sub-title of the book refers to him as the pioneer of science popularisation in Punjab, his were pioneering efforts in the entire country. And it may not be an exaggeration to say that they remain unique to this day considering that the post-independence Indian scientific community has by and large, accorded little importance to communicating science to the public."

The 150th birth anniversary of Ruchi Ram Sahni should be celebrated throughout the country. Sahni should be accorded his due place for his multi-faceted contribution in shaping modern India. The year 2013 also marks the 100th year of Indian Science Congress. The year 2013 should be declared as the Year of Scientific Temper to honour Sahni, who did so much for creating scientific awareness in the country. Science communicators and science communication should be given due importance they deserve.

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The Third Pole: Must Be Protected

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Introduction: Generally, we know of two Poles of the Earth, i.e. North and South Poles. Those areas are known for the distinct environment prevailing there. The geographic North Pole or the true North Pole is the northernmost point on the surface of the Earth, located within the Arctic Ocean, about 725 km from Greenland on the northern side. Most of the time, the North Pole is covered by sea ice which covers most of the Arctic Ocean. However, in recent times liquid water has been observed at the North Pole. The depth of the ocean around the North Pole is more than 4 km. The ice is about 3 to 4 metres thick over large areas and certain parts may be even 20 metres thick. The area of sea ice is between 9 to12 millions sq. km. Obviously, the sea ice stores a very large quantity of water. Additionally, the Greenland ice sheet covers more than 1.7 million sq. km. The volume of ice there is more than 2.5 million cubic km. An important observation about the North Pole and adjoining area is recently emerging evidences of Arctic ice decreasing in volume by about 3% per decade. The reduction in volume is certainly a matter of worry as it indicates change in the global environment. The quantity of ice in the Arctic is however too big by all standards and the quantity of water stored there is huge.

The South Pole of the Earth is situated within the Antarctica. About 98% of the Antarctica is covered by ice sheet extending to more than 14.5 million sq. km. The ice mass is estimated to be between 25 to 30 million cubic km, which is the largest single ice mass on the Earth. The ice mass represents the largest store house of fresh water on the Earth, with about 70% of the total fresh water present on the Earth being present in the Antarctic ice mass. An important feature observed regarding the Antarctic ice mass is that during the last few decades it is showing a growing trend. This is opposite the trend around the North Pole, which is showing decreasing trend.

In recent years, quite often we hear about the Third Pole. Obviously, on account of its shape, the Earth does not have any scope for a Third Pole. Still, the name is in circulation and it is now a standard nomenclature. The name Third Pole has been given to the Hindu Kush-Himalayan region which spreads to more than 4.3 million sq. km. The mountainous region spreads across several countries including Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan.

Mountains and their importance

Mountains cover about 24%, i.e., roughly one fourth of the world's land area and the mountainous areas are home to about 12% of the total world population. Also, an additional 14% of the total population lives in the immediate vicinity of the mountains. Another important feature of the mountains is that many of the world's major rivers originate there. As a result, more than half of the world's mountain areas play a vital role in supplying water to the downstream regions. Also, mountains play a vital role in water purification and water retention. Mountains retain huge quantities of water in the form of groundwater, ice, and snow and in various lakes and streams spread over mountains world over. The water is utilised by people living in the mountains and by those who inhabit the downstream areas.

A series of snow capped Himalayan peaks

On account of varying altitudes and distinct environment, the mountains support distinct ecosystems and biodiversity. Those ecosystems and the plants and animals present there are generally unable to survive at lower altitudes. We can actually see the same easily. For example, people visiting the North-East and other hill stations in India bring different types of plants from those areas to the plains. In the plains the plants are unable to survive and they die. The issue of concern is that some of those plants are rare or threatened. For example, wild orchids are commonly sold on the roadside in the North-East and people do purchase them being unaware that they are threatening the biodiversity of the region.

An important issue related to mountainous areas is that the services provided by the mountains are generally not recognised. One reason is the general ignorance about the contribution made by mountainous areas. The other reason is that many of the services cannot be assigned any price tag or market value. However, Millennium Ecosystem Assessment (2003) has listed the important services rendered by the mountains. These include aesthetic, ecosystem goods, UV protection, flood and drought mitigation, climate stability, pollination, pest control, purification of water, detoxification and decomposition of wastes, soil generation and soil fertility, seed dispersal, etc. A large part of the Earth's biodiversity is present in the mountains and they can survive only there.

The Himalayas

If we look at the geographical map of Asia, apart from other features, the most prominent structure is certainly the Himalayas. The mountain range separates the Indian subcontinent from the Tibetan Plateau. It extends from eastern part of

Tibet and China to the area where India, Afghanistan, China and Pakistan meet. Two independent nations viz., Bhutan and Nepal lie totally within the mountain range while the mountain range covers substantial portions of the other countries. The name Himalaya has its origin in Sanskrit, meaning "abode of snow". The reason is obvious. Large portions of the Himalayas remain covered with snow almost round the year.

In an extended manner, the name Himalayas is also used to describe the massive mountain system that includes the Karakoram, the Hindu Kush, and various other ranges which extend out from the Pamir Knot; a reason due to which it is also known as the Himalayan mountain system. The main Himalayan range extends from west to east, starting from the Indus river valley and continues to the Brahmaputra river valley. It is in the form of an arc, about 2,400-km long. The width varies from about 400 km in the western part; i.e., Kashmir-Xinjiang region, to about 150 km in the eastern part; i.e., Tibet-Arunachal Pradesh region. The complete range includes three coextensive sub-ranges. Out of these – the northernmost – is the highest one. It is known as the Great or Inner Himalayas. A very important feature of this mountain range is that the Earth's highest points lie there. The Himalayan system has two peaks which are more than 8,000 m high and more than hundred peaks which are beyond 7,200 m in height. In comparison, the highest mountains in the Americas and Europe rarely exceed 6,000 m. In fact, the Himalayan-Karakoram range includes nine of the ten highest peaks on Earth. Further, if we consider Hindu Kush, Karakorum, Pamir, Tian Shah, and Tibet together, 66 highest mountains on the Earth will be in the Himalayas. The next i.e. 67th namely the Aconcagua – is outside the Himalayan system. Shivalik Hills, which does not have very high peaks, is in the southernmost side. In the middle is the Lesser Himalayas, which has peaks that rise up to about 5,000 m. As stated earlier, the Himalayan ranges rise from the plains located in India, Bangladesh and Pakistan. Interspersed between the peaks and the massifs there are river gorges formed due to erosion. Also, extremely deep valleys are present in the area. In addition, there are large glaciers which show slow creeping movements.

The Himalayan range plays important role in determining the climate of the region. The southern side of the range acts as a huge climatic barrier which forces the summer monsoon rain clouds to cause rain. That is the reason that some of the rainiest places are located close to the mountain range. Also, several of the large rivers originate in the area. The Ganges, Indus, Brahmaputra, Mekong, Yangtze, and the Yellow River are some of the examples. Another important feature of the area is that rains do not reach the leeward side. That is why some of the most arid areas of the Earth are located in the leeward side of the range. Tibetan plateau is the example.

Origin of the Himalayas

Geologists have presented evidence in support of the theory that the Himalayas originated due to the impact of the Indian tectonic plate travelling northward and its collision with the Eurasian plate. The event took place about 40-50 million years ago, traversing about 15 cm per year. The collision forced the lighter rocks of the sea-beds of that time to be lifted up, forming the Himalayan arc. This theory finds support by the findings that Mount Everest is made of marine limestone. That is the reason quite often fossils of sea organisms have been found at altitudes of several thousand metres. The rock that was pushed up during the formation of mountain comprised of sandstone and limestone. Originally, those materials were at the bottom of the ocean.

A stream passing through Himalaya

Here it may not be out of place to mention that certain recent estimates suggest that the age of the Himalayas may be more than 450 million years. This is about nine times the original estimates. George Gehrels, of the University of Arizona in Tucson, and his colleagues say: "We've come to the conclusion that there was an older mountain range in place before the current Himalayas". Gehrels' team had analysed radioactive uranium in garnet and zircon grains from Himalayan rocks. They found evidence to indicate that many of the grains were between 450 million and 500 million years old. On the basis of the same, they proposed that the peaks in the Himalayas may have got part of their height to an earlier continental crash.

The Third Pole

The Himalayan system has been namedthe "Third Pole" on account of the large quantities of snow and ice held there. The Himalayan system has large numbers of glaciers in different regions. The total number adds up to several thousands. These glaciers act as huge stores of fresh water estimated to be about 12,000 cubic km. The Siachen Glacier at the India-Pakistan border is about 70 km long. Siachen occupies the second place in terms of length outside the polar region. Gangotri and Yamunotri (Uttarakhand), Nubra, Biafo and Baltoro (Karakoram region), Zemu (Sikkim), and Khumbu glaciers (Mount Everest region) are other glaciers of the Himalayas which deserve special mention. As noted earlier, the Himalayas contain the greatest areas of glaciers and permanent snow outside the polar region. On melting, the glaciers and snow provide water to large areas and large numbers of people in different countries associated directly or indirectly with the Himalayas. The water so produced becomes even more important as part of the same becomes available during summer. The water feeds big and small rivers and lakes and keeps them flowing. In turn people dependent on those rivers and lakes benefit immensely. In this regard it is important to note that although the Himalayan range is close to the tropics, snow is present round the year in the mountain system, at least in the higher reaches. That is the reason that melt-water feeds the rivers and lakes round the year. No doubt the quantity of melt-water varies in different seasons; but it is available round the year.

Several major river systems originate in the region. Combined drainage basin of those rivers is so huge that about 3 billion people in 18 countries inhabit those basins. Asia's ten largest rivers originate from the Himalayan range and these rivers support the existence of more than a billion people. No doubt, during hot summer the snow remains confined to the higher reaches. But snow plays an important role in adding water to the rivers even during summer. In due course the rivers combine and form two large river systems. On account of the same the Himalayas play crucial role in determining the quality of life in the entire region. The Table below provides information about major rivers fed by the glaciers in the Himalayan region. These rivers provide support base to large populations in different areas.

Bhagirathi river in the Himalaya

Another characteristic of the Himalayan region is that it supports a large numbers of lakes. Most of the lakes are situated at altitudes up to 5,000 m. At higher latitudes too there are lakes. But their average size is smaller. Probably the most well-known lake in the Himalayan region is Pangong Tso. That is the largest lake in the Himalayan region with surface area of 700 sq. km. Another reason for its being famous is that is that the lake crosses India-China border. Another lake, Yamdrok Tso, which is in the Central Tibet, has an area of about 640 sq. km. The famous Lake Manasarovar has an area of 410 sq. km. Similarly, there are other lakes, although not so big. However, together those lakes store huge quantities of water. The lakes provide support to the local needs and then water entering various rivers from those lakes contributes to different degrees in meeting the demand of the people living downstream.

Table: Principal glacier-fed river systems of the Himalayas

River	Mountain area km^2	Glacier area km^2
Indus	268,842	7,890
Jhelum	33,670	170
Chenab	27,195	2,944
Ravi	8,092	206
Sutlej	47,915	1,295
Beas	12,504	638
Jamuna	11,655	125
Ganga	23,051	2,312
Ramganga	6,734	3
Kali	16,317	997
Karnali	53,354	1,543
Gandak	37,814	1,845
Kosi	61,901	1,281
Tista	12,432	495
Raikad	26,418	195
Manas	31,080	528
Subansiri	81,130	725
Brahmaputra	256,928	108
Dibang	12,950	90
Lohit	20,720	425

(Table from Subramanian,2010: Rivers of South Asia- to link or not to link. Capital pub, New Delhi. 395 pages)

Global warming -Threat to the Third Pole

An issue of great concern is that on account of global warming, temperatures are rising in the Himalayan region. Even more important is the fact that the temperature in the Himalayas is rising at a faster pace as compared to the global average. It is estimated that global warming has raised the average temperature of the Earth by less than 1 C during the last one hundred years while certain regions in the Himalayas have experienced a 0.6 C rise in temperature during the last one decade. This kind of unusual rise in temperature is a cause of worry. Environmentalists, administrators, and planners are worried, as any substantial rise in temperature may adversely affect agriculture, biodiversity, health status of people living in the area. Another possible consequence will be that water-availability in the Himalayan region and downstream will be adversely affected. Yet another related development pertains to increased frequency of floods in the Himalayas and also downstream, as melt water is likely to be available in larger quantities than normal. Consequently, the overall economy of the area and the living conditions of the people are bound to be adversely affected.

Some time ago a report based on satellite observations was published. The report was prepared by the Intergovernmental Panel on Climate Change (IPCC). The report claimed that all of the ice in the Himalayas could be gone by 2035. However, the report came under fire from different corners including a coordinating lead author of the IPCC chapter. But the issue was never settled. In situ measurements have produced evidences to suggest that many of the more than 45,000 glaciers in the Himalayan and Tibetan region are losing mass. The comforting fact is that taking into account the observed rate of decline recorded so far, many experts doubt if even small glaciers will melt completely before the end of the current century.

In the last few years the issue of glacier retreat has become important, as several papers were published based on data from the GRACE gravity-sensing satellites, highlighting the problem of groundwater depletion in India. We know that the glaciers in the Himalayas add melt-water to the rivers in the Himalayan region. The rivers then bring water to the plains and enrich the ground water resource. But if the glaciers are affected and they disappear partially or completely, run-off to the headwaters of most of the rivers, including the ten major rivers will come down. The list of rivers will include the Indus and the Ganges which serve very large areas of the country. Although it is difficult to conclude whether or when that may happen, one thing is clear that the danger exists.

At this point the question is: What is the reason that the glaciers are likely to disappear? The answer is that it may happen on account of global warming. As discussed earlier, the concern is greater because the warming is taking place at a faster rate at higher altitudes than in the lowlands. Now,

it is generally accepted that global warming may become a potential threat for the North and South Poles. Large portions of snow and ice may melt. But some people are considering the same to be a positive development. Agriculture may expand, navigation may become easier, exploration for oil, gas and minerals, etc., may become economical and so on. But the problem does not end there. Global warming will be a threat to the Third Pole as well.

The importance of the Third Pole cannot be overemphasised. As noted earlier, it has the Earth's largest store of water after North and South Poles. The water is held here in more than 46,000 glaciers and vast expanses of permanent snow. That is why the Third Pole is also called Asia's water tower. The glaciers feed the continent's largest rivers. In turn, the rivers sustain 1.5 billion people across ten countries. Several reports published during last few years claim that the glaciers in the Third Pole region are melting at a fast pace. As discussed earlier, one consequence could be reduced discharge during the lean season to the rivers affecting ground water, agriculture, drinking water availability, health conditions, etc. But that is not the end. Lakes in the region may overflow due to flow of larger volumes of water than they can hold. The overflow may cause large scale floods in the valleys.

The uncertainty

However, the tragedy is that not much is known about how climate change is unfolding in the region. With the aim to rectify this situation, Third Pole Environment (TPE), an international programme led by the Chinese Academy of Sciences' Institute of Tibetan Plateau Research (ITP) in Beijing has started a certain initiative. Also, different researchers in the region have planned to fill the current knowledge gap. Says Yao Tandong, Director of the ITP and chairman of the TPE Science Committee: "The only way forward is for the international community to work together to assess the risks associated with climate change."

One more dimension is that the region's population is expected to grow quite fast in the future. From the Indian point of view it is very important. The reason is that India is expected to be the most populous country in the world by the middle of the current century. Obviously, the requirements of different resources from the environment are going to rise. Hence, it is essential that the researchers make it a top priority to understand the status and fate of glaciers in the Himalayas which are a vital source of water for a large part of population of the country. The major issue is that it is not possible to anticipate how fast it may happen and how this will affect water resources. There is no glacier inventory for the entire region. Satellite studies offer only a rough estimate of the glaciated area. Remoteness of the areas involved, high altitudes and harsh weather conditions hamper measurements on the ground.

In this regard there have been claims which are not unanimous. A recent publication by United Nations Environment Programme (UNEP) and the World Glacier Monitoring Service (WGMS) clearly says: "The ongoing trend of global and rapid, if not accelerating, glacier shrinkage on the century timescale is of non-periodic nature and may lead to the de-glaciation of large parts of many mountain ranges in the coming decades". Obviously, the Indian Himalayas will not be any exception.

Neglect of the mountainous areas

Mountains and people therin especially in the developing countries, have been historically exploited or at best neglected. Even in recent times there has not been much change in the situation. For example, concrete measures and policy proposals proposed in the form of United Nations Framework Convention on Climate Change (UNFCCC) still lack a clear mountain perspective. An important opportunity which was there was missed after 1992. Agenda 21 and the UN Framework Convention on Climate Change (UNFCCC) were adopted in 1992. But the two did not bring expected results, although these initiatives provided solid grounds for promoting sustainable development of the mountainous regions.

The mountain agenda has never been addressed properly by either of the two initiatives. This situation is more serious keeping in view the fact that people living in the mountains have contributed very little to global greenhouse gas emissions, while the expectations are that they will be the first among the vulnerable communities to face the consequences of the global warming and climate change. Certain impacts are already visible. Shrinkages of glaciers and snow mass at high altitudes have been observed in different areas. Ultimately, there will be problem of water availability in the mountains. The downstream population will also suffer. But the mountains will be worst affected on account of the terrain, ecological conditions prevalent there and lack of alternative sources. Also, mountain areas suffer from certain inherent problems. For example, FAO has classified 78% of the world's mountain land surface as not suitable or only marginally suitable for agriculture. If water scarcity becomes an issue, agricultural activities will suffer badly in the mountains.

In this regard it is important that when Chapter 13, viz., 'Managing Fragile Ecosystems: Sustainable Mountain Development' was incorporated in Agenda 21 during the 1992 Earth Summit, it was taken for granted that the importance of mountains and their contribution in ecological and social terms was finally being acknowledged on global scale. The Chapter focussed on two programmes, viz., generating and strengthening knowledge about the ecology and sustainable development of mountain ecosystems; and promoting integrated watershed development and livelihood opportunities. The Food and Agriculture Organization (FAO) was assigned the responsibility to act as Task Manager for Chapter 13 and to report on the implementation of the two programmes. With the same aim, FAO convened a Task Force in 1994. During the decade after the Earth Summit, several types of specific initiatives were started by international institutions, governments, NGOs and scientific organisations with reference to the Chapter 13. One such initiative was the establishment of the Mountain Forum in 1995. It was a global network. The aim was exchange of information, mutual support, and advocacy aimed towards equitable and ecologically sustainable mountain development and conservation. But in due course of time it was realised that Chapter 13, which proved to be a good starting point, did not adequately address several issues related to sustainable mountain development. Also, the issue of proper recognition and valuation of services and benefits accruing from mountains could not be resolved. Similarly, the role of mountains in providing livelihood to people and the spiritual and recreational aspects of mountains were not assigned proper value and importance.

A lot of hope was generated again when in 1998 the United Nations General Assembly designated 2002 as the International Year of Mountains (IYM). The resolution was supported by 130 nations. It was expected that the Year could raise awareness about the importance of mountains and in turn the awareness could lead to positive actions for conservation of mountains, ecosystems present there, and other resources connected to the mountains. The awareness could also pave ways to promote better living conditions for people directly or indirectly dependent on mountain resources. The Mountain Agenda gained new momentum and several types of initiatives were started. For example, Adelboden Group out of which the SARD-M (Sustainable Agriculture and Rural Development in Mountains) project emerged, GLOCHAMORE (Global Change in Mountain Regions), and the Mountain Research Initiative (MRI) took shape. Also in the same year the Mountain Partnership was initiated during the World Summit on Sustainable Development held in Johannesburg.

But these initiatives, too, could not cut much ice, especially with reference to the mountains in the developing countries. In the two major UN conventions, UNFCCC and UNCCD, the role of mountains was never explicitly recognised in funding instruments and negotiation processes. In the Biodiversity Convention, the COP 10 in Nagoya has made some progress. A 10-year Action Plan (2011-20) was prepared. The Action Plan is aimed towards conservation of mountain biodiversity through community participation and sustainable livelihoods. Similar efforts are needed to include mountain concerns in the UNFCC and UNCCD processes to push the agenda of adaptation and sustainable land, water and forest/vegetation management. If it does not happen, the mountain ecosystems and people dependent on those ecosystems will suffer.

Indian situation

FFrom an Indian point of view, the neglect of the mountainous region is quite a grey area as a large part of her population lives in the mountains. Another issue is that another large chunk of the country's population is directly or indirectly dependent on water and other resources received from the mountains. Historically, the people living in the Indian mountains have been in constant disadvantage. Disproportionate poverty level, poor health conditions, prevalence of large-scale food insecurity and malnutrition, large-scale dependence on natural resources, limited livelihood opportunities, overall marginalization, etc., make them much more vulnerable to environmental and natural vagaries. The tragedy has been that the developmental approaches pursued in the country have not brought desired results for the mountain areas. The Working Group formed during the Eighth Five Year Plan (1992-97) remarked: "The hill areas of the country are faced with certain peculiar problems inhibiting the process of development. On account of the difficult terrain, variable agro-climatic conditions, distinct socio-cultural features, the hill areas have remained backward." But nothing substantial happened. Seriousness of the situation can be realised from the fact that during the 54th Meeting of the NDC (National Developmental Council) in 2008, the Prime Minister had to make a sharp observation on the backwardness of the mountain areas of the country. As a consequence, the Planning Commission set up a Task Force to address the problems of the hill states and hill areas and to prepare a proposal for comprehensive development of those areas. A more serious issue is that the Planning Commission Task Force discovered that most of the recommendations of the earlier Working Groups/Task Forces/ Committees constituted for the development of the mountain regions in the country were never implemented.

Conclusion

Under the circumstances it is critical that the importance of the Third Pole is recognized and serious efforts are made to conserve and protect it. the Third Pole. Otherwise, a large number of countries and millions of people living in those countries will suffer despite being not responsible for the consequences. Not only people who inhabit the mountainous regions, but also, very large numbers of people living downstream in different countries will suffer. Under the circumstances, it is essential that the factors responsible for global warming have to be addressed on a priority basis. ■

Continued from page 36 **(A Tale of Two Digits)**

hexadecimal digit. For example, the binary number '10011100' can be written as '9C' in the hexadecimal number system, where 1001 = 9 and 1100 = 12 = C."

"What is the advantage of having the octal and hexadecimal number systems?"

"As I have mentioned earlier, it makes the representation of binary numbers a lot easier. During the early development phase of the computer, the hexadecimal codes were entered as instructions. You can imagine, entering a binary code as instruction will make the life very cumbersome."

"Do we still use hexadecimal numbers as instruction to a computer?"

"In general, instructions are written in English like language, called the *high level language*. These instructions are converted to a hexadecimal code and eventually a binary code is generated. The binary code is finally deciphered by the computer. However, there are some applications where the hexadecimal codes are entered directly. "

1 byte	=	8 bits
1 KB	=	2^{10} bytes = 1024 bytes
1 MB	=	2^{20} bytes
1 GB	=	2^{30} bytes

"Uncle, I have realised now that the binary number system is not merely a method to represent numbers; rather it is the basis of the entire computer applications."

"You are right. All the advancement of computers and associated applications would not have been possible without the binary numbers."

"The world of binary number is indeed amazing! Uncle, thank you very much for introducing me to this amazing world!"

"Yes Googol. Next time when you'll switch on a computer, I hope that you'll appreciate how the magic of mathematics is playing an important role behind the scene!"

"It's like the computer playing an infinite number of Botticelli games with us!"

"That's a good analogy, Googol." ■

Dizziness
Causes and Cures

Dr Yatish Agarwal
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> *Passions spin the plot:*
> *We are betrayed by what is false within.*
> –George Meredith, Modern Love

Dizziness, or vertigo, is a common, vexing symptom, and epidemiologic data indicate that more than 20 per cent of adults experience dizziness within a given year. The symptoms are rather tell-tale: when you suffer an attack, you feel that you or your surroundings are moving. These false sensations are often accompanied by a feeling of spinning and may sometimes be associated with nausea and, at times, severe vomiting.

Depending upon its cause, vertigo can occur at any age. However, many of the causes are most often in people aged 60 and above. This is also true for benign paroxysmal positional vertigo (a disorder arising in the inner ear). Aside from ageing, there are no definite factors that may increase the risk of benign paroxysmal positional vertigo.

What are the causes?

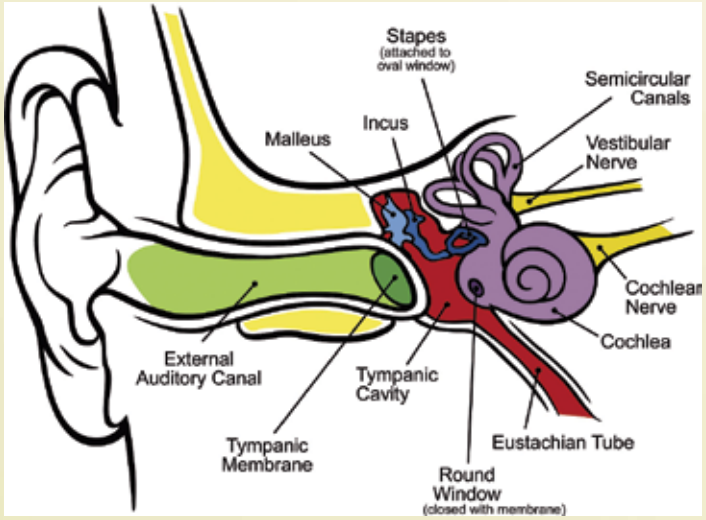
Vertigo can be brought on by a variety of causes.

Cervical spondylosis

Vertigo is often associated with arthritis in the neck, a condition generally known as cervical spondylosis. In this condition, vertigo occurs when the head is turned or tilted, thereby compressing blood vessels that supply parts of the brain involved with balance.

Benign paroxysmal positional vertigo

Most often doctors cannot find a definite cause. This frequently however relates to a condition known as benign paroxysmal positional vertigo (BPPV). It is a common cause of recurrent vertigo. Episodes are brief, lasting less than a minute and typically 15–20 seconds and are always provoked by changes in head position relative to gravity, such as lying down, rolling over in bed, rising from a supine position, and extending the head to look upward.



The inner ear plays a key role in these attacks. Inside the ear, there is a tiny organ known as the vestibular labyrinth. It includes three loop-shaped structures (semi-circular canals) that contain fluid and fine hair-like sensors that monitor the rotation of the head. Other structures, called otolith organs, in the ear monitor movements of our head — up and down, right and left, back and forth — and the head's position related to gravity. These otolith organs — the utricle and saccule — contain crystals that make ussensitive to movement and gravity.

The complexities of the inner ear

For a variety of reasons, these crystals can be dislodged. When they are dislodged, they can move into one of the semicircular canals — especially while lying down. This causes the semicircular canal to become sensitive to head position changes it would normally not respond to. As a result, we feel dizzy.

Labyrinthitis

Infection of the vestibular apparatus — labyrinthitis — is another common cause. The infection usually begins as a viral infection of the respiratory tract, such as common cold or flu, or, less frequently, a bacterial infection of the middle ear. This type of vertigo usually starts suddenly and lasts for 1–2 weeks.

Ménière's disease

Ménière's disease is a rare disorder in which the amount of fluid in the inner ear increases intermittently. The raised pressure in the inner ear disturbs the organs of hearing and balance, causing sudden attacks of ringing or buzzing sounds and dizziness so severe that the affected person may fall to the ground.

Ménière's disease usually affects one ear, but both ears can become involved. The condition is most common in people aged between 20 and 60 years and sometimes runs in families.

Attacks of Ménière's disease results in dizziness, hearing loss, and pain, pressure, or fullness in the affected ear. The hearing loss and aural symptoms are key features of Ménière's disease which distinguish it from other confusing conditions.

Audiometry at the time of an attack shows a characteristic asymmetric low-frequency hearing loss; hearing commonly improves between attacks, although permanent hearing loss may occur

eventually. Patients suspected of having Ménière's disease should take the advice of an otolaryngologist (ENT) for further evaluation.

Basket of common culprits

Overwork, stress, excessive alcohol intake, food poisoning, heatstroke, and adverse effect to certain medications can also produce vertigo, but such attacks are usually short in duration.

Head injury

A prior head injury with a minor to severe blow to the head may make a person more susceptible to benign paroxysmal positional vertigo. Such cases are not sometimes easy to pick, since the CT scan and MR of the brain may not yield any significant finding.

Serious causes

Rare causes of vertigo include a tumour affecting the nerve connecting the inner ear to the brain (acoustic neuroma), a stroke, or multiple sclerosis.

Treatments and medications

Treatment of vestibular symptoms should be driven by the underlying diagnosis. Simply treating dizziness with vestibular suppressant medications is often not helpful and may worsen the symptoms.

If the doctor diagnoses benign paroxysmal positional vertigo (BPPV), he may recommend an examination by an ENT specialist, who might consider treating with a series of movements known as the canalith repositioning procedure.

Canalith repositioning

Performed in the doctor's office, the canalith repositioning procedure consists of several simple and slow manoeuvres for positioning the head. The goal is to move particles from the fluid-filled semicircular canals of the inner ear into a tiny bag-like open area (vestibule) that houses one of the otolith organs (utricle) in the ear where these particles don't cause trouble and are more easily reabsorbed. Each position is held for about 30 seconds after the symptoms or abnormal eye movements stop. This procedure is usually effective after one or two treatments.

After the procedure, one must avoid lying flat or placing the treated ear below shoulder level for the rest of that day. For the first night following the procedure, it is important to elevate the head on a few pillows when asleep. This allows time for the particles floating in the labyrinth to settle into the vestibule and be reabsorbed by the fluids in the inner ear as stated above.

On the following morning of this outpatient procedure, the restrictions will be lifted.

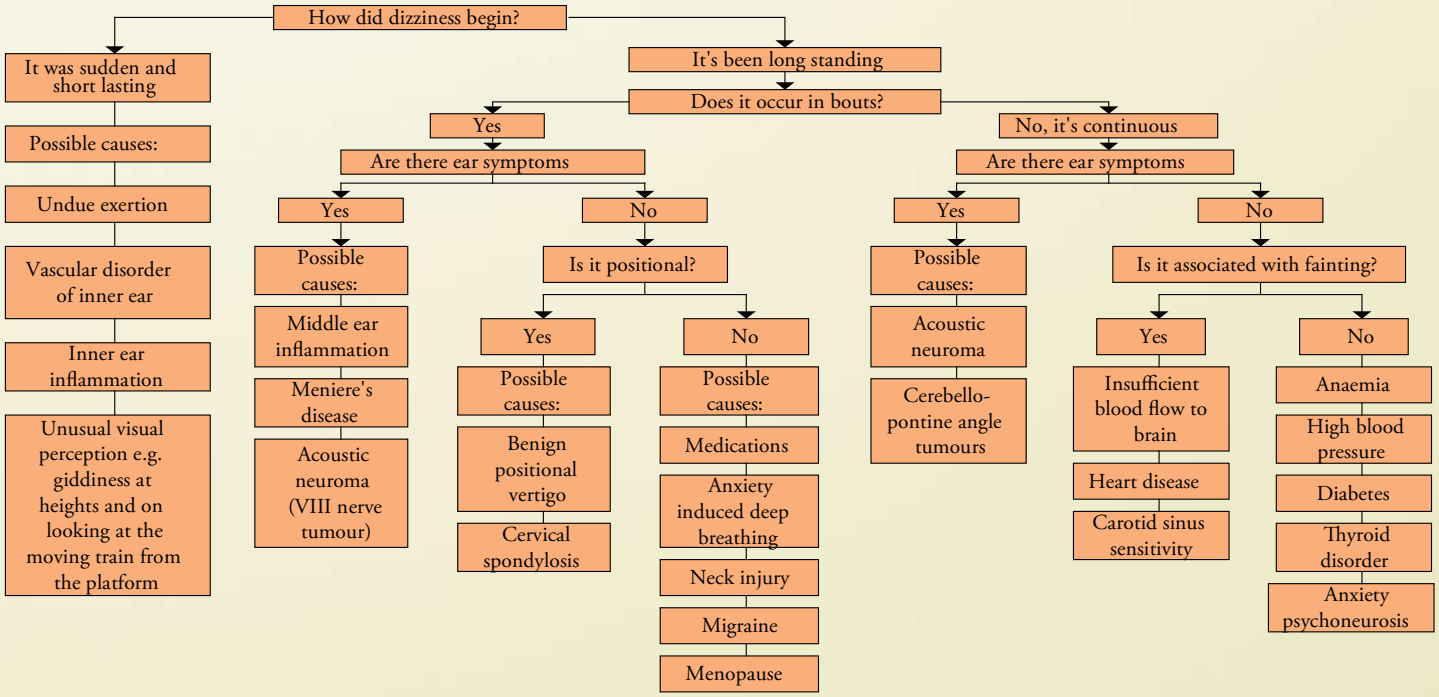
Surgical alternative

In rare situations in which the canalith repositioning procedure isn't effective, the doctor may recommend a surgical procedure in which a bone plug is used to block the portion of the inner ear that's causing dizziness. The plug prevents the semicircular canal in the ear from being able to respond to particle movements or head movements in general. The success rate for canal plugging surgery is quite good.

Medications

To relieve one's symptoms, the doctor might prescribe one or more of the following medications:

CAUSES OF DIZZINESS



Betahistine
This medication is available in the market as Vertin, Betavert, and Vertstar, and is packed into 8 mg, 16 mg and 24 mg tablets. The doctor may recommend two or three doses a day of this medicine. The period of treatment depends upon the severity of symptoms, but is often long.

Cinnarizine
Sold in the market as Cinzan, Stugeron, Vertigon, and packed as 25 mg tablets; this medication works in the same way as Betahistine.

Prochlorperazine
This medication is available in the market as Stemetil and is packed into 5 mg tablets. Your doctor may recommend this tablet at bedtime, or two or three times a day. The period of treatment depends upon the severity of symptoms, but is often long.

These three medications can make one feel drowsy, lethargic, and cause dryness of mouth. Some people also experience visual disturbances.

Antacids
Antacids and H2 receptor blockers such as pantaprazole may also prove useful in this setting.

What Can we Do under these circumstances?
In case one is diagnosed with benign paroxysmal positional vertigo, consider these tips.

Take it easy
Be aware of the possibility of losing your balance, which can lead to falling and serious injury. Sit down immediately when you feel dizzy. Alternatively, just lie still. Close your eyes. Breathe easy. Avoid sudden movement.

If you are at the wheel, put your foot on the brakes and stop. Pull up to the side. Never stretch your luck. You could easily have an accident, particularly if the symptoms are severe.

Keep the night light on
Use good lighting if you get up at night.

Use a cane
Walk with a cane for stability, if you are at risk of a fall.

Take medical help
Work closely with your doctor to manage your symptoms effectively. BPPV may recur even after successful therapy. Fortunately, although there's no cure, the condition can be managed with physical therapy and home treatments.

Simple lifestyle measures
Making some simple changes in the way you lead your life may also provide you considerable respite. Here's how:

Do not overexert
You may experience spells of dizziness if you overexert to the point of exhaustion. Work in a planned way and within your limits. Think ahead and use your resources optimally.

Dissipate stress and anxiety
Stress and anxiety have become part and parcel of daily life. Do not let them trip you. You should learn to cope and dissipate these in a healthy way, instead of falling prey to them.

Some people take stress to their lungs and begin to breathe too rapidly. This can make them dizzy. Never do this. Just breathe slowly and steadily.

Strengthen your neck
Positional dizziness is commonly related to a poorly maintained neck. The changes of spondylosis in the neck can cause pressure on the arteries which feed the brain and lead to dizzy bouts. Strong neck muscles and a good postural hygiene can prevent this.

Maintain good hydration
Particularly during summer months when one must always be careful to drink lot of fluids and to keep the body adequately hydrated. A fluid-depleted body can fall prey to bouts of dizziness.

Do not let sugar levels fall
If you miss meals and let your blood sugar level drop low due to the strain of work, time pressure or mere carelessness, you sure are asking for it. Hypoglycaemia or a low sugar level can lead to a splitting headache and also make you dizzy.

Keep your ears clean
Mild dizziness can also result from the accumulation of wax in the ears and blocked Eustachian tubes. Keep your ears clean and if you have a blocked or discharging ear, see your ENT specialist right away.

In any case, all patients who suffer from recurrent spells of giddiness need a thorough ENT examination. Most people do well if the doctor can lay his hand on the cause and help you overcome it. ■

Recent developments in science and technology

Biman Basu
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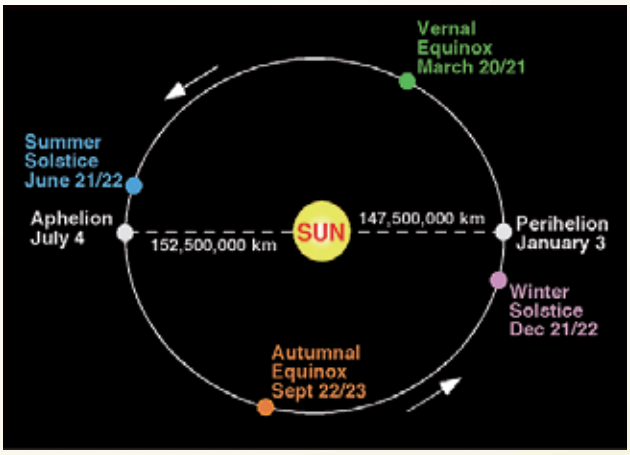
Astronomical Unit redefined

The Astronomical Unit is (AU) is an important unit for measuring distances with respect to astronomical objects. It is defined as the average distance from the Sun to the Earth, or about 150 million kilometres (93 million miles). It is a convenient unit for measuring large distances. For example, Earth is 1 AU from the Sun, and Mars is 1.523 AU, which is much easier to express than saying that Mars is 227,939,000 km away from the Sun. Similarly, Pluto is 39.48 AU from the Sun, and the newly discovered dwarf planet Eris is at a distance of 67.67 AU. The Oortcloud, the source of long-period comets in the Solar System, is thought to be some 50,000 AU from the Sun.



The Astronomical Unit is the average distance between the Sun and the Earth.

Till recently the definition of AU was quite complicated. It was defined as "the radius of an unperturbed circular Newtonian orbit about the Sun of a particle having infinitesimal mass, moving with a mean motion of 0.01720209895 radians per day (known as the Gaussian gravitational constant)". Besides being complicated, the Sun posed a big problem in this definition. The Gaussian gravitational constant being based on the solar mass, the value of AU was inextricably tied to the mass of the Sun. But since the Sun keeps losing mass as it radiates energy, this was causing the value of AU to change slowly as well.

Recently the International Astronomical Union (IAU) – the world's top astronomical body – has approved a revised definition of the Astronomical Unit at its XXVIII General Assembly held in Beijing, China, in August 2012. The new IAU definition does away with any calculations and gives AU a more precise value. Now, officially, the AU is 149,597,870,700 metres; that is, 149,597,870.7 kilometres, or 92,955,807.273 miles, exactly. This is nine metres, or about 30 feet, more than the previously agreed value.

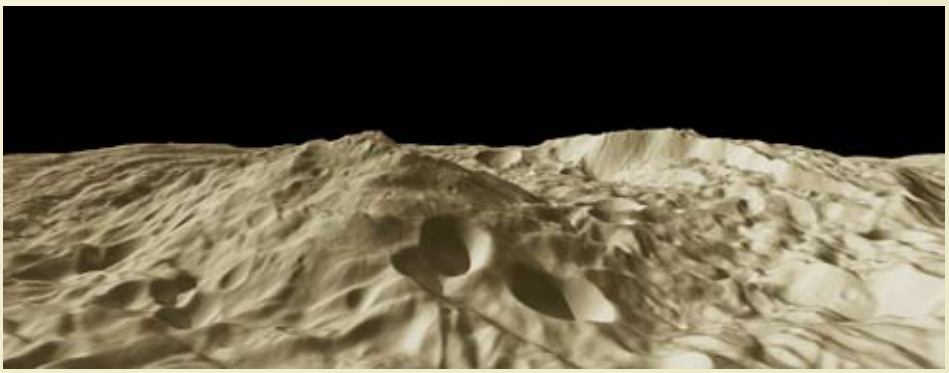
Until now, the value in metres of AU was determined experimentally, depending on the models, observations, and the reference system used, which often varied. The revised definition wipes away the problems of the old definition of AU because a fixed distance has nothing to do with the Sun's mass, and the metre is defined as the distance travelled by light in a vacuum in 1/299,792,458 of a second. Because the speed of light is constant in all reference frames, the AU will no longer change depending on an observer's location in the Solar System or the Sun's mass.

Traces of water found on Vesta

Vesta is the brightest asteroid known and is the second most massive object in the asteroid belt. It is irregular in shape and has a mean diameter of about 525 kilometres. It was under observation by NASA's *Dawn* spacecraft, equipped with a high resolution camera and two spectrometers, since July 2011. *Dawn* was placed in orbit around Vesta at an average altitude of about 210 kilometres above the surface of the asteroid, passing over the asteroid's poles as it rotated below. During the past year *Dawn* has comprehensively mapped this previously uncharted world, and sent back a wealth of data about this rocky object. The spacecraft has also compiled a detailed map of the asteroid's surface, the first of its kind so far.

Two new papers, published in *Science* on 20 September 2012 (doi: 10.1126/science.1225354 and doi: 10.1126/science.1225374) reveal abundant hydrogen on Vesta and pitted craters that indicate the presence of volatiles such as nitrogen, carbon, and water. Taken together, the findings point to presence of water on the asteroid. However, its small size and lack of an atmosphere means the water could not exist there in a liquid state but might linger as a solid beneath its surface or disperse as vapour into space. *Dawn* did not find actual water ice at Vesta, but it found evidence of hydrated minerals and dust on the giant asteroid.

Signatures of hydrogen, in the form of hydroxyl or water, were detected by *Dawn*'s gamma ray and neutron detector (GRaND). According to Thomas Prettyman, the lead



Surface of the asteroid Vesta as imaged by NASA's Dawn spacecraft.

scientist for GRaND at the Planetary Science Institute in Tucson, Arizona, USA, the source of the hydrogen within Vesta's surface appears to be hydrated minerals delivered by carbon-rich space rocks that collided with Vesta at speeds slow enough to preserve their volatile content. GRaND's data are the first direct measurements describing the elemental composition of Vesta's surface. According to the scientists, the water is probably locked within the lattice of carbonaceous chondrites, a class of dark-coloured meteorites known to have struck Vesta in the past and mixed into its surface.

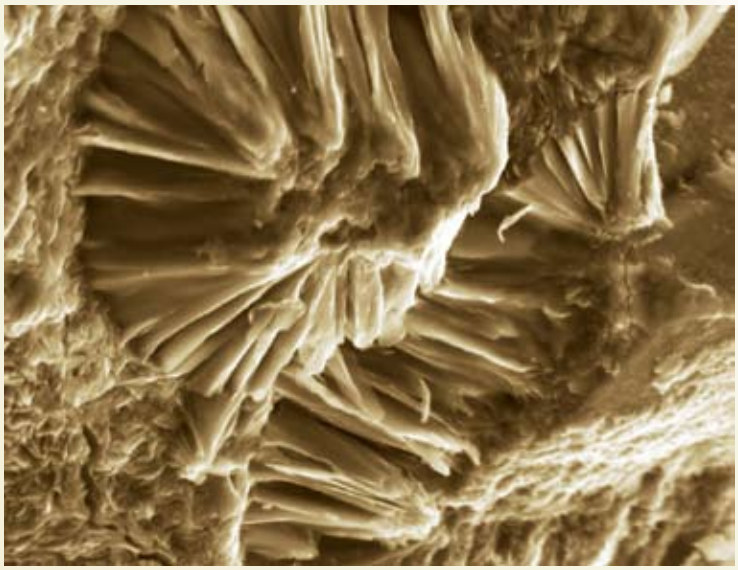
The *Dawn* findings are helping researchers understand how a once-molten proto-planet – a category that includes early Earth – could gather water early in its history as it cooled and spun through space. According to the researchers, the water must have arrived on Vesta after it cooled because early in the solar system's history, asteroids and terrestrial planets were formed from molten material and the extremely high temperatures of young Vesta would have instantly evaporated any volatile material such as water. Vesta's regolith, or rocky soil, is estimated to hold only 5 per cent water by weight. Due to the low gravity of Vesta, the impacts would have ploughed into the rocky asteroid at slower speeds than impacts at Earth or the Moon. Although surprising, the finding of water on Vesta is not as unexpected as it would have been a decade ago. Today researchers have found evidence for water ice on the Moon and Mars also.

Dawn's findings are helping scientists unlock some of the secrets of how the solar system, including our own Earth, was formed. After completing its mission at Vesta, *Dawn* left for its next destination – the dwarf planet Ceres in the asteroid belt, on 5 September 2012. Unlike other spacecraft used to explore planets, *Dawn* uses an ion propulsion system, which is less powerful than conventional chemical rockets, but can run for far longer duration compared to regular rockets. *Dawn* will reach Ceres sometime around 2015.

Mars clay not formed by water

Mars has been one of the most explored planets since 1960, with a total of 38 missions sent by USA and USSR and one mission each by Japan and the European Space Agency. But as many as 16 missions, including the one by Japanese ended in failure. The US record has been much better. Of the 25 total Mars missions it had sent, more than two-thirds have succeeded, which include seven landing missions.

From the images and data sent back by these missions it was inferred that in the distant past Mars had plenty of water. Clay layers found across Mars suggested that from about 4.2 billion to 3.5 billion years ago, the planet was warm enough to have large bodies of liquid water. When the *Mars Express* and *Mars Reconnaissance Orbiter* studied these clays from orbit several years ago, geologists assumed the clays were a result of large bodies of water weathering and altering Mars' basalt surface. They were of the view that Mars clays could have formed in one of two ways: through soil interacting with standing water on the surface, or from water bubbling up from below via hydrothermal vents. And both these conditions would have encouraged life to form.



This image shows magma-spawned clay particles covering unaltered crystals in a basaltic lava flow from Mururoa seamount, French Polynesia. Similar structures on Mars cast doubt on its wet past, scientists say. (Credit: Meunier-Riffaut)

However, recent analysis of Martian meteorites indicate that some clays found on the Red Planet may not have formed the way scientists had thought – due to presence of water – but may have formed through volcanic action. Such clays might have been formed in hot Martian magma rich in water. If so, that water would have been far too hot to support microbial life. In a recent paper in *Nature Geoscience* (9 September 2012, doi: 10.1038/ngeo1572), a French-US team of researchers led by Alain Meunier of the University of Poitiers in France, report the similarity of chemical composition of some Mars clay minerals dating back to 4.2 billion to 3.5 billion years with clays found at the Mururoa Atoll in French Polynesia, which are known to have been formed from cooling of water-rich lava. Crystallising lava may have contained tiny pockets where water could react with other chemicals to make small amounts of iron- and magnesium-rich clay. No additional water flowing on the surface or below ground would be needed. According to the researchers, such an origin is also consistent with the hydrogen isotope compositions of clays in some Martian meteorites and the widespread presence of these clays in massive basaltic lavas, breccias, and regolith. Moreover, these ancient Martian clays are up to a few hundred metres thick, which is more likely to be associated with lava flows than soil interacting with water.

However, the new findings do not necessarily mean that all Martian clays were formed in the absence of water. Some planetary scientists do not fully agree with the new hypothesis. They point out that the new hypothesis does not explain why the Martian surface appears to have tracks and channels cut by flowing liquid. Nor does it account for certain mineral deposits of hematite that scientists believe may have formed when water ran past them. It is expected that NASA's Mars rover *Curiosity* might shed some light on the debate by giving scientists a close-up look at some clays in the lower layers of Mount Sharp in the middle of Gale Crater, which could very well have been the site of a Martian lake, billions of years in the past and clays found there could have been created by water. ■

Letters to the editor

Informative article

Dream 2047 is an excellent informative magazine that can help boost scientific temper among readers. I must thank Dr. Vinay B Kamble for the interesting article on "Higgs Boson - Gods Particle" (September 2012) in which the Standard Model was explained in very simple manner. I would like to know more about the same topic.

I would also appreciate if you can publish an article on Vedic Mathematics in a forthcoming issue.

Ashish HEGDE
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Higgs boson

The article on Higgs boson by Dr VB Kamble in *Dream 2047* (September and October 2012) was really very informative. In the article the name God particle for Higgs boson, which was misquoted by the media, was clearly explained. The contents were extremely articulative and conveyed the concepts in a extremely simple and convincing manner. Science communication as taken up by VP is really commendable. I personally feel the need of an exclusive science channel to spread the scientific thoughts and concepts and to develop scientific temper among the masses in general and children in particular.

Dr Manoj Kumar Srivastava
Assistant Professor, Department of Physics
ACC Wing, Indian Military Academy,
Dehradun-248007

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First of all I would like to say that heartily thank the entire team of this valuable monthly magazine. Without hesitation I can say that it is an unique Sc. magazine of all over India. This magazine is very useful for Sc. students, writers, sc. clubs and sc. communicators and the man who is most interested in sc. subject. The main feel of this magazine is that it is provided free of cost by Vigyan Prasar. In fact, it is a real boon for all of us. It satisfies all the needs of readers. By reading *Dream 2047* one can improve their science skills. The sections of this magazine are an editorial, Biographies of scientists, an interview, recent developments in S&T and medical series. Each articles of this magazine is written by great sc. writers and articles are exceptionally good. I have been readily of since two years and I shall be a very good fan of this magazine. I think, it is very helpful publication for all of us. Each men should read it regularly for getting the best sc. knowledge. At the end of wishing you all the best in your future endeavours.

Mr. Mukund Kumar Tiwari
Co-ordinator, Newton Sc. Club
Piprahi, Ward No. 5, Sheohar, Bihar – 843334

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Invigorating articles

The article "The Calculus Affair" (Dream 2047 October 2012) was written in a simple, lucid style and described well the applications of calculus for calculating speed, and time-and-distance problems, which was very useful to readers. The two-part article on Higgs Boson was also invigorating. The article on "Dizziness" was quite informative. I would request you to publish a future list of events for prior intimation and enhanced participation. Articles on a few emerging areas like energy efficiency, climate change, renewable energy/green energy, biotechnology, zero energy buildings, and observances of various important days of the month can be too considered from the next issue.

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Brainstorming for Science Clubs

A two-day brainstorming session to decide the road map for science clubs was organised jointly by Vigyan Prasar and Gujarat Council of Science and Technology (GUJCOST), in the sprawling campus of the Institute of Seismological Research (ISR) in Gandhinagar during 30-31 August 2012. At the end of the brainstorming session the participating experts expressed the hope that soon the country will witness a science club movement that will provide a tool for informal science learning for the communities to combat poverty, pollution and diseases. They also expressed the feeling that collective thoughts and togetherness promoted through science clubs provide us the means to look at our own role and responsibilities to shape our society and explore the limitless potential that lies amongst the thousands of science club members.

About 30 experts and resource persons working in different disciplines across the country attended the programme and had in-depth discussion on the science club activities that can act as a spark to motivate children to learn and appreciate science. There were five technical sessions including (i) Current functions of science clubs; (ii) Making science clubs nuclei of change and hubs of information; (iii) Financial implication of science club activities; (iv) Accountability/reporting of club activities; and (v) New vistas/new initiatives for science club movement on which the experts had in-depth discussion.

Dr. Rajendra Singh, Magsaysay awardee for water movement, Padma Bhusan and renowned science populariser Dr. Saroj Ghose, Dr. Pramod Verma, Science Advisor and Director General of MP State S&T Council, Dr. Rajendra Dhobal, Director General of Uttarakhand State & S&T Council, Dr. P. Iyamperumal, Executive Director, TN State & Council, Dr. Surendra Singh, Advisor, Manipur State S&T Council, Dr. Amita Gill, Director, DST, Rajasthan, Dr. V.B. Kamble, Ex-Director, Vigyan Prasar conducted various interactive sessions.

The aim of the brainstorming session was to strengthen the working of science clubs and develop a road map for them so as to motivate the children and youth to take up scientific activities and contribute towards the cherished goals of achieving a scientific society. At present, Vigyan Prasar has more than 12,000 science clubs across the country. In addition, there are large numbers of eco-clubs, DNA Clubs, and State science clubs with a large number students and teachers working together. The specific recommendations given by the experts are being finalised as a report on Science Club Movement in India.

Experts brainstorms for science club future

(Report by: B.K. Tyagi) ■

Cartoon by : V.S.S. Sastri E-mail: vsssastri@gmail.com