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The Enigmatic e

Transit of Venus
6 June 2012

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

Venus Transit

Dr. Subodh Mahanti

Venus Transit takes place when Venus comes in between the Sun and the Earth in a straight line. We are familiar with solar eclipses. A solar eclipse (total, partial or annular) takes place when the Moon comes in between the Sun and the Earth. When one of the two inner planets, namely Mercury and Venus comes in between the Sun and the Earth, the phenomenon is called transit and not eclipse. Unlike in case of solar eclipses we see a black dot passing across the bright disc of the Sun. This is because the discs of the planets Mercury and Venus, as seen from the Earth, are much smaller than that of the Moon. The path traversed by black dot in a transit across the surface of the Sun depends on the geometry involved. A planetary transit lasts for several hours.

Compared to solar eclipses, the planetary transits are rare. In a century there can be 13 to 14 Mercury transits. The transit of Venus is even much rarer compared to transit of Mercury. The forthcoming Venus transit on 6 June 2012 will be the last transit of Venus to be seen in the 21st century. The next transit of Venus will take place on 11 December 2117. There was no transit of Venus in 20th century.

The transit of Venus is one of the rarest celestial events. Since 1600 or since the first use of telescope for observing the celestial bodies in 1609 by the Italian astronomer Galileo Galilei (1564-1642), there have been only seven transits of Venus till date (1631, 1639, 1761, 1769, 1874, 1882, and 2004). In every 243 years four Venus transits occur and within this time cycle a definite pattern can be seen. In the present epoch Venus transit follow a pattern of recurrence at intervals of 8, 121.5, 8, and 105.5 years. The transit of Venus on 8 June 2004 took place after a gap of 121.5 years following the transit of 6 December 1882. The forthcoming transit is taking place exactly after eight years of the last transit (8 June 2004). The transit of 11 December 2117 will be followed by a transit on 8 December 2125. These occurrences clearly demonstrate the pattern of 105.5, 8, 121.5, and 8 years. However, this is not the only pattern seen in the basic cycle of 243 years. The presently seen pattern will not be seen after AD 2846, it will be replaced by a pattern of 105.5, 129.5, and 8 years. Prior to AD 1518 another pattern was seen.

Planetary transits are of utmost importance to astronomers. Transits, particularly Venus transits, were used to measure the actual distance (say in kilometres) between the Sun and the Earth, which is called Astronomical Unit. Finding the actual value of the Astronomical Unit was an important scientific problem in the 18th century. The actual value of the astronomical unit made it possible to get an idea of the expanse of the solar system. Today the most accurate method of determination of the astronomical unit is by radar sounding method. Transits also help astronomers to find out many other features of the planets.

A transit starts with contact I; that is, when the Planet's disk is externally tangent to the Sun. The planet becomes visible as a small notch along the solar limb soon after contact I. When the planet is internally tangent to the Sun it is called contact II. At contact II the entire disk of the planet becomes visible for the first time. After contact II the planet moves slowly across the disk of the Sun, lasting several hours. Finally, the planet reaches to the opposite limb of the Sun and once again is internally tangent to the Sun. This point is called contact III. The transit ends at contact IV when the planet's limb is externally tangent to the Sun.

Johaness Kepler (1571-1630), who is regarded as the founder of celestial mechanics, first predicted the occurrence of Venus transit on 6 December 1631. Kepler also predicted the transit of Mercury in the same year. It was Kepler who had demonstrated that the planets moved around the Sun in elliptical orbits and he formulated the three laws of planetary motions. Based on his planetary laws, Kepler published tables showing future planetary positions. He called them Rudolphine Tables in honour of King Rudolph. The first predictions of transits of Mercury (November 1631) and Venus (December 1631) were indicated in Rudolphine Tables. Pierre Gassendi (1592-1655), the French philosopher and astronomer, observed the Mercury transit of 1631 and in doing so he became the first person ever to witness a planetary transit. The transit of Venus of 1631 was not visible from Europe. No expeditions were organised to observe it from elsewhere. Jeremiah Horrocks (1617 or 1619-1641), English astronomer, while reworking Kepler's calculations observed that transits of Venus occurred in pairs at interval of eight years, roughly every 120 years. Horrocks and William Crabtree observed the Venus transit that took place on 4 December 1639 and based on their observations

Vigyan Prasar in association with Indian Institute of Astrophysics, Bengaluru and Amateur Astronomers Association of Delhi will webcast the Live Transit of Venus on 06 June 2012 from sunrise to about 10:45 AM from the world's highest Observatory-Himalayan Chandra Telescope at Hanle. PLEASE DO WATCH THE TRANSIT from: www.vigyanprasar.gov.in

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Horrocks calculated the distance between the Sun and the Earth as 90,123,000 kilometres.

In 1691, Edmond Halley (1656-1742), the English astronomer, announced that the distance between the Sun and the Earth might be calculated by observation of the transits of the inner planets. He pointed out that the transits of Venus will be ideally suited for the purpose. He presented a definite plan for doing this. He presented an outline of a practical programme of observation for calculating the distance in a paper published in 1716. Halley pointed out that by measuring the solar parallax the value of the Astronomical Unit could be determined. Halley did not live to implement his programme. However, he inspired astronomers from all parts of the world to prepare for observations of the forthcoming transits of 1761 and 1769 with a view to determining the distance between the Sun and the Earth. Astronomers planned to observe the Venus transits of 1761 and 1769.

In those days it was not easy to travel long distances. Moreover, the transits could be observed only from some of the inaccessible places of the Earth of those days—South Africa, Siberia, North America, the Indian Ocean, the South Pacific and Central America. In those days these places could be reached after a long and difficult journey by wooden sailing ships. There was an ongoing war between France and England. Shipwrecks and diseases were other problems. However, in spite of many difficulties in undertaking journeys, expeditions were organised by French and English astronomers respectively for observing the 1761 Venus transit.

There were three French expeditions. The expedition under the leadership of Alexandre Gui Pingre (1711-1796) reached the French Island of Rodrigues, off the coast of Madagascar in the Indian Ocean. For Pingre and his team the conditions were not favourable for observation. It rained during the morning of 6 June 1761 and subsequently the sky remained covered with thick clouds for quite some time. As a result they could not determine the first and second contacts between Venus and Sun as well as the final contact. However, the expedition was not a total failure as they could make some useful observations. Pingre had to face lot of problems while coming back to France. Another French expedition led by Jean-Baptiste Chappe d'Auteroche (1722-1769) went to Tobolsk in Siberia. The journey was difficult but d'Auteroche could make observations of great importance to his contemporaries. In fact, his observations were used till the end of 19th century. There was a third French expedition led by Guillaume Joseph Hyacynthe Jean-Baptiste Le Gentil de la Galaisiere (1725-1792), popularly known as Le Gentil. Le Gentil's destination was Pondicherry in India at the time under French control. After reaching Mauritius, Le Gentil learnt that it would be impossible to reach Pondicherry as the Indian Ocean was swarming with British warships. Nevertheless he made an attempt to reach Pondicherry. However, on his way he learnt that Pondicherry had fallen to British forces. They sailed back to Mauritius and decided to stay back so that he could observe the 1769 transit. In 1769, Le Gentil was in Pondicherry (by that time it was recaptured by the French forces) but this time clouds prevented Le Gentil in observing the transit. Le Gentil did not succeed in observing transit but his courage, dedication and passion for scientific observations will be remembered as a source of inspiration.

The British expedition led by Charles Mason (1728-1786) and Jeremiah Dixon (1733-1770) reached Bencoolen in Sumatra. They could not reach their destination as their ship was attacked by a French frigate. Thirteen team members were killed and another 37 were wounded. There was also some damage to their ship and astronomical equipment. After making necessary repairs they realised that they would not be able to reach Bencoolen on time for observing the transit and so they sailed for Cape of Good Hope. They could reach Cape of Good Hope on time and obtain useful data of the observations. The other British expedition led by Nevil Maskelyne (1732-1811) was sent to St. Helena, but the data collected by this expedition was not of much use.

There were other expeditions for observing the 1761 Venus transit, John Winthrop of Harvard College in Massachusetts Bay Colony went to St. Johns, Newfoundland and Maximilian Hell (1720-1792) of Austria went to Vardo, Norway above Arctic Circle. They could obtain useful data. There were other expeditions.

In spite of many expeditions sent to observe the 1761 transit it did not become possible to obtain definitive measurement of the solar parallax needed for measuring the actual value of the Astronomical Unit. Renewed efforts were made to observe the 1769 transit . This time Chappe d'Auteroche went to Mission San Jose del Cabo on the tip of Baja and collected excellent data. However, d'Auteroche and all his assistants except his engineer Pauly were wiped out by the epidemic that struck Mission San Jose. Pauly brought back the observational records.

The British expedition for the 1769 Venus Transit led by William Wales (1734-1798) and J. Dymond went to Hudson Bay station. They could obtain good data. Captain James Cook (1728-1779) and Joseph Banks (1743-1820), who had undertaken a famous expedition (1768-1771) to circumnavigate the globe and explore the Southern Pacific, observed the 1769 transit in Tahiti. The astronomer in Capt. Cook's team Charles Green made the observations. Unfortunately, in 1769 also, it was not possible to get definitive value of the solar parallax. The problems faced by astronomers in 18th century were longitudinal precision, inability to handle black drop effect, and flaws in the telescopes.

Expeditions were organised to observe, the 19th century Venus transits (1874 and 1882). By this time observation methods were further improved. Spectroscopic observations were possible. The Italian team led by Petro Tacchini of the Palarmo Astronomical Observatory made spectroscopic observations of the 1874 Venus transit at Madhupur in Eastern India. Father Eugene Lafont (1837-1908) of St. Xavier's College of Kolkata had joined the Italian team at Madhupur. Pathani Samanta and Ankitam Venkata Narasinga Rao of India made observations of the transit of Venus. Finally it was possible to get a definitive value of solar parallax, and the value of the Astronomical Unit was found to be 149.59 (± 0.31) million kilometres.

For astronomers the importance of Venus transit has not reduced and they will continue to observe the forthcoming transits. Being one of the rarest celestial events, the transit of Venus provides an ideal opportunity for science communicators and organisations engaged in science communication for creating awareness about science in general and astronomy in particular. Students should be encouraged to undertake astronomical activities. However, it should be remembered that due precaution should be taken for observing the Sun otherwise eyes could be damaged.

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The Enigmatic '*e*'

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My uncle and I were on our daily evening stroll when we spotted a branch of tree that blocked our path.

'Googol, please help me move this branch to the side of the path – it will be less visible in the night and may cause problem to other walkers,' uncle said.

'It must be due to the strong wind that blew yesterday evening,' I tried to reason as I was helping him to clear the path.

'I think so. Well Googol, here is a riddle for you. How does a mathematician describe a large branch of tree that has fallen off due to natural cause?' uncle asked.

'A mathematician will find mathematics in the fallen branches of tree!' I was a bit amused.

'Natural log,' pat came the reply from uncle.

'Oh, I got it now. The 'log' is also the short form of 'logarithm' and the 'natural logarithm' of a number is obtained by taking the base as *e*,' I replied.

'You are right, the pun was intended,' uncle smiled.

'Uncle, I don't know much about the number '*e*' – could you please elaborate it?' I was eagerly waiting for a breeze of mathematical ideas from my mathematician uncle.

'The number *e* is one of the most fascinating mathematical constants. It appears in natural logarithm, calculus and in many mathematical equations. Decimal representation of *e* never ends and never repeats,' uncle said.

'I knew π is a very interesting number and it's also very useful. So *e* is also an interesting constant. Historically, were they discovered around the same time?' I asked.

'Well, history of π goes back to ancient times. The Egyptians mentioned about something similar to π in their writings on papyrus scroll as early as 1650 BC. Moreover, its concept can be grasped easily as the ratio of the circumference of a circle to its diameter. However, it was not the case with the number *e*. Not only the concept of *e* came much later, around the year 1700, its history is closely associated with calculus, the subject traditionally regarded as higher mathematics. To mathematicians, however, *e* is equally important as π.'

The person who discovered *e* must have been a genius!'

'Indeed he was. But it's not easy to decide who should be given the credit as the discoverer of *e*'.

'Does it mean several mathematicians were involved in discovering the number *e*?'

'It appears the number *e* was known to mathematicians long before the invention of the logarithm and calculus. It first appeared in connection with the formula for calculating compound interest'.

'How could the formula for calculating compound interest be related to *e*?

'With an annual interest rate of 100%, how much will you get from a bank after one year if your principal is Rs 1?' uncle asked.

'Very simple. I will get Rs 2 after one year.'

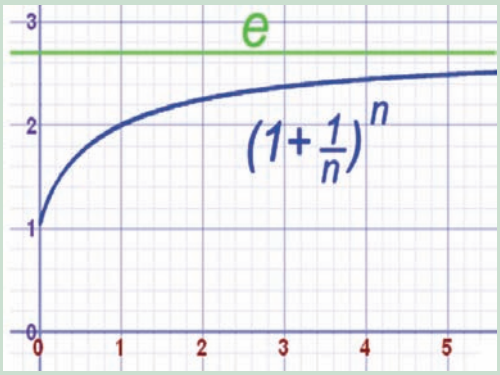
'Now assume that the bank is calculating the compound interest and it is calculated half-yearly. Can you tell me how much will you get at the end of one year?'

'Hmm, compounding the interest will give a different answer. It is not so simple now – please help me,' I confessed.

'Yes, compound interest is the interest on the principal amount plus the interest accrued on the principal amount over a time period. One of the formulae for calculating the compound interest can be expressed mathematically as: $S = P\,(1 + r/n)^n$, where S is the total amount you will receive, P is the principal, r is the rate of interest expressed as decimal (and not as percentage), n is the number of times the interest is compounded per year. With P = 1, r = 1 (i.e. 100%), the formula becomes $S = (1 + 1/n)^n$. For half yearly compound interest calculation, you calculate compound interest two times a year and hence put n = 2'.

'Thanks for your help. I will get: $S = (1 + ½)^2 = (1.5)^2 = 2.25$,' I replied.

'Now, if you increase 'n' to 4, i.e. if interest is calculated quarterly, $S = (1 + ¼)^4 = 2.44$. If n is increased further, say n = 12, $S = (1 + 1/12)^{12} = 2.613$. If you keep increasing n, S will approach a limit, about 2.71828. This observation was made during 16 century'.



n	$(1 + 1/n)^n$
1	2.00000
2	2.25000
5	2.48832
10	2.59374
100	2.70481
1,000	2.71692
10,000	2.71815
100,000	2.71827

The value of $(1 + 1/n)^n$ approaches e as n gets bigger and bigger

'That is amazing! Is this the value of *e*?'

'Yes, you got it right – this is the approximate value of *e* for five decimal points.'

'I will memorise this, 2.71828...,' I mumbled.

'Or, there is an easy way to remember the value of *e* to some digits. Remember the curious pattern that after the 2.7, the number '1828' appears twice. This gives: 2.7 1828 1828,' uncle said.

'That's nice; it's easy to remember then,'

'And then follows the numbers in degrees of the angles of a right-angled isosceles (two equal angles) triangle. This gives us the values: 45, 90, 45. So if you put all of these together, you get the value of *e* to a considerable length: 2.7 1828 1828 45 90 45,'

'How many digits of *e* are known today?'

'Interestingly, the number of known digits of *e* has increased dramatically during the last few decades. This is due both to higher performance of computers and to algorithmic improvements. In July 2010, Shigeru Kondo and Alexander J. Yee computed the value of *e* up to 1,000,000,000,000 digits.'

'That's very interesting. So who discovered this unique mathematical phenomenon for the first time and hence the value of *e*?'

'The discovery, most likely was an experimental observation rather than the result of rigorous mathematical deduction. Hence it is difficult to give the credit to any individual. The result is fascinating because inadvertently the concept of limit was introduced in this financial calculation. Note, $S = (1 + 1/n)^n$ with n approaching infinity, S approaches *e*.'

'When did mathematicians knew about *e*?' I asked uncle.

John Napier
(1550 – 1617)

'The familiar role of *e* as the natural base of logarithms came much later. Scottish theologian and mathematician John Napier, while trying to simplify multiplication, invented a model which transforms multiplication into addition and hence came up with the idea of logarithm. He created first table of logarithms in 1614. The model is almost equivalent to what we know as logarithm today:'

$y = \log_b x$ if $b^Y = x$

'Give me an example.'

'For example, if $b = 2$ and $Y = 4$, then: $b^Y = 2^4 = 2 \times 2 \times 2 \times = 16 = X$. If you now take the logarithm of 16 with base 2, then it gives 4 which is Y. So the logarithm helps in simplifying the concept of multiplication. In fact, for any value of the base, log(M×N) equals to log(M) plus log(N)'

'I know that the logarithm table is used for mathematical calculations'.

'Not only for computational mathematics; logarithmic functions are central to almost every branch of pure and applied mathematics.'

'So the application of logarithmic function is not restricted to the field of mathematics only.'

'Yes, the logarithmic functions are essential in a host of applications, ranging from physics and chemistry to biology, physiology, art and music.'

'But how is *e* associated with logarithm?'

'Napier's work was translated in 1618 where, in an appendix, there is equivalent statement that $\log_e 10 = 2.302$. This seems to be the first explicit recognition of the role of the number *e* in mathematics.'

'So Napier invented the logarithm with base *e*?'

'Although Napier's definition did not use bases or algebraic equations, he did use a number close to 1/*e* as the base. Algebra was not advanced enough in Napier's time to allow such a definition. Logarithmic tables were constructed; even tables very close to natural logarithmic tables, but the base, '*e*' did not make a direct appearance'

'So Napier did not mention anything about *e*'.

'You may say that. However, Napier unknowingly came very close to discovering the number *e*, which, a century later, was recognised as the natural base of logarithm'.

'I am eager to know when did *e* get its recognition as a mathematical constant.'

'German mathematician and philosopher Gottfried Leibniz, in his work on calculus, identified a constant of value 2.718 and labelled it *b*.'

Leonhard Euler
(1707 – 1783)

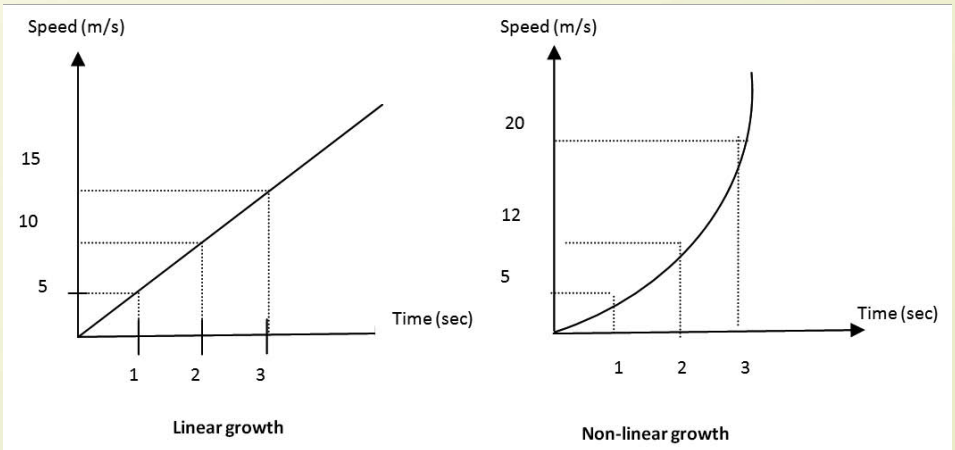
'But that is the value of *e*!'

'Yes. But It was Leonhard Euler who gave the constant its letter designation, '*e*', and discovered many of its remarkable properties. Euler's discoveries cast new light on the previous work, bringing out the relevance of *e* to a host of results and applications.'

'I have heard about exponential growth. Does it have anything to do with *e*?'

'Exponential growth signifies nonlinear increase. However mathematical equations representing exponential growth is not necessarily be a function of *e*.'

'Please elaborate'



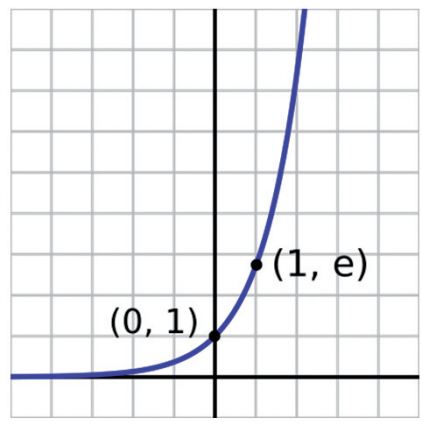
'Say, a car starts from rest. Its speed after 1 second is 5m/s, after 2 sec 10m/s, after three second 15 m/s and so on. Now if you want to plot a graph with speed in y

axis and time in x axis, you will get a straight line with a positive constant slope with x axis. This is a linearly increasing function. However, if speed of the car after 2 second is 12 m/s, after 3 second 20 m/s, then it is an example of exponential growth and the graph will be a curve, not a straight line. In this case the slope is different at different intervals.'

'Can *e* represent this exponential growth?

'Any function of the form $y = b^x$, where the base b is any positive real number and x is a real or a complex number is called exponential function. If x is positive, the value of y will increase exponentially. If x is negative, the value of y will decrease exponentially, known as exponential decay.'

'I thought *e* must be related to exponential!'



The natural exponential function y = ex. The graph of $y = e^x$ is upward-sloping, and increases faster as *x* increases. The graph always lies above the *x*-axis but can get very close to it for negative *x*

'You are partially right. The most common base is the number *e*. The function $y = e^x$ is called exponential function. When the exponent in this function increases by 1, the value of the function increases by a factor of *e* .The beauty of this function is that derivative of e^x is e^x. Hence the function is used to model a relationship in which a constant change in the independent variable gives the same proportional change (i.e. percentage increase or decrease) in the dependent variable.'

'Can exponential function be related with natural logarithm?' I enquired.

'Very good question. If we take natural logarithm of the exponential function $y = e^x$ we get $\log_e y = \log_e e^x = x \log_e e = x$. This is a equation with natural logarithm and the curve becomes straight line if plotted in a logarithmic scale.'

'This is amazing!'

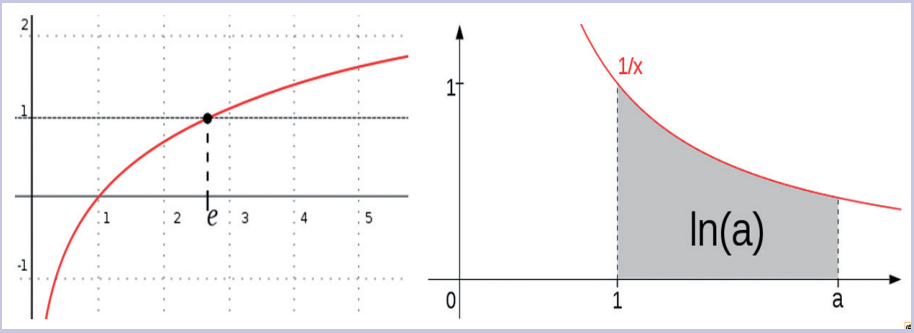
'Indeed it is. The mathematical constant *e* transforms a complex looking expression to a very simple form. Thanks to Napier for his ingenuity and effort in making the logarithmic table. The logarithm and its close associate e enable scientists to do complex mathematical modelling that otherwise would have been impossible.'

'Thank you for telling me about the astonishing features and the importance of *e*. Next time I come across any equation involving logarithm and *e*, I will try to visualise it in the light of whatever you told me. Please tell me more about the properties of *e* according to the number theorem.'

'Googol, if we dwell more on mathematics now, we will inevitably miss the beauty of nature that is just unfolding in front of us. So let's keep our discussion on more enchanting facts of Euler's number for tomorrow.'

Uncle was right. While walking and listening to uncle, I did not realise that the setting Sun was glowing in the horizon and the rain-washed sky was looking like a nature's easel splattered with dazzling colours. After an enchanting encounter with Euler's number, it's time to enjoy the nature!

Natural Logarithm



The natural logarithm is the logarithm to the base *e*. The natural logarithm is generally written as ln(x) or $\log_e x$.

The natural logarithm of a number x is the power to which e would have to be raised to equal x. For example, ln(7.389...) is 2, because e^2=7.389.... The natural log of *e* itself [ln(*e*)] is 1 because $e^1 = e$, while the natural logarithm of 1 [ln(1)] is 0, since $e^0 = 1$.

The natural logarithm can be defined for any positive real number 'a' as the area under the curve y = 1/x from 1 to 'a'. The simplicity of this definition, which is matched in many other formulas involving the natural logarithm, leads to the term 'natural'.

Alternative characterisations of *e*

The number *e* is the sum of the infinite series

$$e = 1 + \frac{1}{1!} + \frac{1}{2!} + \frac{1}{3!} + \cdots$$

where *n*! is the factorial of *n*. For example, 5! = 5×4×3×2×1 = 120.

From the infinite series it is clear that decimal representation of *e* can never end and can never repeat!

The numerical value of *e* truncated to 50 decimal places is

2.71828182845904523536028747135266249775724709369995...

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An excellent account on history and chronology of pi may be found at: http://en.wikipedia.org/wiki/E_(mathematical_constant)

Pleistocene park plant resurrected

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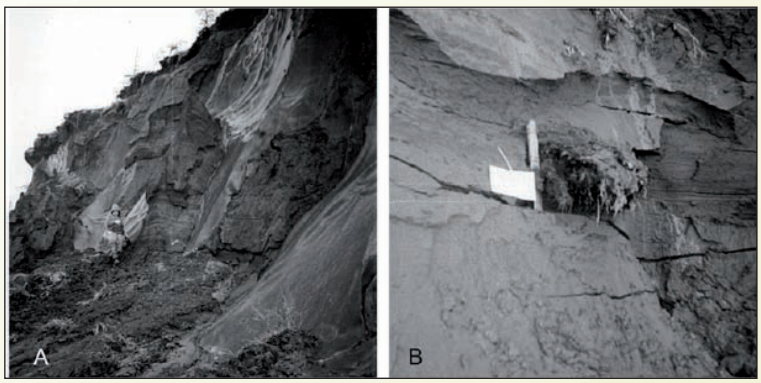
To a casual look, the two nondescript plants placed in pots carefully placed at a corner of the Russian Soil Cryology Laboratory in Moscow may be unimpressive. With ordinary white flowers, bottle green leaves the plant has hardly anything distinct to dazzle the viewer and the plant, narrow-leafed Campion (*Silene stenophylla*), would hardly win any award in a flower show. But it is the most ancient, viable, multi-cellular, living organism on Earth. Just as Rip Van Winkle woke up from deep slumber of many years to find the world changed so much, these plants have been brought back to life from seeds buried by squirrels in Siberian permafrost more than 30,000 years ago.

Of course it is not first time scientists have attempted to bring back to life plants from seeds buried ages ago. In 2008, scientists in Israel resurrected a palm tree from seeds, dating back to times of Jesus Christ, buried at the Masada fortress near the Dead Sea in Israel. Aptly named Phoenix palm, the seeds dating back to 1st century were coaxed into growing into a viable tree; which in turn produced seeds that could germinate. While that was just, 2,000 years old seed, those of the new Russian Campion flower are a whopping 30,000 years old.

The seeds of Campion from the time of last Ice Age were found when the permafrost in the Northern Siberia thawed due to the warming effects of the climate change. As the snow melted away, archaeologist could find Pleistocene – last Ice Age – human settlements along the banks of the lower Kolyma River in northeastern Siberia. About 30,000 years ago, during the last Ice Age this region was arid grasslands, known by palaeontologists as the 'mammoth steppe', populated by mammoths, woolly rhinoceros, and long-horned bison. This unique ecosystem, which has no contemporary counterpart, vanished about 13,000 years ago, when the Ice Age gave way to inter-glacial period.

While excavating in this region, archaeologists stumbled onto more than 70 squirrel hibernation burrows. The burrows were well stocked; there were more than 600,000 to 800,000 seeds in each of these fossil burrows. During the last Ice Age, Arctic ground squirrels that foraged this bleak treeless tundra had stashed these seeds into the burrows for meeting the needs of the harsh winter. When examined with powerful microscope, scientists were able to confirm that these seeds were actually mix of fruits of Campion, sedge, Arctic dock, and alpine bearberry – all plants still growing in the region today. Accelerator mass spectrometry (AMS) radiocarbon dating showed these fruits and seeds to be 31,800 ± 300 years old.



Fossil burrows along Kolyma River

Resurrected 30,000 years old plant

Covered under increasing layers of snowfall, over years, the squirrel's burrow had fossilised. Buried under a layer of 20-40 metres of ice the football-sized burrows had become frozen solid. Cemented and sealed shut by ice, these turned into tiny cryogenic freezers. The chambers also held hay and animal fur, used by snoozing rodents to snuggle into. Thus the natural giant freezer created by the permafrost essentially kept the seeds dry and at frigid minus 7 degrees Celsius. Thus, when these seeds were excavated after about 30,000 years later, they were as fresh as daisy.

Researchers had previously attempted to grow plants from these seeds; and these seeds did begin to germinate, but then faltered and died. A team led by David Gilichinsky and Svetlana Yashina tried a different trick (Svetlana Yashina *et al.*, 'Regeneration of whole fertile plants from 30,000-y-old fruit tissue buried in Siberian permafrost', *PNAS* 6 March 2012, vol. 109 no. 10; 4008-4013). Instead of trying to plant the seeds and nurturing the plant in a conventional way, they tried to use tissue culture. After carefully removing the fleshy placental tissue around the seed, they placed the tissue in a test tube. When bathed in a brew of sugars, vitamins and growth factors, roots and shoots emerged from the tissue. As these Campion plants were grown from tissue culture through micropropagation, they were genetically identical clone of the mother plant that lived about 30,000 years ago. It is as if the plant that existed 30,000 years ago had been resurrected.

The authors speculate that part of the reason they were successful with this plant placental tissue, though mature seeds were a failure, is because it has especially high levels of organic substances such as

Continued on page 20

Binode Kanungo

A school dropout teaches the masses

Binode Kanungo (1912-1990) is remembered well in Odisha as the creator of the most comprehensive encyclopaedia in Odia language. The single-handed project initiated in the early 1950's planned for a 75-volume encyclopedia – *Jnanmandal* (Circle of Knowledge) - to be written in simple language for general readers. Although the project could not be completed in Binode babu's life time, nor afterwards, even in its shortened form, it remains witness to the determination of the man as well as to his lucid style of presentation, especially of science subjects. He termed his style of presentation *sukhapathya* or easy-reading as opposed to the more commonly used *janapriya* or popular. In keeping with his socio-political philosophy, he called his writing efforts as *loksahitya* aimed at the democratisation of knowledge. As he wrote later, the inspiration for this came from 'Gandhi Sahitya' - the lucid writings of Gandhiji who could write on a wide range of topics and address these to a 'labourer or the Viceroy' with equal ease. Hidden in the glow of *Jnanmadal* are Binode babu's other contribution in the fields of children's literature and mass education. For children he brought out a magazine, writing much of its contents and several short books on science and other subjects. Two of his books are autobiographical in nature and provide an insight to his life and thoughts as well as glimpses of contemporary events and personalities.

But the most important aspect of this prolific writer is his personal and educational background - he never completed his high school studies and spent his prime years, 18 to 32 (1930-1944), in and out of imprisonment. Having joined the freedom movement at that tender age his mind was moulded through association with people of high ideals. This included Gandhiji from up close. He also spent his time in jail to enhance his knowledge through voracious reading and honed his natural writing skills by maintaining copious 'prison diaries'. His education was further refined during the free interludes outside the jail by working as a newspaper reporter and feature writer. In this centenary year of Binode Kanungo's birth, it is important to explore his work both to draw inspiration from it as well as to find guidance for the present science communication efforts.

Childhood

Binode Kanungo was born on the 6 June 1912 in the village Mallipur, about 30 kilometres from Cuttack, then an emerging centre for Odia nationalism as well as the freedom movement activities in Odisha. He was the youngest of four surviving children having followed three elder sisters. His father Keshab was a landed gentry and mother Peera Devi came from an educated family and could read both Odia and Bengali. The family was reasonably well off at the time of Binode's birth, but fell on hard times shortly afterwards. It was a difficult period for the family and the mother was worried about Binode's future. Fortunately her brother Artaballabh Mohanty, a renowned Professor of Sanskrit and an important figure in the field of Odia literature, made sure that Binode went to 'school' at the age of four. The school being the traditional village *chatasali* under a single teacher who was the most revered person in the village. This early education consisted mostly of basic writing, arithmetic, lyrics and the epics, and for Binode it continued till 1917. Mother's bold decision helped Binode again. She arranged to send him to live with his uncle, Prof. Mohanty's family and pursue his primary schooling at their village Naganpur.

Binode Kanungo at work in the Jnanmandal Office

Early education

Benode continued his studies at Naganpur till late 1922 after which he came to Cuttack and lived with his uncle on the campus of Ravenshaw College. There was no good middle school near the college for Binode to join, so he sort of hung around the uncle's house for a few years. But this turned out to be an important learning experience as well. Ravenshaw College was the hub of higher learning in Odisha and its campus saw the footfall of many important persons from all walks of life. Young Binode met many of them and being outgoing and inquisitive he got to know them more than casually. He became dear 'Bina' to many of them. Secondly, Prof. Mohanty had founded the Prachi Samity at that time to trace and preserve early Odia literary works existing mostly as palm leaf manuscripts and to prepare authentic versions of these for printing. This involved reading out the calligraphic stylus impressions from different copies of any work and weeding out the errors which crept in during the hand copying of the manuscripts. Binode being an active and interested member of this team - he had 'nothing else to do' - became familiar with the Odia language and literature from that early age.

Back in school and out

Some professors of the Ravenshaw College, including the noted academician Pranakrushna Parija, were teaching the campus children in their spare time. They took the initiative to start a formal school for this purpose. As a result a middle school was started on 11 February 1926 at Ranihat near the college campus. Binode joined this school to continue his formal studies and passed the 'minor' common examination in 1927 with a scholarship. Binode Kanungo then joined the Ravenshaw Collegiate, the oldest and most famous high school in the state, in January 1928 for his secondary schooling. Studies at the Collegiate went on smoothly and Binode entered class X in January 1930. He was to sit for the matriculation examination the next year.

But other events intervened to give an unexpected and irretraceable turn to his life. During the past few years Binode had come in contact with senior students and young men active in the freedom movement. He had on many occasions listened to their animated discussions and found himself deeply excited about the cause. The civil disobedience movement soon gathered momentum and the final moment for Binode came on the 10 April 1930. He jumped the school gate

along with a few friends and joined the *satyagrahis*. He was expelled from the school the next day. He not only left his school but he lost his home too, as he did not want to go back to his uncle's house. He stayed with the Congress workers and continued with the nationalist activities.

Another break came his way when the senior workers were arrested and sent to prison. Youngsters like Binode first took to reading out written speeches at public meetings and then to improvise on their own. They also took the responsibility of circulating an underground newspaper for which they started writing too. And for Binode this was the beginning of a life of communication with the masses.

New schooling

About eight months after leaving school Binode got arrested on 16 November 1930 and was sent to the camp jail at Patna housing five thousand persons. In a way this brought a degree of stability into his life as he was constrained physically and had to abide by the jail routine. The seniors also encouraged the youngsters to study. Development of language skills was stressed upon and most of them started learning Hindi and English. Many books available with the seniors were circulated freely and help in understanding them was available willingly. Reading aloud in groups followed by discussion was very helpful for developing speaking skills. Experienced workers would speak on different topics touching upon the problems facing the nation and its people.

A particular theme that struck Binode was how the British became the rulers of India and how they exploited the country systematically. Not only did they destroy the native economics, they also manipulated the text books with distorted history to make the 'educated' Indians feel inferior to the Europeans. An impression was created that the Indian languages are not suitable for expressing ideas of science and other modern areas of knowledge. The idea of writing in the language of the land was planted in his mind.

Learning in the field

Binode was released in March 1931, but was arrested again in early 1932. The political atmosphere remained volatile for some time and like most active workers Binode was in and out of jail several times till early 1934. In 1934 he and a few friends decided to give up agitational activities and take to constructive work. Accordingly they went to the Champapur Ashram of Pandit Gobind Chandra Mishra, the first Odia to have visited Gandhiji at Sabarmati and to have set up the ashram at Gandhiji's suggestion, to learn about *khadi*. 1934 proved to be even more meaningful for Binode, now a 22-year old youth with some experience. Gandhiji visited Odisha in May that year. After reaching Puri by motor vehicle and train, he had decided to proceed on foot. Binode joined Gandhiji's trek both as a reporter for the *Samaj*, the only Odia daily of that time, and as a senior volunteer to control the crowd around Gandhiji. This brought him into close contact with Gandhiji and many other leading personalities of the time. Just being with Gandhiji and the others for over a month was an unforgettable experience. Listening to them and watching how they interacted with the masses was an education no school could impart. Binode spent the time between 1934 and 1938 at the Sarvodaya Ashram at Bari and got involved in constructive work. His main interests were in *khadi* work and 'Adult education'. The latter had much less to do with literacy than with life skills.

Binode started interacting with the farmers, explaining about and experimenting with various aspects of compost, soil, bee keeping, cattle rearing, soap making, public health, and other social issues. He tried to learn more about the science and philosophy behind the work he was doing. For example, his agricultural activities led him to learn about soil organisms and chemistry; honey extraction introduced him to the physics concepts like centrifugal force. Also enhancing his education during this period were the numerous visitors from all over India that came here. But by the middle of 1938 he was feeling the need for a wider sphere to speed up his academic growth. 1939 brought uneasiness about war breaking out in Europe and the resulting developments in the Indian political situation affected all freedom workers.

From field to desk

So when the war finally started Binode came back to Cuttack and started writing for the *Samaj* on war matters. After a short while he became a member of its editorial team and earned a monthly salary of thirty rupees. Since detailed information about the war was not readily available, the newspaper printed a lot of background material to keep its readers interested and this again gave him a chance to read widely and present the distilled information in a simplified manner. One of Binode's more popular articles was about tanks. Titled *louha danaba* (Iron monster) the 1940 article explained the workings of the machine as well as the role it might play in influencing the course of war. It became so popular that he went on to write about other important weapons. All these were brought together in a book titled *Saptastra* (Seven armaments) and Binode Kanungo joined the world of authors and earned royalty for his work. Also in 1940 he married Sashibala. To the prison school again, India was in a state of political turmoil by 1942 and Binode Kanungo left his job at the *Samaj* to join the new movement.

Finally, the Quit India movement started and as a leading worker he was arrested and held as a 'security prisoner' at the Berhampur jail. Their detention was for an unspecified period and some had thought that it might run for many years. This gave Binode Kanungo a new determination to continue his studies. And he chose to focus on science this time – a subject he had little exposure to so far. His first chance came from an illness when the attending prison physician admonished him for not taking care of his own body. "What do I know about my body to take care of it?" responded Binode. The doctor gave him some medical books to study and set him on a new course of learning. A few of the fellow detainees were doctors or medical students who became ready tutors for the learners. Together they attacked the *Grey's Anatomy* and *Halibotton's Physiology*.

Need to understand concepts like osmosis or metabolism led to supplementary learning in physics and chemistry. With unlimited time on hand and with no restriction on the procurement of books from outside Binode Kanungo made a serious effort at learning the basics of science. Lack of paper for writing was a problem. He had to scrounge around for scrap paper to write on. So innovations were made to overcome it. Writing in very small letters, writing between lines of printed paper, etc., were some of these. It may remind one of Srinivasa Ramanujan, some forty years earlier, picking up packing paper from the markets in Madras and writing with ink of a

different colour on his old writings.

Binode Kanungo's notes ran into thousands of pages and it was fortunate that the jail authorities permitted him to take these away upon his release. An interesting part of this education in the jail was the 'practical' lesson on anatomy. The prison received meat from outside for the inmates. A proposal was made to the authorities that they be supplied with the entire carcass of a goat which they would dissect and explore before using the meat for food. And this was done some eight or ten times.

A new life

Studies in the jail came to an end after more than eighteen months, in July 1944. Binode Kanungo, now 32 and with a family, had found new confidence with his knowledge and was planning to write about 500 short books that would be adequate to make a common man 'educated'. When the war ended a year later, Binode Kanungo decided to take up his commitment to Gandhiji to do *'samagra gram seva'* in his own village and do his writing. Independence came; Gandhiji was assassinated; and many other things changed. Binode Kanungo entered the fray in the first general election in 1952 for an assembly seat and lost. This was his only brief brush with active politics. By 1953 he realised that the political and administrative atmosphere in the country was no longer conducive for 'Gandhi work' in the field. Yet he thought that he could continue such work through his writing efforts, which would be an extension of Gandhiji's '*Lokshikhsa*'. By now he had already written a few books like '*Air*', '*Pisciculture*', '*What is a Vote*' and these had been received well. Then the idea of producing an encyclopaedia struck him. But after looking through the existing encyclopaedias in English and Indian languages he realised the magnitude of the problem. He was familiar with the problems encountered in the publication of *The Purnachandra Odia Bhashakosha*, a voluminous Odia lexicon compiled by Gopal Chandra Praharaj in the 1930's. Still it inspired him as well – if Praharaj produced a word dictionary, he would work towards a knowledge dictionary (*Jnan Abhidhan*).

The encyclopaedia

In early 1954 he moved back to Cuttack with the idea of encyclopaedia writing in mind and the venture capital in his pocket - the whole of one rupee! Years were spent in planning out the contents of the encyclopedia and in reading for it. Much time and energy went into collecting reference material and sorting and storing these in proper order for easy retrieval. The encyclopaedia was named *Jnanmandal* and was to be published in 75 volumes. It was only in mid-1959 that the preparation of the manuscript started and the first volume was released on 2 December 1960. Later on it was scaled down to 50 volumes, and only 40 of these, consisting of about 8,000 pages, could be published between 1960 and 1987. The entries covered were up to the Odia letter '*Ja*' (19th out of 46 letters). In all there was a little over 4,000 entries of which geographical ones accounted for almost half; 374 were scientific and 720 biographical. Nearly 150 entries were long articles running into 9 pages or more. He also brought out a shorter encyclopaedia for children, *Shishu Jnanmandal* in two volumes, in 1988.

Encyclopedia for general readers Jnanmandal (left) and for children Shishu Jnanmandal (right)

Other publications

While developing the idea of the encyclopaedia Binode babu did not lose sight of his earlier idea of producing short and easy readers. A scheme he would later call '500 letters in my alphabet' (*Mo Barnabodhare Panchasaha Akshara*) referring to the 500 titles, 365 of which would be on science topics and the rest on social sciences and personalities. The first of these appeared in 1954 and was titled the 'endless river in a moving land' (*Chalanti Raijara Amunha Nai*). Presented in a storytelling style, it dealt with the circulation of blood in an endless loop within a living (moving) body. The titles of the books in this series were really attractive. About 25 such titles were published till 1984. Some of the others were the 'Hearth that will not die' (Sun), '600 engines for 200 vehicles' (muscles), 'Conquering the sea' (Salt movement), 'Pack your things' (Freedom movement), 'How one became many' (agriculture). Some of these titles were also rendered in Hindi by the author himself. He also started a children's magazine *'Shishu Sampada'* in 1954 and wrote most of the contents himself. His objective in this was to 'satisfy the knowledge-hunger of the Odia children by providing 'knowledge-food' for them.' The articles were well illustrated and entertaining, a majority being on science topics. The magazine, however, could not be published in a timely manner because of the pressure of the encyclopaedia work, but survived into the 1970's with occasional issues. '500 letters in my alphabet' a series of short books with fascinating titles and contents.

500 letters in my alphabet: a series of short books with facinating titles and contents

Active till the end

Binode babu was a gregarious and affable person. Doors to his *Jnanmandal* office were open to all. During the 1960's he used to bring the *Jnanmandal* volumes to the subscribers' houses and never left in a hurry. This and the vast sea of facts at the tip of his tongue earned him the sobriquet *'Chalanti Jnanmandal'* (The moving encyclopaedia). He was honoured with 'Padmashree' in 1986 by Government of India and the Films Division prepared a documentary on him around this time.

Always willing to join hands with any new programme, Benode Kanungo became the patron of the Bharat Jan Vigyan Jatha (BJVJ, 1987) in Odisha and donated a large number of his books to be used in the programme. He continued his writing activities till the end came on 22 June 1990.

Presentation by: Nikhil Mohan Pattnaik, with inputs from Srujanika team.

Peter Okebukola:
A crusader for science

Biman Basu
E-mail: bimanbasu@gmail.com

Born in 1951, Professor Peter Okebukola is the winner of the prestigious 1992 Kalinga Prize for science popularisation. (He shared the Prize with Jorge Flores Valdés of Mexico.) He had specialised training at the Massachusetts Institute of Technology (MIT), and Harvard University. He now specialises in quality assurance in education systems, science, computer and environmental education. He is the President of the Global University Network for Innovation GUNI-Africa. He is also the African Representative and Member of the Board of Directors of the International Council of Associations for Science Education. He is a Fellow and Past President of the Science Teachers Association of Nigeria as well as of the National Association for Environmental Education. He was Dean of Education, Deputy Vice-Chancellor and Acting Vice-Chancellor of Lagos State University, Director of the University's Centre for Environment and Science Education, and Visiting Professor at the Curtin University of Technology, Perth, Australia.

Till recently Prof. Okebukola was the Executive Secretary of the National Universities Commission (NUC) of Nigeria and has superintended over quality assurance of the 75 universities in the country. He served as Consultant to the African Quality Rating Mechanism, an initiative of the African Union to improve the quality of higher education in Africa through quality self-rating. He has won several international gold medals in science and computer education.

Prof. Okebukola was in Bhubaneswar to attend the International Conference for Celebration of the 60th Anniversary of UNESCO Kalinga Prize for Popularisation of Science held on 5-6 January 2012. In Bhubaneswar, Biman Basu spoke to him on various topics relating to science education and popularisation of science. Here are excerpts of the interview.

Biman Basu: Prof. Okebukola, you started your career at a very young age of 19 as a school teacher in Lagos. What made you take up this particular profession of science popularisation and succeed so well?

Peter Okebukola: My interest in science developed after I joined the secondary school. I went to the chemistry lab and I saw students mix one colourless liquid with another and the mixture turned blue! They poured the colourless liquid into another and it turned red! It was like magic! I was greatly excited, and I became interested in science. I got inspiration from my father.

Prof. Peter Okebukola (Photo: Biman Basu)

I think that science is important for humanity. It helps one to develop objectivity and have a rational attitude of mind. In fact, science is so important that we should let everybody be scientifically literate. So I have a goal in life – to pursue science and technology education.

BB: You had some specialised training at MIT and Harvard. In which areas did you receive training there?

PO: I received specialised training at the two institutions in higher education because I looked at higher education as a resource centre for my country Nigeria. If we could give our people the right resource, the right education, then only there could be development and people would get the benefits of science. So I focussed at the Ministry level on science in higher education and I'm happy to say that I have been able to apply the knowledge skills that are available in promoting science and technology development at the higher education level in Nigeria.

BB: Your research efforts cover several areas – higher education, computers in education and e-learning, co-operative learning, metacognitive strategies in science education, environmental education, and eco-cultural influences on the learning of science concepts. How do you define eco-cultural influences on the learning of science concepts?

PO: What I mean is that learning of science – the manner in which you learn science – is livelihood and culture dependent. Eco is ecology and culture is culture. For example, we have African culture, Indian culture, and so on. Eco-cultural implies the way science is learnt in a cultural context. The African child, for instance, learns science in a cultural ambience different from that in India. My studies over the years have shown that if you want your students to learn science better and to develop knowledge applications of science, you have got to take it as part of your culture.

As you know the African society is largely superstitious – lots of taboos, lots of cultural practices that impede the spread of science. So you have to bring in science in a way that the traditional beliefs and practices do not become an obstacle. You have to persevere to deliver science in the classrooms. This is what I call eco-cultural influences in the learning of science.

BB: In many societies these taboos and superstitions are held very close to their tradition and when we try to tell them about the scientific facts many are not willing to believe us. Do you find a similar situation in Nigeria?

PO: Yes, the situation is the same in Nigeria. When such taboos and cultural

practices are ingrained in an individual they are very difficult to uproot; they remain almost forever. That is why in teaching science we call upon the teachers to let teaching of basic science done in a way that does not allow such bad cultural practices, taboos and superstitions to thrive, because as soon as these taboos and superstitions emerge in the system or individual, science can help remove them. So before the student gets into the habit of believing in these taboos and superstitions science helps them in understanding and rejecting them. If taboos come first they are difficult to remove, but if science comes first taboos and superstitions are easier to fight.

BB: Don't you think that if we catch them young; that is, if we start explaining these things to them right from their childhood they will grow up not burdened by taboos and superstitions?

PO: Oh, yes. You're right. And that's what we're trying to do. But it is not easy to fight superstition because of the intensity of brainwashing, and also fear. But I tell you, about 90 per cent of the system would be in favour of science and only 10 per cent would be supporting taboos.

BB: What do you consider is the best medium for popularising science?

PO: The best medium, definitely, is the radio. Let me tell you, TV is a powerful medium and is widely used around the world, especially in the developed countries. But in Africa majority of the population do not have access to TV. But they can be reached by the radio. Radio can be on the move because it uses battery. You can carry it on a bicycle. Radio can broadcast programmes in the local languages, which is not always possible with TV. We conducted a study on which media will work in Africa, which confirmed that the radio was the most popular and effective of the media for popularising science in villages.

BB: What language is mostly used in Nigeria for science popularisation?

PO: The official language is English, but because of the largely different populations we have three major languages – Hausa in the North, Yoruba in the West, and Igbo in the East. These are the three major blocks that cover almost the entire population of Nigeria.

BB: But how do you manage to convey scientific matter in these languages which may not be having any script?

PO: Our national policy is that, in the early years of education, up to the age of nine, teaching of all subjects is done in the local language. So we have the equivalents of the English words in science in the local languages. We use this vocabulary of science in local languages for science programmes on the radio.

BB: You've mentioned that after winning the Kalinga Prize in 1992 you have started this campaign in popularising science with great vigour and lots of new activities have started since then. One activity you mentioned is that of sending SMSs to mobile phones. How do you go about?

PO: We send SMSs to mobile phones carrying very short messages in science – about environment; about pollution; about resource use; about issues related to climate change; about the condition of our globe; about malaria; about AIDS – very short messages that can be read in English and in the local languages. I tell you, it's a very important medium because, even more than the radio, you can receive it anywhere.

BB: Is there a way of interaction also? For example, after one receives a message if he or she has a question to clarify.

PO: Unfortunately no, because it is a one-way communication.

BB: You do a science programme on radio every week. What kind of topics you select for these programmes?

PO: We have programmes on agriculture, on health, on environment, and we also have science quiz. We reach about 40 million listeners every week and I am the chairman of the quiz bureau. It is actually a programme that I chair, supported by the Science Teachers' Association of Nigeria and some other agencies.

BB: Have these programmes brought about any measurable change in the science literacy or general awareness about science in Nigeria?

PO: Unfortunately, we do not have any empirical data. But from the feedback I receive from people at the airport, in the market place, and elsewhere I can say the programmes are quite popular.

BB: Thank you Prof. Okebukola for sparing your valuable time. I wish you all success in your crusade to remove superstitions and bring science to the people of Africa.

PO: Thank you very much.

Letters to the editor

Excellent article on zero

I am a primary teacher in Junagadh, Gujarat. I have been reading *Dream 2047* regularly for the last four years. When the magazine is in my hand in the beginning of the month I feel very happy. In last issue (May 2012), I read the article about zero. It was wonderful. My students and I had big questions about the history of zero, for which we could not find the answers. But after reading your article we found the answer to our questions. So we all are very thankful to you for publishing the excellent article on zero.

Praful M. Ravaliya
Junagadh, Gujarat

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David Hilbert

It was really a pleasure to read about David Hilbert in April issue of *Dream 2047*. Being a teacher of physics with specialisation in theoretical physics I know about Hilbert Space, but his contributions to other sections came to light from Dr. Mahanti's article. Also, it was interesting to learn that Harish-Chandra did his PhD under PAM Dirac. I do agree that to explain nature, physics demands its own set of mathematics. Harish-Chandra probably did not like Dirac for this argument, but the wonderful contribution of Dirac to physics will always be remembered.

Leeladhar Chouhan
Assistant Professor, Deptt.of Physics
BB Engineering College
Kokrajhar, Assam

*****

Maths and plants

I very much enjoyed reading the article 'The Story of Zero' and also the one on medicinal plants. It will help me write articles in Tamil, particularly on mathematicians and their maths. I congratulate all concerned with *Dream 2047*.

A.C.S. Mani. (Tamil Nadu)
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*****

Amoebiasis:

All you wanted to know about

Dr Yatish Agarwal
e-mail: dryatish@yahoo.com

> *"I have found it to be the most serious objection to coarse labours long continued, that they also compelled me to eat and drink coarsely."*
>
> –Henry David Thoreau in Walden, "Higher Laws"

Amoebiasis is a common tummy-wrench in this part of the world. Usually, the infection results from drinking water or eating food contaminated with the microscopic single-celled parasite *Entamoeba histolytica*. If you are careless about eating at such coarse places where little attention is paid to personal hygiene, you run the highest risk. The parasite is excreted in the faeces of infected people.

Amoebiasis is an infection of the gut. Worldwide, the disease is very common, affecting about 500 million people. It is mostly contracted in developing countries in the tropics, where many people live in pitiable conditions. A large number of people – up to 20 per cent – who dwell in areas with poor sanitation and hygiene have some form of parasite within their intestine, but may not have any symptoms. Such people usually do not suffer from a serious harm but remain infective and can pass the parasite to others. The disease occurs when a food infected with the protozoa is eaten or swallowed.

The disease can progress to *amoebic dysentery* in the wide, lower part of the intestine and may spread to cause severe damage to the intestine. In such severe cases, ulcers may develop in the walls of the intestine. The parasitic protozoa may also spread to other parts of the body through the bloodstream and produce amoebic abscesses in the liver, lungs, and brain and elsewhere in the body.

Symptoms

Depending upon the severity and the seat of the disease, amoebiasis can present with a wide variety of symptoms:

Amoebiasis

Once a person gets infected, amoebae persist in the intestine for months or years and, although there may be no symptoms for a long time, it is still possible to develop illness many years later. Around one in ten people infected with amoebiasis become ill from the disease. The symptoms are not usually severe and may be mistaken for diarrhoea. They include:

- Loose stools or diarrhoea,
- Mild stomach pain,
- Stomach cramps,
- Change in bowel habits and a feeling of incomplete evacuation, and
- Loss of weight and low grade fever.

This may occur later in the course of infection. Recurrence of amoebiasis is a fairly common phenomenon.

Amoebic dysentery

Amoebic dysentery is a severe form of amoebiasis. The symptoms usually first appear between five days and several weeks after the initial infection, and may include:

- Blood and mucus in the stools,
- Severe stomach pain, and
- High temperature or fever

Liver abscess

Rarely, the infection invades the liver and causes an abscess. Even less commonly, it spreads to other parts of the body, such as the lungs or brain. If the disease has caused liver abscesses, there will be:

- High fever,
- Weakness and extreme tiredness,
- Pain in the right upper portion of the stomach,
- Nausea, and
- Loss of appetite

Sometimes an abscess may burst upwards through the diaphragm into the lung and the contents can be coughed up. Symptoms usually develop one to four weeks after infection.

Causes

Amoebiasis is caused by a single-cell parasite *Entamoeba histolytica*. The parasite burrows into the wall of the intestine to cause small abscesses and ulcers. From there they enter the veins of the intestine and are carried to the liver. If they reach the liver in large numbers, they may cause large abscesses full of chocolate-brown pus consisting of broken-down liver tissue.

Amoebiasis occurs when a person eats or swallows a food article that has been infected with the *Entamoeba histolytica* parasite. It is especially common in areas where sanitation and personal hygiene conditions are poor, and human excrement is used as fertiliser.

Amoebic dysentery can also be spread by anal sex or directly from person to person when personal hygiene is poor.

Infection is most commonly caused by:

- Eating or swallowing anything that has touched the stool of a person who is infected with *Entamoeba histolytica*,
- Swallowing something, such as water or food, that is contaminated with *Entamoeba histolytica*, or
- Touching, and bringing to your mouth, cysts (eggs) picked up from surfaces that are contaminated with *Entamoeba histolytica*.

Diagnosis

Mild amoebiasis can often go undiagnosed, as it is passed off as a stomach upset or bout of diarrhoea. If your doctor or GP suspects amoebiasis, they may ask you to provide several stool samples, over a period of a few days. This is then viewed under a microscope to look for the *Entamoeba histolytica* parasite.

It is possible to misdiagnose amoebiasis, as the *Entamoeba histolytica* parasite looks very similar to a minor parasite called *Entamoeba dispar*. This is a common infection that does not require treatment. However, sometimes your doctor may presume that the *histolytica* parasite is present and give you treatment to be on the safe side.

If your doctor thinks that the infection may have spread beyond the wall of your intestine, you may need a blood test to confirm the diagnosis. Diagnosis is confirmed by detection of antibodies against the *Entamoeba histolytica* parasite in serum. However, blood tests are not common practice, as they may show a positive result if you have had the infection in the past.

Your doctor may also decide to perform an endoscopy. During this procedure, a flexible instrument with its own light, called an endoscope, is passed in through the anus. Your doctor is then able to see the walls of your large intestine more clearly on a screen.

You doctor may also advise you to undergo an ultrasound examination of the abdomen, particularly if a liver abscess is suspected. Rarely, a computed tomographic (CT) examination of the abdomen may also be necessary if the liver abscess is atypical or has ruptured into the chest or abdomen.

Treatment

Amoebiasis is usually treated with a course of anti-amoebic pills. The most common anti-amoebic used for this condition is metronidazole. The standard dose is 400–800mg tablets, three times a day for between seven and ten days.

Other anti-amoebic pills used include tinidazole 800mg tablets, three times daily for five days. You must avoid alcohol altogether when taking anti-amoebic pills.

Children and pregnant women

Children are usually prescribed much smaller doses. Pregnant women should inform their doctor of their physical condition and generally avoid taking anti-amoebic pills unless the condition is threatening the long-term health of the mother or baby and the doctor feels there is no other way out.

Managing amoebic liver abscess

If you develop an amoebic liver abscess and have not responded well to anti-amoebic treatment after seven days, or there is a high risk that the abscess may rupture, your doctor may suggest a small operation to drain the abscess. This will involve drawing out the pus with a syringe under ultrasound guidance or placing a small rubber tube called a catheter in the abscess to drain out the fluid.

Surgery

In very rare cases, when there are serious complications such as peritonitis, surgery may be necessary to help the doctor understand more fully what is happening inside the abdomen.

Prevention

Amoebiasis can be prevented by good hygiene and sanitary conditions. This is an enormous challenge for people living in poor conditions, where there is poor or no access to fresh safe water and disinfectant.

Stick to safe water

In most areas of the country, the public water source has a high risk of contamination by the *Entamoeba histolytica* parasite. Hence, it is best not to use tap water drawn from municipal supply for drinking. Instead:

- Drink only safe bottled or boiled (for 10 minutes) water. Or carbonated (bubbly) drinks from sealed cans or bottles.
- Use only perfect ice that's been created from a safe water source. Do not have ice or ice-lollies (*barf ga golla*), with questionable safety. Do not partake of ice served by street vendors in "*nimbu-paani*" or soft drinks.
- While travelling, make water safe by filtering it through an 'absolute one micron or less' filter and dissolving iodine tablets in the filtered water. Absolute 1-micron filters can be found in camping/outdoor supply stores.

Observe good personal hygiene

- The risk of spreading the infection is greatly reduced by getting treatment as quickly as possible after infection and practicing good hygiene. In particular, this means regular hand washing with soap and water, after using the toilet, and before handling food.
- Keep the utensils you cook in and the cutlery and the crockery clean.
- Replace kitchen sponges often and wash and wipe clean crockery before use.
- Avoid food that may have been exposed to flies, rats, mice or dust.

Keep away from wayside eateries

- Do not eat or drink anything sold by street vendors, except sealed bottled or canned drinks.
- Avoid eating at wayside restaurants and *dhabas*.
- Do not eat fresh fruit or vegetables that you did not peel yourself.
- Do not eat or drink milk, cheese, or dairy products that may not have been pasteurised.

Clean energy options and nuclear safety
Celebration of National Science Day 2012

Vigyan Prasar organised National Science Day programme in collaboration with National Science Centre, New Delhi at National Science Centre, New Delhi on February 28 and 29, 2012 with the focal theme "Clean Energy Options and Nuclear Safety". Students, teachers, and science communicators participated in the programme.

Special lectures by invited speakers Dr. Amit Roy, Director, Inter-University Accelerator Centre, New Delhi and Dr. R.K. Shivpuri, Scientific Advisor, University of Delhi, along with sessions on interaction with scientists on nuclear radiation, nuclear energy and sustainable development were organised to highlight the energy crisis and need for clean energy options in coming years. As a part of this programme Vigyan Prasar organised a national-level Essay Writing, Slogan Writing and Poster Making Competition on the theme 'Clean Energy Options – Nuclear Energy and Nuclear Safety'.

Dr. Amit Roy gave popular lecture on "Nuclear Radiation – Bane or Boon" in which he talked about different types of radiation and their sources and highlighted the benefits and applications of nuclear radiation. He said the penetrating and ionising power of nuclear radiations makes them useful for a wide range of applications.

Dr. R.K. Shivpuri gave a popular lecture on "Nuclear Energy and sustainable development" in which he discussed the need to harness nuclear energy and challenges in the way to harness it. He said an important need is to manage energy and environment in a sustainable way. Sustainable development is not a matter of choice but a necessity. Nuclear energy is and will be part of the solution.

Students from all over the country enthusiastically participated in the essay and slogan competitions on the topic "Clean energy options: Nuclear energy and nuclear safety". Vigyan Prasar received nearly 300 entries in essay competition and nearly 350 entries in slogan competition from various parts of the country. On-the-spot poster making competition was held during the programme.

The essays received contained a wide range of opinions on nuclear energy as a clean, safe and reliable source of energy, especially in view of concerns about climate change and global warming, as it does not emit carbon and toxic gases.

The Slogan competition, organised at national level, also attracted young students from all over the country, and exciting slogans were prepared by the participants. These slogans are: (1) *"Parmanu urja aisa raaz, Swachchh vishvashneeya surakshit kaaz"*; (2) *"Sthayee urja, sthayee vikas"*; (3) *"Spare the oil, split the atom"*; (4) *"Ham sabne ye jana hai, unnat nabhikeeya paddhati apnana hai"*; (5) *"Naabhikeeya urja – Vikalp na dooja"*; (6) *Bhavishya hoga ujjval aur charon dishaon ke prakash, jab parmanu urja kee sanskriti ka ham milkar karenge vikas"* Similar enthusiasm was found among the participants of Poster making competition, who expressed their views on the theme of "Clean energy and nuclear safety" through colours.

Kinkini Dasgupta Mishra and Nimish Kapoor ■

Launch of Science@Mobile

VP has launched an innovative scheme of popularising science through mobile devices named 'Science@mobile' on National Science Day. It is a joint project of Vigyan Prasar with National Centre for Innovation in Distance Education (NCIDE) of Indira Gandhi National Open University (IGNOU). One can register free to get interesting and informative science SMS in his/her mobile.

Dr. Amit Roy, Director, Inter-University Accelerator Centre formally launched Science@Mobile service. Present in the occasion were Prof. M. Aslam, Vice Chancellor, IGNOU; Dr Subodh Mahanti, Honorary Director, VP; Dr. C. K. Ghosh, Director, NCIDE; Shri Rama Sharma, Director, National Science Centre, Delhi and Dr. O.P. Sharma, project coordinator of Science@Mobile, NCIDE. For details please log-on to www.vigyanprasar.gov.in

Dr Arvind C Rande ■

The winners

Essay competition:

Ms. Riddhi Dayal, Delhi University, New Delhi (First); Mr. Samarth Arora, Manipal Institute, Karnataka (Second); Mr. Prathamesh Kumar, IIT, New Delhi (Third); Mr. Shashank Kumar, New Delhi, Mr. Nirlesh Singh, HBTI, Kanpur, Mr. Kushagra Kamani, Thapar University, Patiala, and Mr. Sakshi Gopal Mishra, HBTI, Kanpur (Consolation Prizes).

Slogan writing competition:

Ms. Sunita Sharma, Government College of Education, Patiala (First); Mr. Kumar Jaideep, BIET, West Bengal (Second); Ms. Jaya Bharati, Ran Vijay Smarak Mahavidyalya, Bokaro (Third); Mr. Subrat Tripathi, Manipal University, Manipal and Mr. Deepak Dwivedi, OP Jindal Institute, Raigarh (Consolation Prize).

Poster making competition:

Mr. Munish Kumar, College Arts, Delhi University (First); Ms. Mini Gupta, Ramjas College, Delhi University (Second), Mr. Vishvaratan Bharati, Jamia University, New Delhi (Third); Ms. Aditi Jaitly, GGS Indrapasth University, Delhi and Mr. Anil Singh, Jamia University New Delhi (Consolation Prizes).

The winners were presented the awards by Dr Subodh Mahanti, Director, Vigyan Prasar and Shri D. Rama Sarma, Director, National Science Centre. The 1st prize carried Rs.5000 in cash; the 2nd prize, Rs.4000 in cash; and the 3rd prize carried Rs.3000 in cash. The consolation prizes carried Rs.1500 in cash each. All participants were felicitated with certificates of merit and mementos.

National Seminar on Scientific Temper and Science writing in Hindi

Vigyan Prasar (Deptt. of Science & Technology), National Institute of Science Communications and Information Resources (NISCAIR) and Mahadevi Verma Srajan Peet (Kumuon University Nainital) jointly organized a National Seminar on Scientific Temper and science writing in Hindi at Mahadevi Verma Srajan Peet, Ramgarh Nainital during 26-27 March 2012. This Seminar was organized on the occasion of birthday of famous and reputed Hindi writer and poet Mahadevi Verma Ji.

To create the awareness about scientific temper among the common mass particularly in youth at local level, it was decide in the resolution passed during National seminar at Palampur (HP) and International seminar at New Delhi, that all the concern organizations will collectively organize a sensitization programmes at different parts of the country. Keeping this in mind workshop at Ramgarh, all famous Hindi writers, Science writers, Scientists, Journalists, Science teachers and student were participated for the discussion on the above issue.

Inaugural session of the seminar was started on, 26 March 2012, with the welcome address of Professor Laxman Singh Bist 'Batrohi' Director, Mahadevi Verma Srajan Peet, Ramgarh, Nanital (UT). In his speech, he said " we could only imagine a society with full of scientific attitude until and unless we do not present science scientifically, logically, and trustworthy".

Dr. S. Mahanti, Director VP, focused on Scientific temper and said that" talking about science is on thing and spreading scientific messages among common man is another. Further he emphasized that science start with curiosity and with this human being discovered various mysteries of the nature. This in result gave a birth the method of science whose foundation is experiments, hypothesis and research. Discovery of science is a continuous process in which new truth are always welcomed.

Talking on *scientific temper how & Why,* Shri Gauhar Raja, Scientist and Head, NISCAIR said "scientific temper is the part of our traditions. We made our constitution by selecting good thoughts from all the important traditions. If we do not spread scientific message in our own languages, we will not reached up to our desired goal". He also mentioned that man always been asking questions from many centuries on why & how. Why leads towards the religion and how leads to truth of science.

Senior writer, Shri Prempal Sharma expressed his concern about the scientific temper and society. He said "we have made on constitution sovereign but could not make our society till now. Today our society is divided on the basis of caste, religion, states".

Talking on scientific temper and literature, Shri Pankaj Bist, well-known writer and editor, *Samyaantar* said "science always proceed further with the experiences gain in the past". Shri Srideshwar Singh famous poet, story writer and teacher (Khateema), Shri Dinesh Karnataka, story writer and teacher (Rani Bagh), Shri Trapan Singh, story writer (Tehari), also discussed their view of the above subject.

(L-R) Prof. Laxman Singh Bist 'Batrohi'; Shri Pankaj Bist; Dr. Govind Singh Dr. Subodh Mahanti; Shri Prempal Sharma; Shri Gauhar Raja; Prof. Kavita Pandey during the inaugural session

Drawing a relation between scientific Temper and hindi journalism, Dr. Govind Singh, Head Journalism Division, Uttarakhand Open University, highlighted a major changes takes place in media after globalization. In this session various other speakers including, Shri Anil Yadav, writer social activist and principal editor Pioneers, Shri Baskher Ukreti, Main spokesperson, Danik Hindustan, Shri Prabhat Ranjan, story writer, Professor and blogger, New Delhi, Shri Rohit Joshi, web Journalist and Shri Krishna Singh Journalist (New Delhi) shared their experiences.

Prof. Kavita Pandey, Professor in Kumaun University Nanital, expressed her view on scientific temper especially in women and said "science has an inbuilt power of analyzing and reasoning of the facts. Giving equal status of women in society will also be an example of Scientific Temper". On this occasion Professor, Geeta Tiwari, Professor, Kumuon University Nanital added that science to be communicated up to grass root level of the society.

Dr. Naveen Kumar Naithani, famous story writer and science teacher express his concern on science teaching and scientific temper and said that "scientific temper may be created among the mass through educating people". In this session story writer and social activist, Shri Trapen Singh Chuhan, straightforwardly said "science and religion may not go together. Religion always maintains the past but science welcomes the present. Whenever science feel uncomfortable to answers the common question then superstition appears.

Beside the above, several participants including famous poet and teacher Shri Srideshwar, Prof. Lalit Tiwari, Shri Kapil Tripathi, Scientist,Vigyan Prasar, Shri Rahul Singh, Journalist, Prof. Gangaram Bist, Smt. Uma Johi, Gram Pradhan ,Ramgarh, shared their experiences in the different sessions.

During the seminar three books namely i) *Karama Nasha,* a collection of poems by Shri Srideshwar Singh ii) *Meri Vigyan Dairy* by Shri Devendra Mewari and iii) *Meri Priya Vigyan Kathayan* by Shri Devendra Mewari, were also released.

In concluding session of the seminar, Dr. Surjeet Singh, Scientist, NISCAIR shared his experiences gained from National Seminar at Palampur (HP) and International conference at New Delhi with the participants. Shri Devendra Mewari, science writer, Delhi told about the important of scientific awareness in area like Ramgarh, Nanital and conducted an open session on suggestions came out during the two days discussion and prepared a Ramgarh draft resolution. In last, Shri Surjeet Singh presented a vote of thanks. Vigyan Prasar is planning to organized a similar kind of seminars at different parts of the country.

Kapil Kumar Tripathi ■

Workshop and review meeting on National Mathematical Year 2012

Vigyan Prasar in association with Institute of Mathematical Sciences (IMSc) organised a three-day review and workshop during 5-7 April 2012 at IMSc, Chennai. The objective of the workshop was to review the current efforts in popularising mathematics, assess the tools and techniques being used, and propose suitable programmes for mathematics popularisation. This was part of the VP's mathematics popularisation programme during National Mathematical Year 2012. Thirty-nine mathematics educators, math-communicators, and working mathematicians participated in the workshop. Initiatives in mathematics popularisation to general public and math education at school level were presented and discussed. The workshop was inaugurated by professor R Balasubramanian, Director, IMSc. Dr T. V. Venkateshwaran, scientists 'E' and Shri Rintu Nath, scientists 'E', represented Vigyan Prasar and presented two papers.

During the workshop there was common agreement that the popular perception of mathematics is often portrayed as difficult, boring and essentially consisting of never-ending calculations. Mathematics is often seen as an activity that has little use for imagination and creativity. Therefore, to create appreciation of mathematics in the society, it was felt necessary to undertake efforts to link mathematics to everyday life and surroundings. National Mathematical Year 2012 should be seen as an opportunity to start various activities and reaching out people to create greater appreciation of mathematics throughout the country.

Mathematics popularisation should attempt to reach out to wider audiences from all strata of society; hence variety of media and strategies need to be adopted. Films, radio and television programmes, and maths festivals (*Ganit mela*) may be organised. Commissioning of columns in newspapers, and public lectures on mathematics-related topics needs to be pursued. While developing programmes for children, efforts should be made to improve the mathematical understanding through innovative methods and hands-on activities. Contribution of mathematics in art, sports, modern technology and everyday life may be highlighted. The contribution of Indian mathematicians could be highlighted with a view to bringing out the multicultural nature of mathematics as well as to see it as part of our cultural heritage. Recreational mathematics like puzzles and games may be promoted through science clubs. Folk mathematics that exists in various parts of the country could be used effectively. Efforts need to be undertaken to make apparent the connection mathematics has to people's everyday surroundings – from error corrections in computer network to use of primes numbers in cryptography (essential for secure e-banking), to mobile networks, to design of folds in satellite panels, and so on. Success stories of mathematicians including women mathematicians could be used to create positive role models.

Recommendations of the workshop and other initiatives of Vigyan Prasar towards National Mathematics Year 2012 are available at **www.vigyanprasar.gov.in**. Mathematics teachers and science communicators may register to enrol them for various activities and projects undertaken by Vigyan Prasar. ■

Continued from page 30 **(Pleistocene park plant resurrected)**

sucrose and phenolic compounds that would be expected to offer some protection against frost damage.

Yashina potted the resurrected tender Campion plants and nurtured them under controlled light and temperature. After two years the plants bloomed. She then fertilised the ancient Campion flowers with each other's pollen, and in a few months, they produced their own seeds and fruits, all viable. After a 30,000-year hiatus these tissues from the seeds could continue their family line. The first generation cultivated from seeds obtained from regenerated plants progressed through all developmental stages and had the same morphological features as parent plants.

Campion plants are still around in Siberia, but Yashina found that the ancient plants are subtly different from their modern counterparts, even those taken from the same region. Ancient plants are slower to grow roots, they produce more buds, and their flower petals were wider. Moreover flowers of the modern plants are always bisexual, whereas the ancient plants produced female flowers first, followed by bisexual flowers. This suggests that the original has a distinct phenotype, adapted to the extreme environment of the Ice Age.

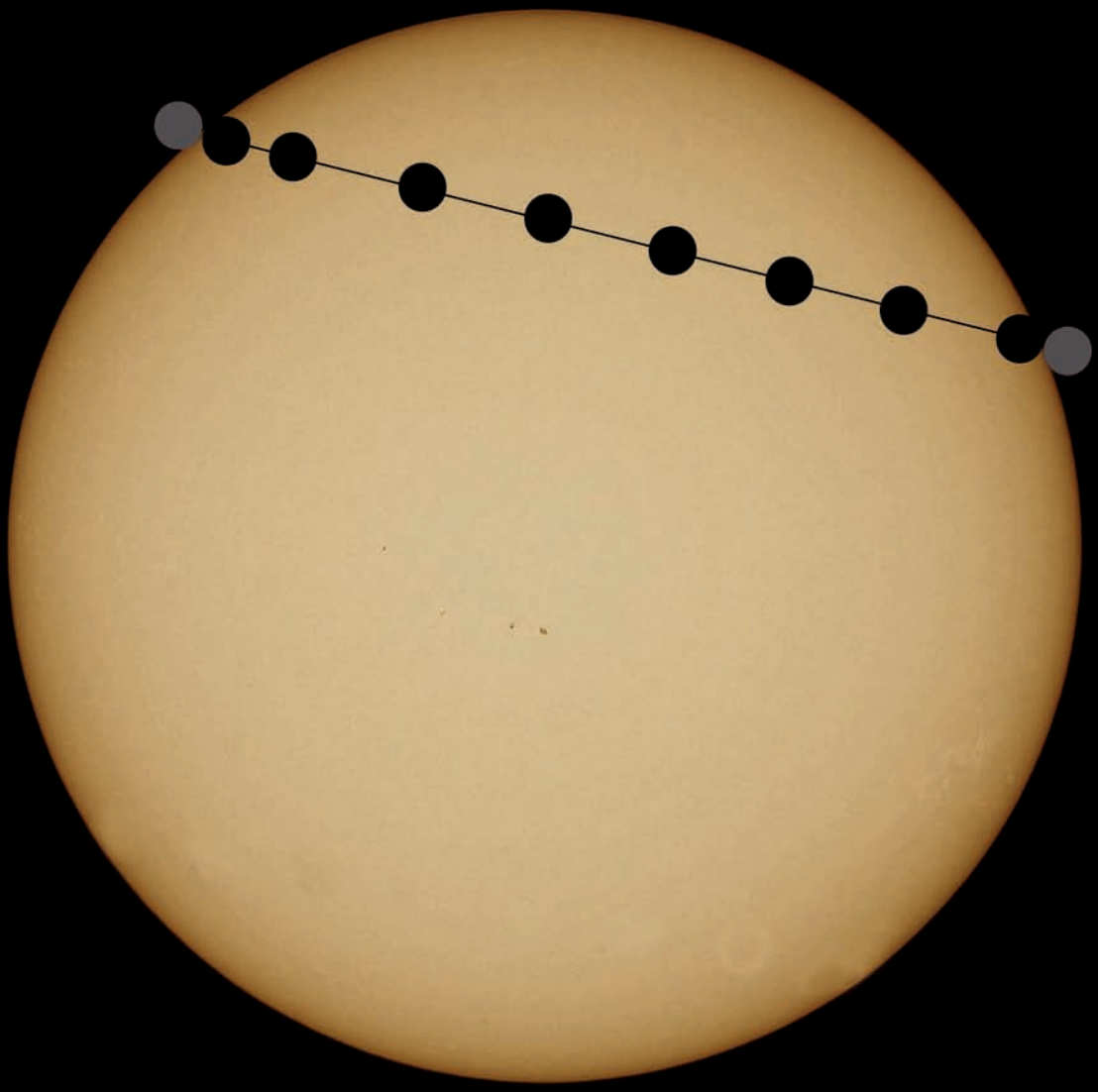
That the seeds were viable even after 30,000 years is a good news for Norway's Svalbard Global Seed Vault and other projects storing seeds to safeguard against the extinction of modern plants. More than hundred nations have contributed and about two million types of plants and vegetation that we eat are preserved in an underground cavern at ultra-low temperature under ultra-high security, in a kind of modern day frozen Noah's Ark. This study shows that we can resurrect a plant from its seeds even after many years of cryopreservation and gives a hope to recover a plant that may be lost due to some calamity. After all, freezing is basically the format for all seed conservation attempts nowadays.

Further, this natural cryopreservation of plant tissue over many thousands of years demonstrates a role for permafrost as a depository for an ancient gene pool, i.e., pre-existing life, which hypothetically has long since vanished from the Earth's surface, a potential source of ancient germplasm, and a laboratory for the study of rates of microevolution. The latest findings are a landmark in research of ancient biological material and the race to potentially revive other species, including some that are extinct. Permafrost that extends over almost fifth of the planet's land area is a vast time capsule; a place where ancient life is preserved and could speak volumes about the evolution of life on Earth. The resurrection of *Silene stenophylla* shows indeed the life kept buried in layers of snow could be revived.

Such resurrection of ancient life forms may also offer vital clues regarding microevolution; by comparing the ancient counterpart with modern day, both at the morphological and molecular level, it is possible to study the contours of evolution.

Sadly, the last author of the paper, Dr. David Gilichinsky, died just 2 days before the paper was published. ■

Transit of Venus
6 June 2012



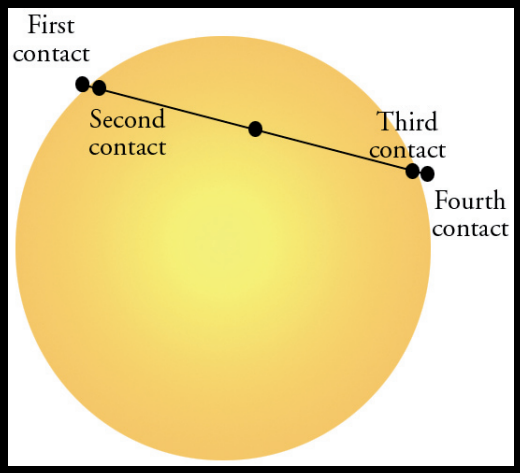
Photographs captured by Vigyan Prasar during last transit (8 June 2004)

First contact | Second contact | The Black drop effect | Transit in progress | Third contact (as seen through cloud cover)

Transit of Venus – the rarest astronomical event

The world will have an opportunity to see one of the rarest astronomical events on 6 June when planet Venus passes in front of the Sun during its last transit in this century. The next transit of Venus will be visible only in the next century, on 11 December 2117 – after a gap of 105½ years. A transit occurs when any of the two inner planets of the solar system – Mercury and Venus – happens to come in a straight line with the Earth and the Sun. Such an alignment, however, occurs very rarely – 13 times in a century for Mercury and only twice in a century for Venus. This is what makes the transit of Venus a much awaited celestial event.

Transits of Venus follow a regular pattern beginning with two transits in December eight years apart. Then follows a gap of 121½ years. Then two more transits occur in June, again eight years apart, followed by a gap of 105½ years. Then the cycle repeats. The transit of 8 June 2004 and the coming one on 6 June 2012 constitute a June pair of transits.



Since the discovery of the telescope, there have been only seven transits of Venus – in 1631, 1639, 1761, 1769, 1874, 1882, and 2004. The coming June transit will be only the eighth one and the ninth one will not be seen till the 22nd century.

Historically, transits of Venus were eagerly awaited and extensively studied because it helped in determination of the Astronomical Unit – the distance between the Sun and Earth. Today, however, it is more of a curiosity, as it offers a unique opportunity to watch one of the rarest astronomical events. Worldwide, preparations are on for watching the 6 June Venus transit. Unlike the transit of 8 June 2004, the entire phase of which was visible, the transit of 2012 will be visible partially from India. The transit this time will start long before the Sun rises in India. But, still, it is expected to be a memorable experience.

Vigyan Prasar has been organising several programmes to train Master Resource Persons to encourage and guide the public, especially children and young people, to watch the transit safely using solar filters and various projection methods.

शुक्र पारगमन – एक दुर्लभतम खगोलीय घटना

6 जून 2012 को घटने वाली दुर्लभतम खगोलीय परिघटना यानि इस शताब्दी के अंतिम पारगमन को देखने का संपूर्ण विश्व को एक अवसर मिलेगा, जिसमें शुक्र ग्रह सूर्य के सामने से गुजरेगा। इसके बाद अगला शुक्र पारगमन केवल अगली शताब्दी में 11 दिसंबर 2117, यानि 105½ वर्ष के अंतराल के बाद ही दिखेगा। पारगमन तब घटित होता है जब सौर मंडल के आतंरिक ग्रह यथा बुध और शुक्र पृथ्वी और सूर्य के बीच एक सीधी रेखा में आते हैं। इस प्रकार का संरेखण बहुत कम (एक शताब्दी में बुध लगभग 13 बार और शुक्र दो बार) होता है। यही कारण है कि शुक्र के पारगमन जैसी खोगोलीय घटना के लिए काफी इंतेज़ार करना पड़ता है।

शुक्र पारगमन का एक नियमित पैटर्न होता है जिसमें दो पारगमन (दिसंबर में घटित होने के बाद आठ वर्षों बाद फिर दिसंबर में एक पारगमन) होते हैं। उसके पश्चात 121½ वर्ष का अंतराल होता है। दो पारगमन (जून में घटित होने के बाद आठ वर्षों बाद फिर जून में एक पारगमन) होते हैं। इसके बाद 105½ वर्ष का अंतराल होता है, और इसी तरह से पैटर्न आगे चलता रहता है। 8 जून 2004 और आने वाली 6 जून 2012 को घटित होने वाला पारगमन जून माह का एक जोड़ा बनाता है।

दूरबीन की खोज के बाद से लेकर अब तक कुल 7 बार (1631, 1639, 1761, 1769, 1874, 1882, और 2004) शुक्र पारगमन हो चुके हैं। आगामी जून में दिखने वाला पारगमन 8वां शुक्र पारगमन होगा और 9वां 22वीं शताब्दी से पहले नहीं देखा जा सकेगा।

ऐतिहासिक रूप से शुक्र पारगमन का बड़ी उत्सुकता से इंतेज़ार किया जाता है और इसका व्यापक स्तर पर अध्ययन किया जाता है, क्योंकि इसी से ही खगोलीय इकाई (सूर्य और पृथ्वी के बीच की दूरी) की गणना में सहायता मिली। वर्तमान समय में, हालांकि, यह इससे कहीं अधिक एक जिज्ञासा के रूप में देखा जाता है क्योंकि यह दुर्लभतम खगोलीय घटनाओं में से एक को देखने का एक अनूठा अवसर प्रदान करता है। 6 जून 2012 के शुक्र पारगमन को देखने के लिए विश्वव्यापी तैयारियां की जा रही हैं। चाहे 8 जून 2004 के शुक्र पारगमन की तरह संपूर्ण चरण नहीं देखे जा सकेंगे, फिर भी भारत से यह आंशिक रूप से देखा जा सकता है। भारत में पारगमन सूर्योदय से बहुत पहले ही शुरू हो जाएगा। फिर भी इस दौरान एक स्मरणीय अनुभव होने की उम्मीद है।

विज्ञान प्रसार आम.जन, विशेषकर बच्चों और युवाओं को सौर फ़िल्टर एवं अन्य प्रेक्षण विधियों का प्रयोग करते हुए सुरक्षित तरीके से पारगमन देखने के लिए प्रोत्साहित करने एवं उनका मार्गदर्शन करने के लिए मास्टर रिसोर्स व्यक्तियों को प्रशिक्षण प्रदान करने के लिए विभिन्न कार्यक्रमों का आयोजन कर रहा है।

(अनुवादः रूपेन्द्र शर्मा) ■