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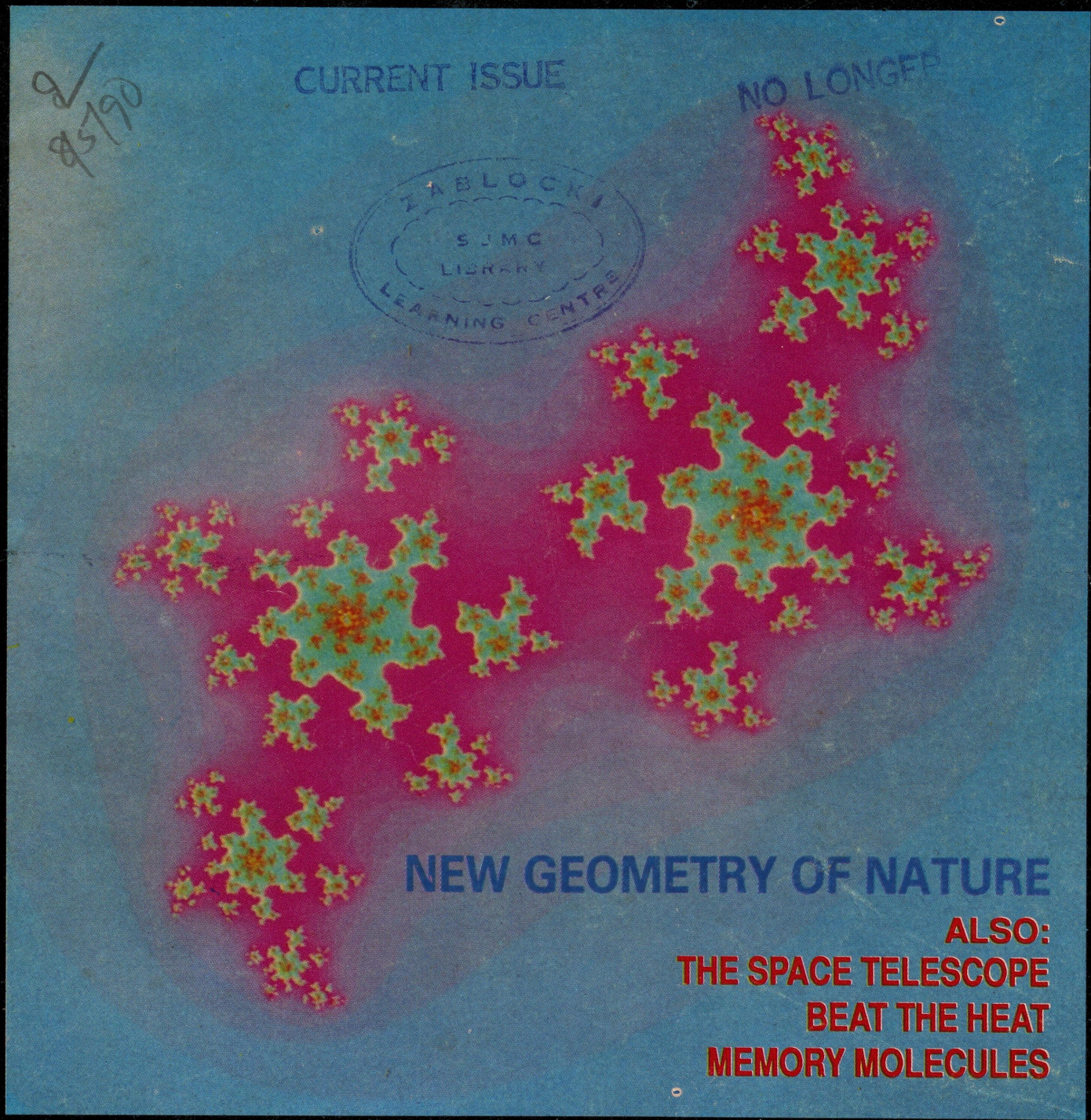

NEW GEOMETRY OF NATURE

ALSO:
THE SPACE TELESCOPE
BEAT THE HEAT
MEMORY MOLECULES

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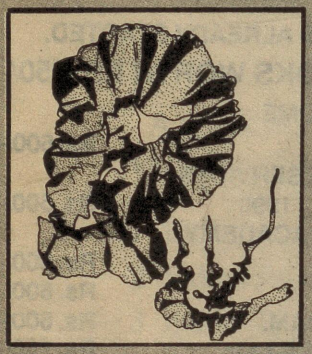

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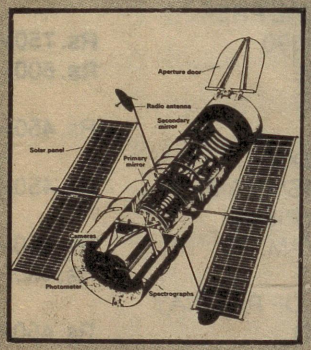

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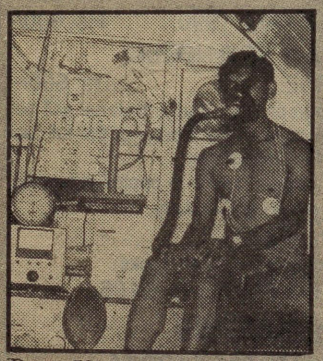

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COVER STORY

ARTICLES

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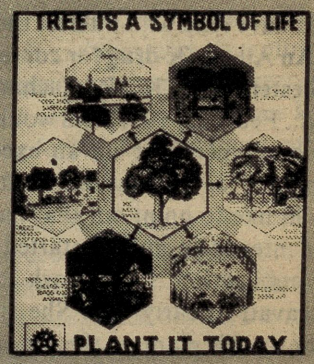

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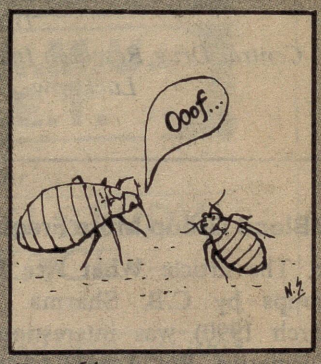

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REACTIONS

The Gugulipid Saga

Sir, I have read with interest the article **An Allovedic drug for containing cholesterol** by K. Ramachandran (*S.R.*, February 1990) and would like to compliment her on an excellent summary of the current status. I would like to point out that the current interest in guggul started after the publication of the work by Dr. Satyavati in early 60's. She started work on this plant on the suggestion of the late Dr. Dwarika Nath. Subsequently detailed work on its chemistry by Dr. Sukhdev while he was at NCL, Pune, and later at Multi-Chem Laboratory, Vadodara, associated with extensive pharmacological studies at CDRI enabled Gugulipid to be marketed. The concept of using standardised extract of plants used in traditional medicine has been developed at CDRI. The extracts need to be standardised using the modern scientific techniques, and experimental and clinical studies have to be undertaken in the same way as would be done with any new drug. Only such studies will enable the use of traditional drugs in modern system of medicine and also ensure consistent effect and reduction in toxicity. Guggul has been the first outcome of such an approach and I do feel that this should have been brought out in the article by the author.

B.N. Dhawan
Director
Central Drug Research Institute
Lucknow-226001

B Blood Group More Frequent

Sir, The article **What Are Blood Groups** by C.B. Sharma (*S.R.*, March 1990) was interesting and informative. But, I want to specify the generalized statement of Mr. Sharma that 'Types A and O of blood groups are most common and AB is the rarest' by adding some further information. The distribution of ABO blood groups varies among different regions and populations of the world depending upon their mating patterns which are effected by ecological and cultural set ups.

Even in India, we do not come across a homogeneous distribution of ABO blood groups as suggested by Sharma because of our mating patterns which are being governed by caste, geographical and other social barriers.

If we screen the literature on the distribution of ABO blood groups, we find that the version of Sharma holds good in America and Europe (White populations). However, in Africa and Asia B blood group exceeds A and somewhere even O, in most of the populations. In India, B blood group exceeds A in so many populations as reported in the book *"The Distributions Of The Human Blood Groups And Other Polymorphisms"* by Mourant, A.E., Kopec, C., ADA, and Domaniewska Sobzak, K. (1976), Oxford University Press, London. Recent researches in Haryana, Punjab, Himachal Pradesh and J & K have also shown the highest frequencies of B group in a number of populations.

J.R. Gaur
Forensic Science Laboratory
Haryana, Madhuban (Karnal)

Pesticides And Environment

Sir, The article **Pesticide Poisoning** (*S.R.*, November 1989) was well written and interesting. Really pesticides are posing a serious threat to human life. Not only pesticides, but also other chemicals are continuously poisoning the Third World. India is presently producing 26,250 metric tonnes of BHC and 8,800 metric tonnes of DDT (both in technical grade). The usage of these pesticides since 1960 has increased from 6,131 tonnes to 49,469 tonnes in 1989.

According to the article, use of a number of such agro-chemicals, identified by the WHO as highly toxic, has been banned or restricted in many countries. Why our government should not adopt effective steps against usage of such harmful pesticides? Though our country's economic condition is dependent on agriculture, inspite of that our government should take necessary steps to ensure a pollution-free environment for our future generations.

Mithu Maity
Abhijit Paul
Calcutta-700 038

Numbering Of The Pages of SR

Sir, The recent changes made by you in *Science Reporter*, though attractive, are less productive and do not suit a science magazine. It is hard to understand why the system of continuous numbering of pages has been done away with. We collect the monthly issues regularly and get them bound into one annual volume. Now, with the changed numbering system it is not possible to have continuation in page numbers in successive issues. Also, the regular column on 'Environment' has altogether been discontinued. Is there no need to make the people aware of the threats to the environment at present?

Sanjai Mishra
Ballia-270 001

Autodigestion Of Stomach

Sir, The articles on diphtheria and malnutrition in *S.R.*, February 1990 issue were informative. But in refer-

ence to a query in 'Brains Trust' by Venugopal Rao about self-digestion of stomach, I wish to add a few words.

Enzymes are chemical compounds present in the body which increase the rate of metabolic processes; for example, digestion. There are many enzymes some of which are capable of digesting the wall of stomach if they are in active state. However, they are secreted by the stomach wall in inactive (zymogen) form and are activated by hydrochloric acid secreted by the stomach cells only when food is present in the stomach. This prevents overactivity and hence autodigestion (digestion of itself) of stomach.

Tejveer Singh Chauhan
Bombay 400 008

Life History Of Renowned Scientists

Sir, Though remarkable changes have been introduced in *Science Reporter* since January 1990, the little effort to flash the life-history of renowned scientists made me sad. Hope, you will take necessary steps in this regard.

Ajaya Kumar Dash
Orissa-755 001

Selected Questions

Sir, In March issue, the articles Blood Groups, The headquarters, Biotechnology, etc. were interesting. I think the questions answered in BrainsTrust should be selected considering the standard of undergraduates. The questions must be more varied.

Sunil Garg
Gwalior-474 001

Some More Rare Plants

Sir, The article **Our Vanishing Plants** (*S.R.*, Jan. 1990) and the information regarding biosphere reserves of India it contained was the one I was looking for, for the last six months. I must thank S.K. Jain for that.

I would like to add a few more rare plants, economically and medicinally important, to the list of plants which have been reported depleted from the Himalayan region: *Aconitum heterohyllum, Didymocarpus pediollata, D. aromatica, Orchis ovalifolia, Malaxis acuminata, Jurinea macrophylla, Allium wallicnii, Angelca glauca, Betula utilis, Juniperus macropoda,* and *Viola serpens.*

Brij Sharma
Jammu (J&K)

Further Reading

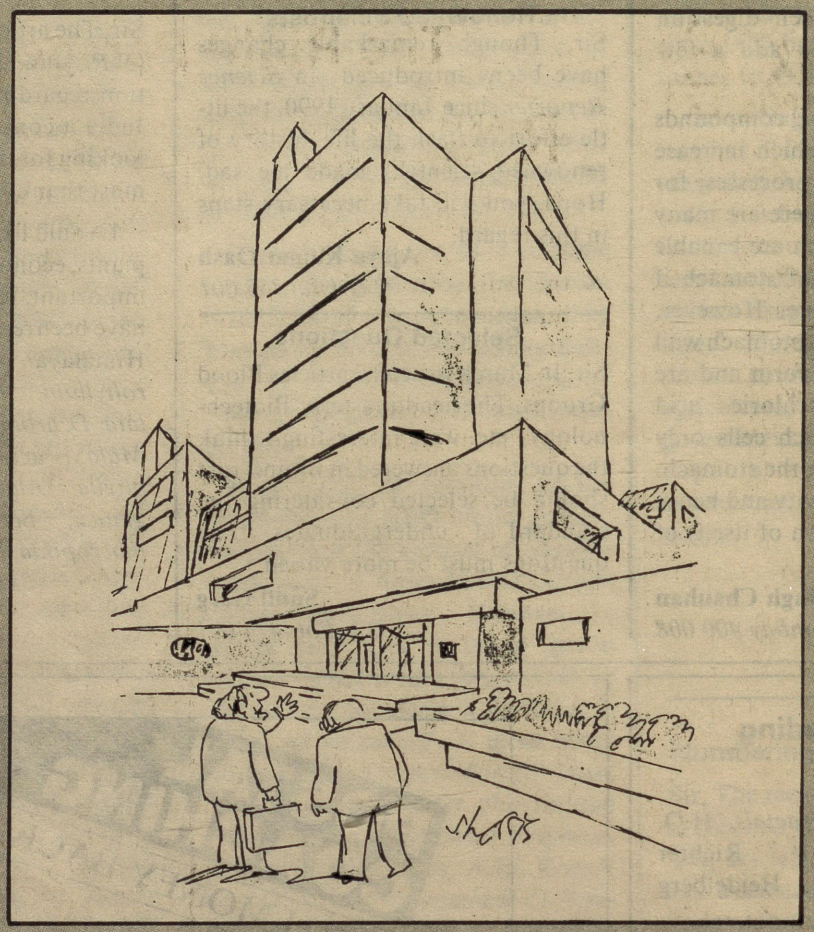
FRACTALS

1. *The Beauty of Fractals,* H.O. Pertgen & P.H. Richter Springer - Verlag, Heidelberg (1986)
2. *The Fractal Geometry of Nature,* Freeman, San Francisco (1982)
3. *Chaos: The Making of a New Science,* J. Gleick Cardinal (1988)

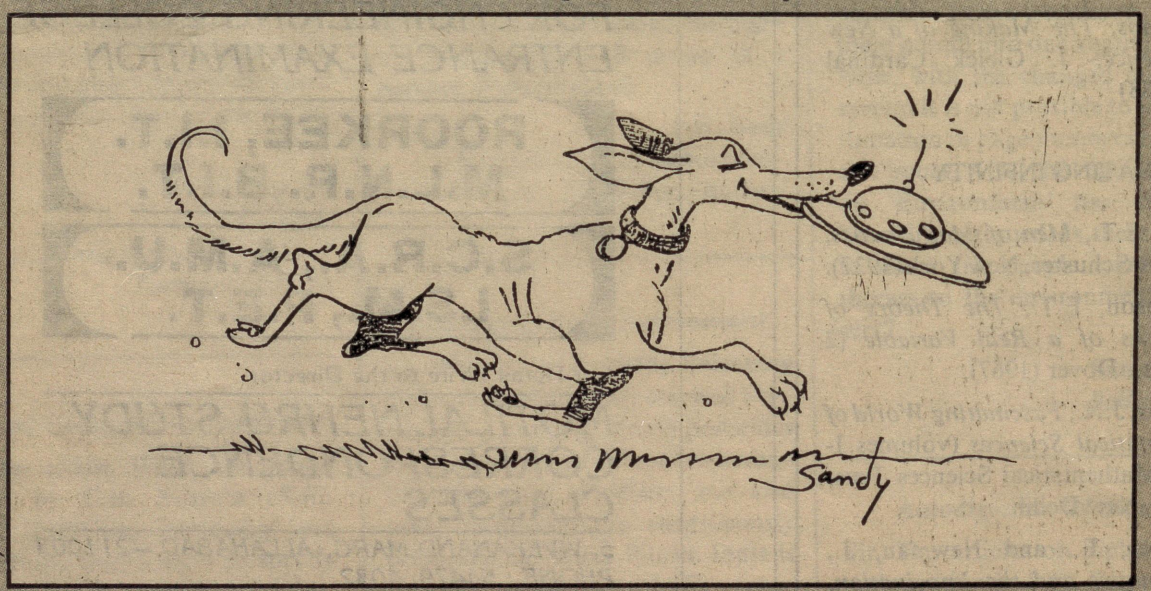
FASCINATING INFINITY

1. Bell, E.T., *Men of Mathematics,* Simon & Schuster, New York (1937).
2. Hobson, E.T., *The Theory of Functions of a Real Variable* (2 volumes), Dover (1967).
3. Kapur, J.N., *Fascinating World of Mathematical Sciences* (volumes I-VIII), Mathematical Sciences Trust Society, New Delhi.
4. Kesner, E., and Newman, J., *Mathematics and the Imagination,* Bell, (1949).

CARTOONS



Here it is-the world's largest miniaturisation plant."



SCIENCE

"Emergency ! Andromeda IV ! We have been captured! "

SCIENCE REPORTER

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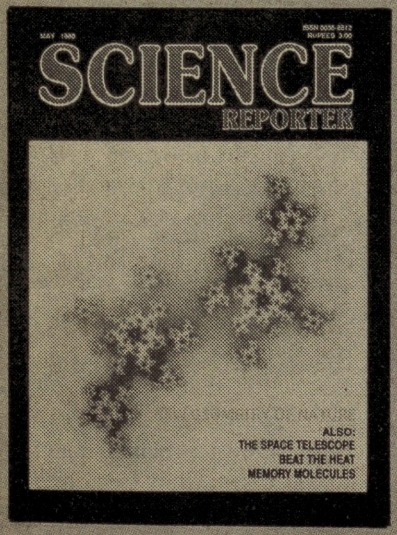


Cover: **Computer generated picture by the author**
Design: **K.B. Dhingra**

The Right Perspective

RARELY does an Indian scientific achievement make front page news in the western media. Often what gets prominence is the seamy or controversial side of Indian science. It was therefore heartening to see the wide international coverage of a piece of research by a team of scientists at the National Chemical Laboratory, Pune. Indeed, the work, on induced flowering of bamboo, has been hailed as a breakthrough which may have far reaching ecological and economic impact, especially on the countries of our region.

That the success comes from the NCL is not surprising. The laboratory has been doing pioneering research in tissue culture and strains developed by it are already commercialised. But NCL is not alone. It stands in good company. Several other research institutions in the country have commendable work which has been widely acclaimed, and there are others which have not received the due appreciation despite their importance in resolving social and economic problems of the country. Unfortunately, most of these success stories hardly find place in our media. Even now, the NCL achievement that has captured the imagination of the editors of the *New York Times, The Economist, New Scientist* and the likes, has not received even a passing mention in most of the Indian periodicals.

Indian expertise in even the advanced areas of biotechnology, computer software, oceanography and meteorology are now sought after by not only the developing countries of southeast Asia, Africa and Latin American but also the advanced countries like the USA and the European countries. Indian manufactured radioisotopes are regularly being exported to Switzerland, France, and USA. Thailand is making use of Indian desalination technology to provide drinking water to its people. Indian technologies in the fields of medicinal drugs and catalysts are able to hold their own in the highly competitive western markets.

Even countries which have access to advanced western technology have sought Indian assistance. The most recent case is that of the Caribbean countries seeking Indian help in charting the entire ocean floor in that theatre. The Indian research ship "Sagar Kanya" is already testing the emerald waters of the Caribbean.

It is rather distressing to find that turning a Nelson's eye to this aspect of Indian science and technology establishment, only the failures, some real, perhaps and equal number of imaginary, are cited by the critics. The contention that the shortcomings are blown out of proportion may be debatable, but there is no denying that an objective assessment arrived at after drawing a balance-sheet of pluses and minuses is rarely, if ever, made. In a democratic set-up, any activity funded by the public has to be subjected to an intense scrutiny and the media have the responsibility of keeping the paymasters properly informed. For that very reason, discharging of that onerous task makes it imperative that a right perspective, not a distorted one, is placed before the people. □

Shanti Swarup Bhatnagar Prize—1988

SHANTI Swarup Bhatnagar Prize, instituted in 1957 by the Council of Scientific and Industrial Research in memory of its principal architect, the late Dr. S.S. Bhatnagar, was awarded to following distinguished scientists in their respective fields of research, by the Prime Minister Shri V.P. Singh in Vigyan Bhawan, New Delhi on 28th March 1990. The Prize carries with it a plaque, citation and a sum of Rs 50,000.

Biological Sciences: Dr. Bhabatarak Bhattacharyya, Bose Institute, Calcutta; Prof. Manchanahalli Rangaswamy Satyanarayana Rao, Indian Institute of Science, Bangalore; **Chemical Sciences:** Prof. Kaushal Kishore, Indian Institute of Science, Bangalore; **Earth Sciences:** Dr. Sampat Kumar Tandon, University of Delhi, Delhi; **Engineering Sciences:** Prof. Surendra Prasad, Indian Institute of Technology, New Delhi; Prof. Bhaskar Dattatraya Kulkarni, National Chemical Laboratory, Pune; **Mathematical Sciences:** Prof. Mihir Baran Banerjee, Himachal Pradesh University, Shimla; Prof. Kalyan Bidhan Sinha, Indian Statistical Institute, New Delhi; **Physical Sciences:** Prof. Deepak Kumar, Jawaharlal Nehru University, New Delhi; Prof. Onkar Nath Srivastava, Banaras Hindu University, Varanasi. □

India Helps The Caribbean To Exploit Its Marine Wealth

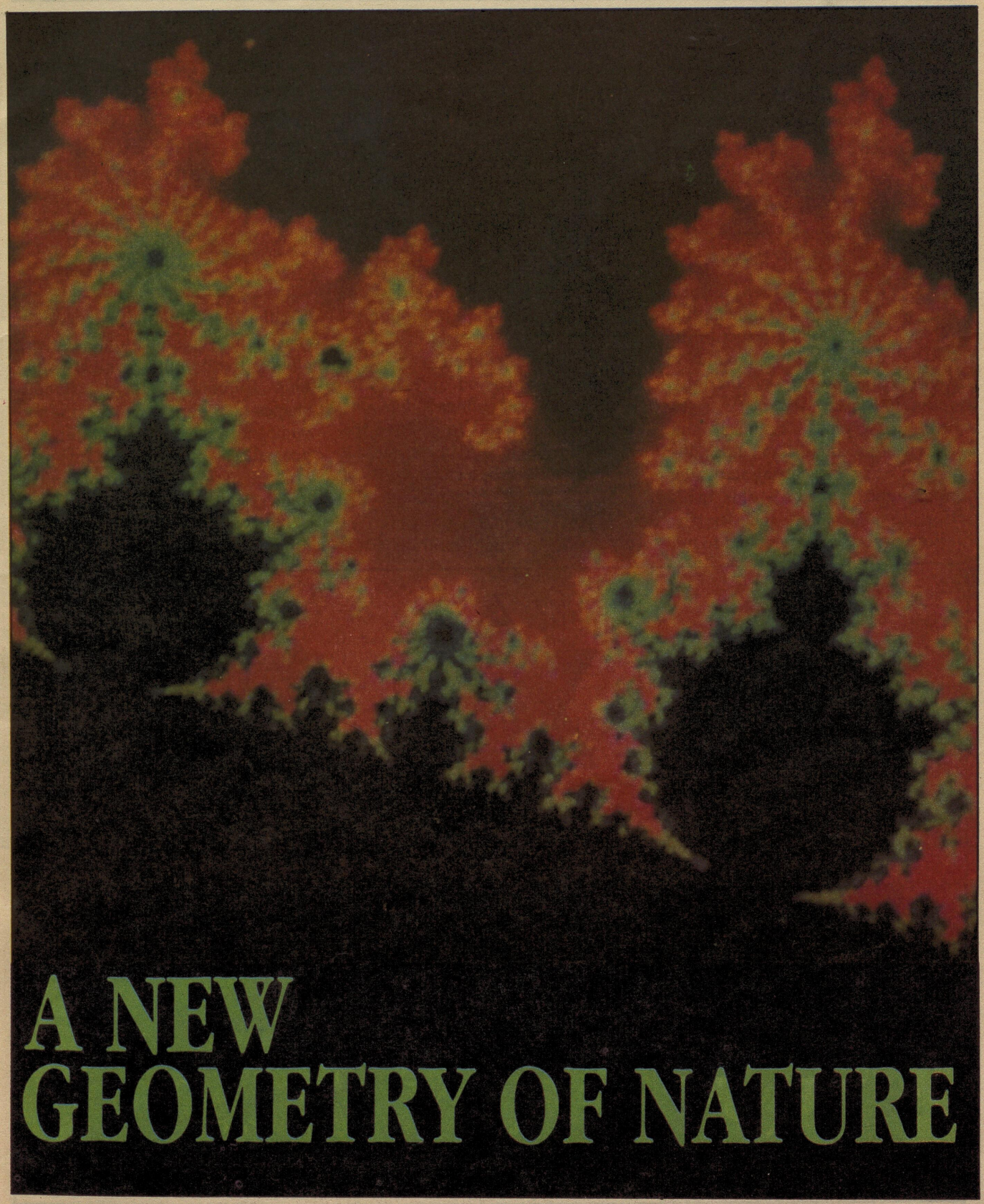
THE Caribbean countries (Antigua and Barmuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, St. Christopher, Nevis, St. Lucia, St. Vincent and Trinidad and Tobago) are in a position to plan a programme to exploit their marine resources without harming the environment. One of India's oceanographic research ships is to leave Goa to reach the Caribbean by April this year as part of a Commonwealth initiative to explore the marine resources of the Caribbean.

Twentyfive Caribbean scientists have been trained in the oceanography and marine sciences at the National Institute of Oceanography at Goa.

The oceanographic survey of the Caribbean aims to collect data on physical, chemical, biological and geological oceanography. The scientists have gained a good working knowledge of areas such as meteorology, turbidity, tides, wave dynamics, fouling of ships' hulls by marine organisms, pollution, marine chemistry, toxicity, food chains, and marine geochemistry.

"The Indian government has made a very generous input into this programme and we hope that it will serve as a pattern for other such programmes involving the less developed Commonwealth countries", said Ulric Troz, Director of Guyana Institute of Applied Science and Technology.

The Caribbean Community Secretariat, the Commonwealth Science Council, the Department of Ocean Development and the National Institute of Oceanography in India have been careful to include an environmental element in the survey. □



A NEW GEOMETRY OF NATURE

Fractals are a very compact and powerful way to describe nature and its self-scaling behaviour, particularly with the advent of computers, says *APARNA BASU*

FOR centuries man has been fascinated by the beautiful and complex structure in which Nature abounds—from the stars in the sky, the lofty mountain peaks, the trees, right down to crystals, beehives and butterflies—spanning an enormous range of scales, and cutting across the animate and inanimate worlds. In his effort to understand and describe various aspects of nature, and to use this knowledge for his own ends, man created the sciences.

ONE of the sciences known to the early Greeks, Indians, Egyptians and other ancient people was geometry. In Egypt its earliest use was in the measurement of agricultural land from which the word "geometry", literally earth measurement, originated. Classical geometry (or Euclidean geometry) is the study of shapes and their interrelations. The circle, parabola and square on the plane, cubes and surfaces of revolution in solid geometry, and even geometry on curved surfaces are defined and well understood. When, however, one wants to describe the more complex shapes in nature such as a tree, a river, or a cloud, classical geometry proves quite inadequate.

Why is this so? A scrutiny of a tree tells us that it is neither straight, nor circular, nor elliptic, nor even a reasonable combination of these shapes. Its contours are highly irregular. In contrast to the smooth shapes in geometry, its form is too complex to be described by familiar geometrical principles. Many patterns in nature possess not only a higher degree of complexity as compared to Euclid, but an altogether different level of complexity. This

"MANY important spatial patterns in Nature are either irregular or fragmented to such an extreme degree that Euclid is hardly of any help in describing their form".

B.B. Mandelbrot
Fractals : Form, Chance & Dimension

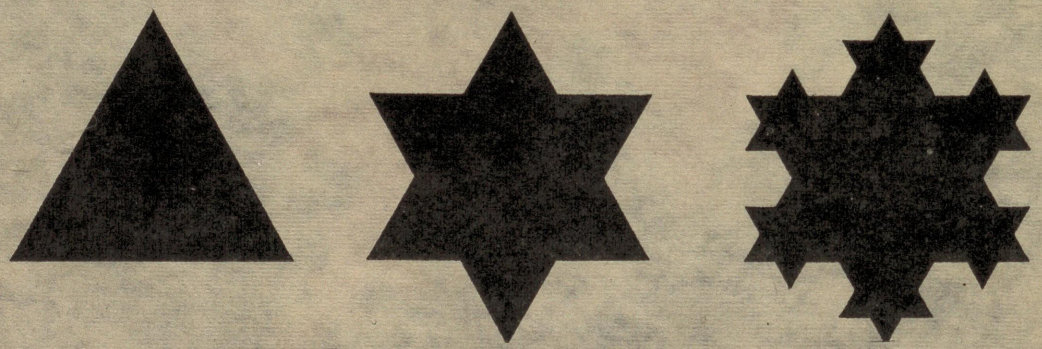


Fig.1

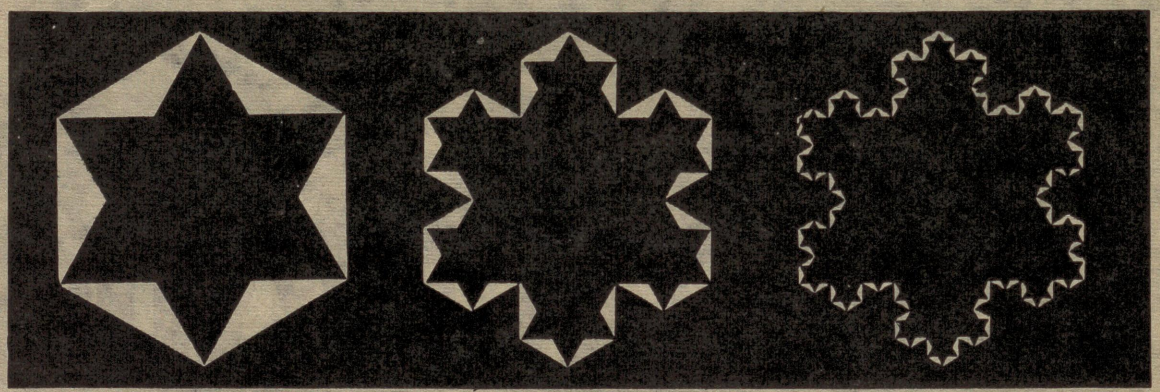


Fig.2

On Benoit Mandelbrot

BENOIT Mandelbrot was born in 1924 in a Lithuanian Jewish family. His father was a clothing wholesaler and his mother a dentist. His uncle Szolem Mandelbrot was a mathematician in Paris. His schooling was irregular—he apparently never learnt the alphabet or multiplication tables beyond five. Forced to move to Tulle in the south of France because of the Nazis, he was befriended by school teachers, many of them scholars stranded by the war. When Paris was liberated, Mandelbrot appeared in the month-long admissions test of the Ecole Normale and Ecole Polytechnique and succeeded, more due to his geometric intuition than his knowledge of algebra or analysis.

At that point of time there was a swing towards greater rigour and a distrust for picturisation on the French mathematical scene. In ten years Mandelbrot left France to join IBM's Research Centre in the US. At IBM he worked on errors in telephone transmission and showed that they had a highly irregular distribution resembling what mathematicians called a Cantor set. He then showed that this set had something in common with other irregular shapes such as the coastline of a country. Much earlier the English scientist Lewis F. Richardson had shown that the length of the coastline depended on the size of the ruler used to measure it. In order to capture the ruggedness of the coast, Mandelbrot

Mandelbrot

extended the concept of dimension beyond 0, 1, 2, 3 to incorporate fractional values—a seeming impossibility. This fractional dimension became a measure of irregularity and fragmentedness of complex shapes.

Mandelbrot's researches into the unity of form led him from mountains to music and soap bubbles. He first published his ideas in a book written in French in 1975. The English version followed in 1977. Prior to that, he had made numerous contributions to the geosciences, economics, biology, even linguistics and had held professorships in several of these departments in addition to positions in mathematics. Highly original and versatile, he was nonetheless not accepted readily by scholars in the early stages.

His discovery of a singularly beautiful structure in the complex plane named the Mandelbrot set spurred tremendous interest in this new field. His book, *The Fractal Geometry of Nature* sold more copies than any recent book on mathematics. In a sense he is a path breaker, intuitively suggesting ideas and convictions which have later been explored fruitfully by others. What helped his natural intuitive ability was his extensive knowledge of the history of mathematical ideas and the sheer single-mindedness with which he pursued his imagination. This led to a synthesis of many scattered discoveries in mathematics and other sciences which, aided by the power of computers, were forged into a single concept—Fractals.

A.B.

was perceived by French mathematician B.B. Mandelbrot, who tried to remedy this absence of geometrical representation for highly complex irregular shapes by introducing a family of shapes which he called "Fractals".

THE word "fractals" arises from the Latin adjective *fractus*, which has the same root as fraction and fragment, and means "irregular or fragmented". Although the term fractal is new (the French version of Mandelbrot's book, *Les objets fractals: Forme, hasard et dimension,* appeared in 1975), individual mathematical entities which we now recognise to be fractals have been known to mathematicians for a long time, notable among them being Cantor, Peano, Lebesgue, Hausdorff, Koch, Sierpinski and Besicovitch. These contributions appeared in the period 1875 to 1922, but were never integrated into the mainstream of mathematics teaching. They were regarded as individual mathematical curiosities. The famous mathematician Henri Poincare refers to them as a 'Gallery of Monsters'. But what merited such a strange name?

The properties of fractals are indeed peculiar. Unlike familiar geometrical shapes which have integer values for topological dimension (simply speaking, a point has zero dimension, a line dimension 1, a square and a sphere dimensions 2 and 3 respectively), the dimension of fractal shapes can take fractional

values. This is known as the Hausdorff-Besicovitch (HB) or fractal dimension. For a fractal, the HB dimension is strictly greater than the topological dimension. Moreover, a fractal curve can be continuous everywhere, but nowhere differentiable. A third interesting characteristic of fractals is that they are self similar, i.e., small parts of the fractal appear to be condensed versions of the whole. This introduces a kind of order in a seemingly irregular pattern. Each of these properties is at variance with the properties of familiar mathematical curves or functions. This is what justifies the introduction of a new geometry to describe families of highly complex irregular shapes.

GEOMETRY can be thought of as a set of prescriptions each of which defines a shape. For example, joining all points at a given distance from a fixed point gives a circle. Similarly, if a string is loosely tied to two pins on a sheet of paper and a pencil moved along the sheet such that the string is held taut, the line traced by the pencil will be an ellipse. We now give a construction which will generate a fractal curve called the Koch curve.

Imagine a triangle with three equal sides. Divide each side into three sections. On the middle section of each side, attach a small triangle whose sides are one third the length of the sides of the first triangle. This forms a star with six points and twelve equal segments. Repeat the same process on each of the twelve segments. After several steps, the outline becomes highly structured with a series of small projections and bays. This outline is called the Koch curve Fig. 1-3.

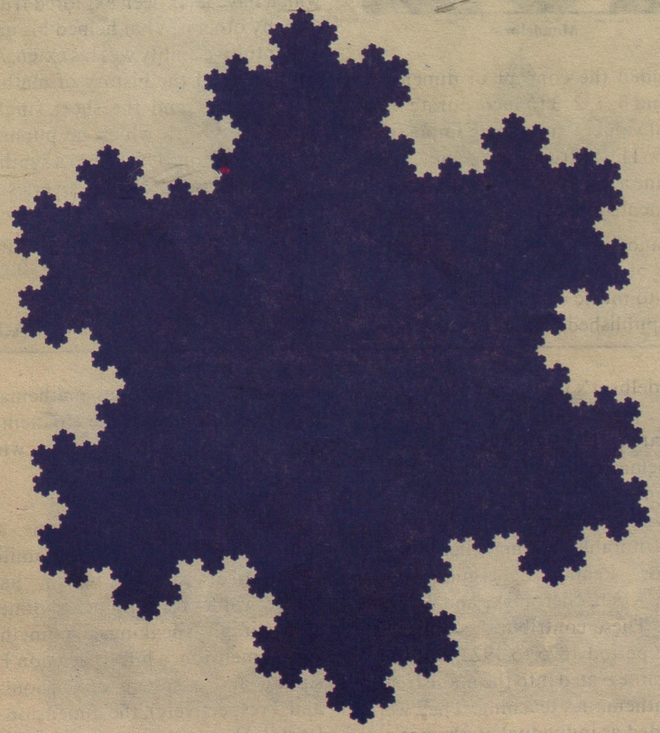


Fig.3

Fractal landscape (From : Creative Computer Graphics, Cambridge Univ. Press, 1984)

The Koch curve, which is the net result of infinitely many steps of the transformation, is a continuous loop, but does not intersect itself because the new triangles are small enough not to encroach upon each other.

At every stage of transformation, the total length of the edge is increased by a factor of 4/3. At the same time the area added on is small so that the total area remains less than the circle drawn through the points of the original triangle. The Koch curve is thus an infinite curve crowding into finite area. It is more than a line which is of dimension one, but less than a plane of dimension two. A dimension which precisely

describes how "space filling" the Koch curve is has the value 1.2618= (log 4/log 3). This is called the "fractal" dimension of the curve.

The Koch curve is without a well defined tangent at any point. To understand this point let us consider the process of drawing a tangent to a curve. A tangent is usually drawn by joining two neighbouring points on a curve and gradually shifting one point closer to the other. This process when carried out on the Koch curve cannot lead to a well-defined tangent direction since micro-irregularities nestle between two points, no matter how close, causing the tangent direction to fluctuate. We say the Koch curve is non-differentiable.

Finally, one notices that if any small part of the Koch curve is expanded, it becomes a replica of the original curve. This property, where pattern is embedded within pattern, is called self similarity and is the essence of fractal curves. Self similarity is symmetry across scales. Another example of a fractal can be generated by removing the middle third from a line, leaving two segments. This process is then repeated on each of the segments leaving smaller and smaller pieces at each stage. At the end of an infinite number of steps one is left with a fractional dust of infinitely many pieces whose dimension would be between 0 and 1, in fact (log 2/log 3). This is called a Cantor set (Fig. 4). One can devise one's own fractal shape by laying down a rule and repeating it in a particular way to generate fascinating patterns with peculiar properties.

THE constructions of the previous section may seem bizarre and far removed from naturally occurring shapes. One may argue

Fractal moonscape and planet created by a computer (From : Discover, June 1982).

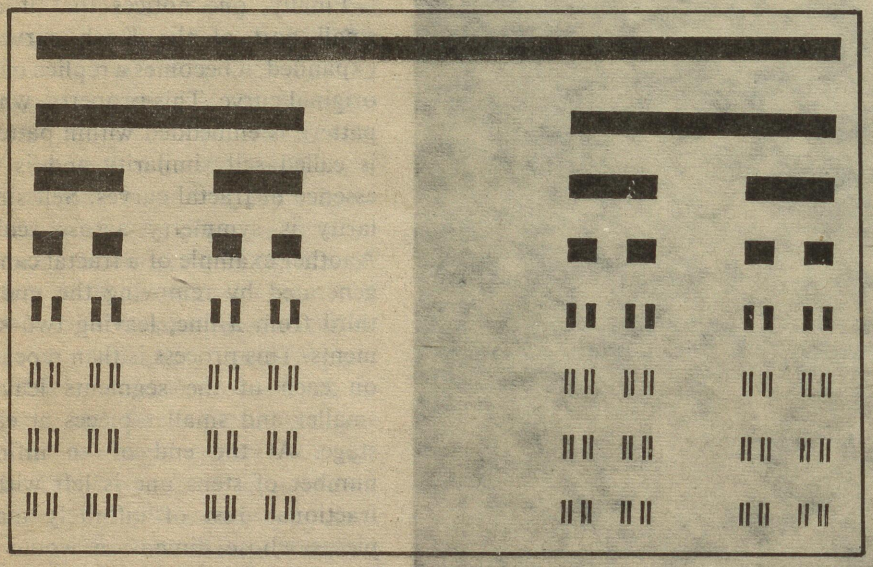


Fig.4

that real lines have finite lengths and do not go to infinity like the Koch curve. Moreover the Koch curve is also artificially regular unlike natural shapes such as mountains or coastlines. The latter problem can usually be rectified by introducing a small amount of randomness in the prescription. As for the length of a natural coastline, the problem was addressed by the British scientist L.F. Richardson, better known for his work on turbulence. The results were found among his papers after his death in 1953. The article on coastlines was published in 1961. Richardson found that the length of a coastline depends on the size of the ruler or scale used to measure it. As the size is reduced, the apparent length increases without limit. He plotted his values on log-log graph paper and found that his values fell on a straight line (Fig. 5). Although Richardson had no interpretation for the slope at that time, Mandelbrot showed that the slope was equal to 1-D, where D is the fractal dimension of the coast.

HOW does one understand, or accept, the idea of a fractional value for dimension which has so far been treated as an integer or whole number? The first thing to remember is that we are talking about two different kinds of "dimensions". The integer kind is called the topological dimension D_T, which we are familiar with. In order to explore fractional dimensions let us first examine the relation between Measures and Dimensions

The measure of a line is its length. If we begin with a ruler of length 1, the length L of a line that is N times longer than 1 is $L = N1$. Similarly, for an area the measure $A = N1^2$ and for volume, $V = N1^3$. Generalising, one may write $M = N1^D$ where M is the measure appropriate to the dimension D.

If we now change the length of the ruler to $1'$, the new measure M' is

$$M' = N'1'^D$$

Clearly, in a system of consistent measures, we would not like the measure to depend on the unit 1. Therefore we want that M should be equal to M', in the limit when 1 becomes small, i.e.

$$N'1'^D = N1^D$$

From this it is easy to deduce that

$$D = \lim_{1 \to 0} \frac{\log (N/N')}{\log (1'/1)}$$

As it turns out, d does not always approach a whole number. It is called the Hausdorff-Besicovitch dimen-

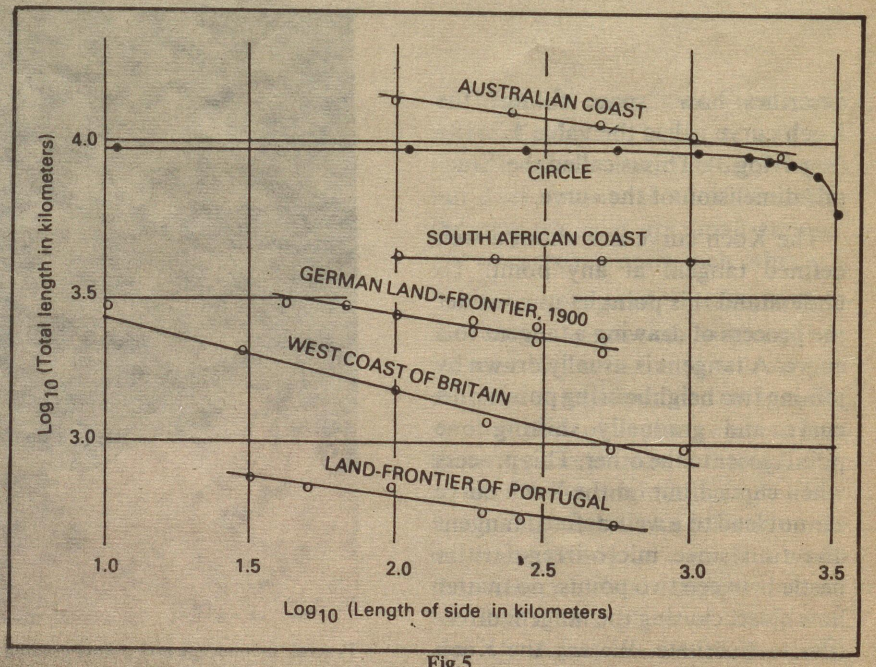


Fig.5

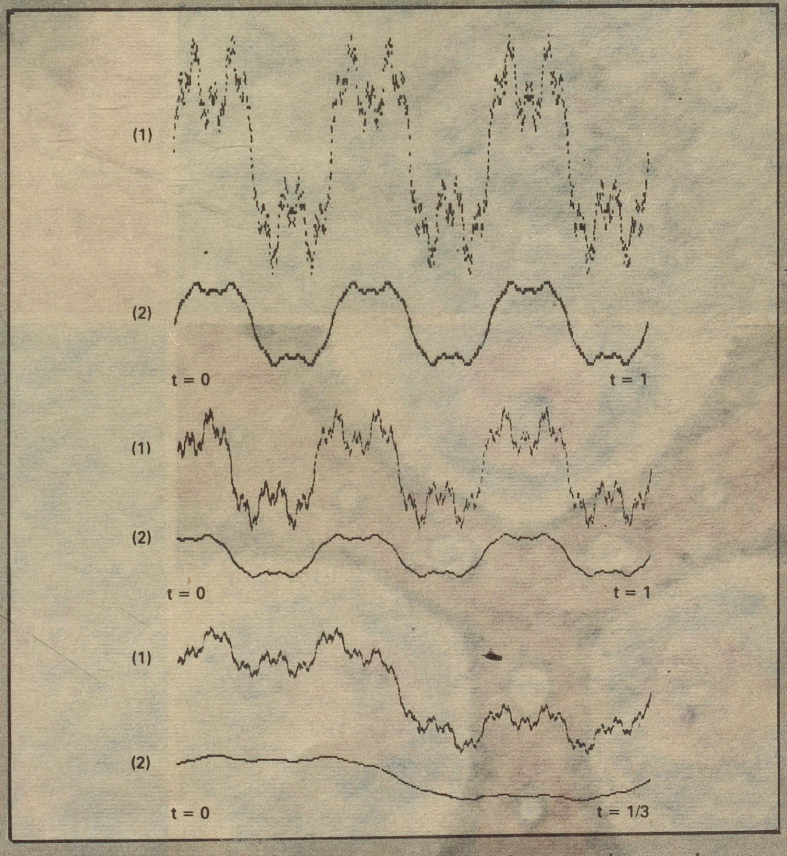
The Wierstrass Function

A MATHEMATICAL function that has fractal properties is the Wierstrass function. First published in 1875, it precipitated a crisis in mathematics because of its peculiar property of being everywhere continuous but nowhere differentiable. The crisis was finally resolved in 1922 with a fresh understanding of the concept of topological dimension.

Although scientists had come across similar functions earlier, their results remained unpublished. Bernard Bolzano (1781–1848) wrote an account in 1834, as noted by A.N. Singh in *The Theory and Constructions of Non-differentiable Functions*, published in Lucknow around 1950. It appears that Bolzano was not aware of the strange properties of the function.

Charles Callerier (1818–1890), a mathematician in Geneva, wrote down a function closely related to the Wierstrass function. Although his work remained largely unnoticed in his lifetime, after his death among his papers a folder was found marked "Very important and I think new, correct, can be published as is", which contained the function which he had constructed as a counter example to the idea that continuous functions are necessarily differentiable. Although the folder was not dated, a student recollected that he had referred to this work in class in 1860. Subsequently it was found that Colleriers function is differentiable at some points.

Wierstrass himself did not publish his work immediately although he presented it at the Berlin Academy in 1872. It appeared in his collected works in 1895. In the meantime the main finding was put on record in 1875 with the following editorial remark "The metaphysics of these functions seems to hide many puzzles, as far as I am concerned, and I cannot get rid of the thought that they will lead to the limit of our intellect".



Although viewed initially as a mathematical curiosity, the Wierstrass function requires only a small modification to yield an approximate model to a wide class of natural phenomena.

Wierstrass writes the series

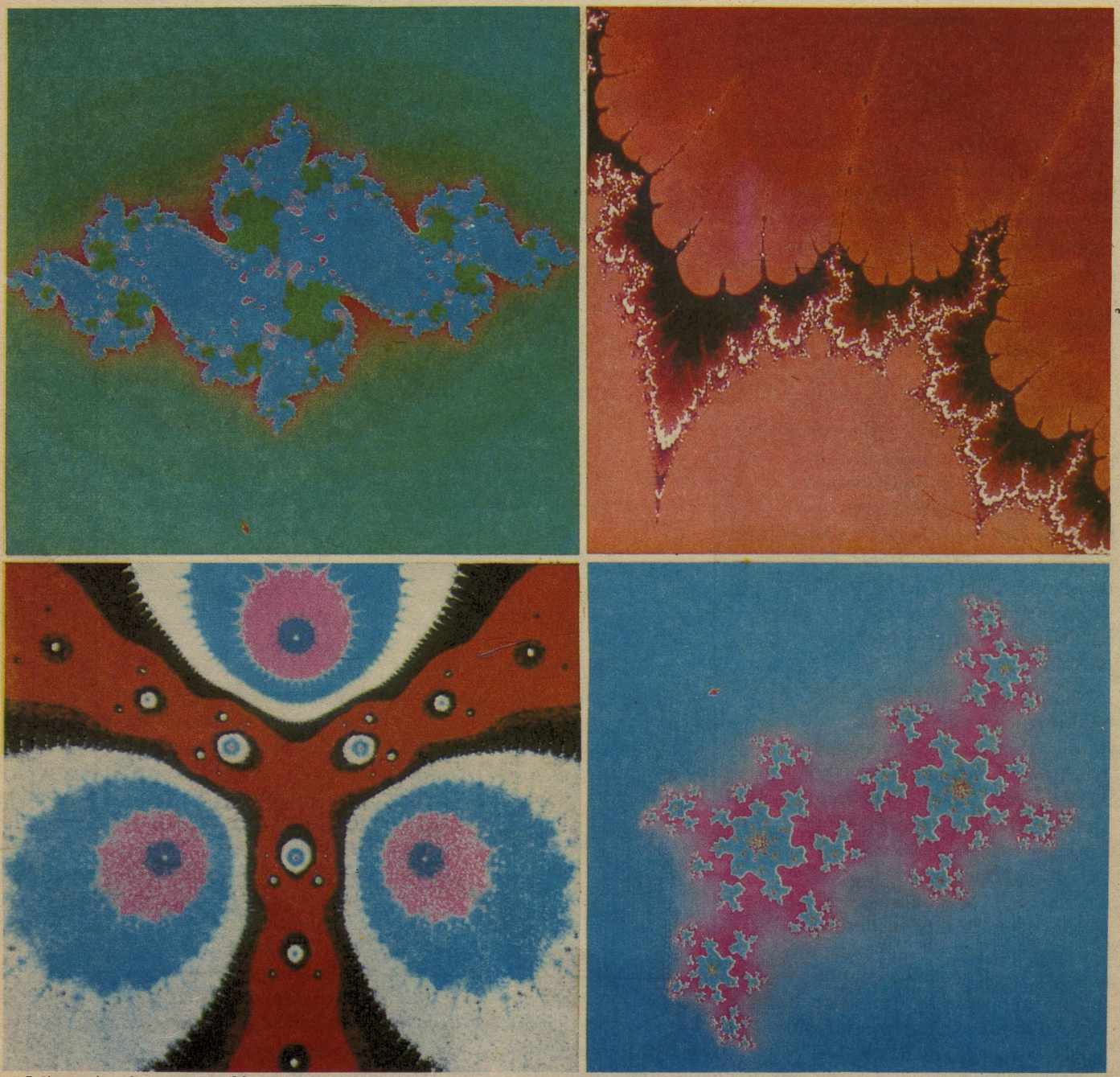
$$\sum_{0 \le n < \infty} W^n \exp(2\pi i \gamma^n t)$$

where γ and W are real numbers satisfying $\gamma > 1$ and $1/\gamma > W > 1$. This series converges for every value of t, is continuous everywhere, but is no where differentiable. (It is left as an exercise to the discriminating reader to show that this is actually so). For $W < 1/\gamma$, the function is completely differentiable. To appreciate this, the following exercise may be attempted. The series given below may be summed up to ten terms for $0 \le t \le 1$.

(1) $y = (\frac{1}{2})^n \text{Cos}\,[2\pi\,(3^n)\,t]$;
(2) $y = (\frac{1}{4})^n \text{Cos}\,[2\pi\,(3^n)\,t]$

The difference between the results as shown in the figure will amply illustrate the property of non differentiability.

A.B.



Julia sets in colour generated by computer

sion. For a fractal, D is always greater than the topological dimension D_T. The Koch curve lies entirely in a plane of Euclidean dimension 2, has topological dimension 1 and fractal dimension log 4/log 3 which is approximately 1.2618. From this one can write a definition for a fractal.

A fractal is a shape whose Hausdorff-Besicovitch dimension D is strictly greater than the topological dimension D_T, but less than the dimension E of the embedding space, i.e. $D_T < D < E$.

WITH the advent of computers, fractals could be generated faster and with relative ease and accuracy. It also became easier to show the link between fractals as mathematical "objects", and shapes that occur in nature. A suitable set of instructions could make the computer draw a fractal that resembled the branches and leaves of a tree, even avenues of tree (Fig. 7-9). It was soon realised that the power of the concept

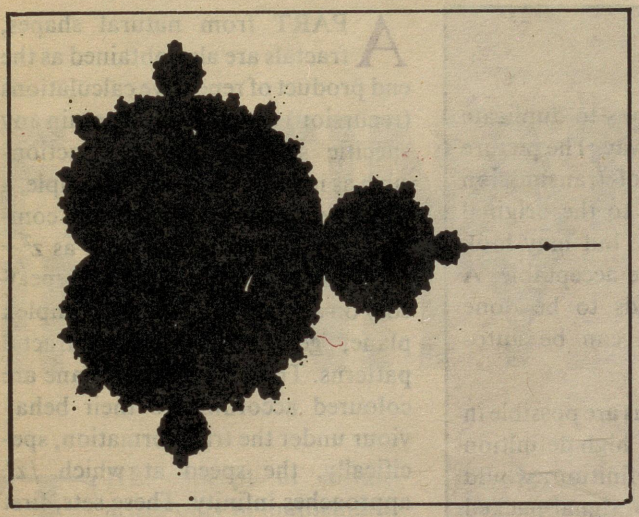


Fig.6

of fractals arises from the fact that these shapes are not just common but almost universal. From bird feathers to the arterial system of the body; from river networks to clouds; nature shows up as being fractal in character. This makes fractals a very compact and powerful way to describe nature and its self-scaling behaviour, and computers have played a very important role in demonstrating this.

MUCH of the interest in fractals has arisen because of the striking landscapes generated by computer algorithms using the properties of fractals.

A reasonable way of generating a surface is to add a random height z(x, y) at a number of points (x, y) on a plane. Successive layers are obtained by reducing the height added in a fixed ratio at every stage of the construction. A mountainous landscape emerges after n steps of the construction. Such a shape is said to be "scaling". However, it is difficult to decide just how many steps are required to obtain a "natural" looking landscape. This is a subjective judgement of the programmer. In this sense it is still an art. If the number of steps is too low the shape may lack structure, while if it is too high, the fine structure begins to look artificial. The reason for this is linked to the existence of an inner and outer scale in real structures. Natural shapes possess the property of scaling only across a given range of scales. Beyond this, other forces take over and the structural similarity ends. It becomes necessary therefore

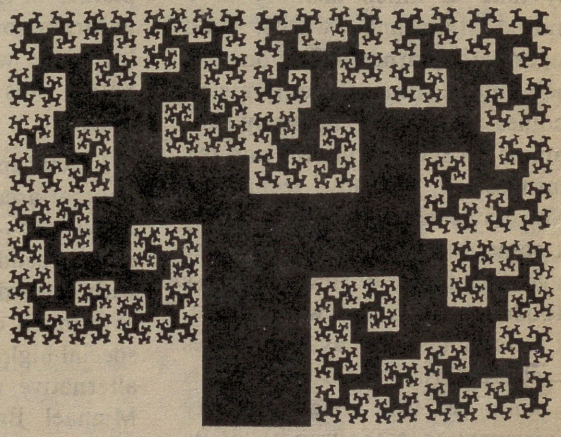


Fig.7

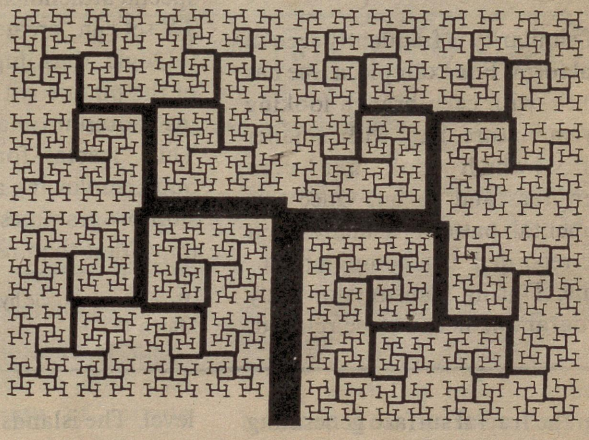


Fig.8

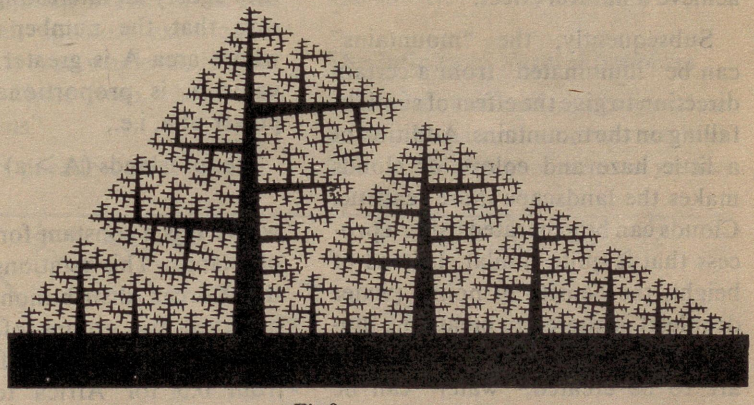


Fig.9

Fractals In The Future

A PICTURE is worth a thousand words but in the computer age it takes much more than just a thousand words! In fact a video image may take as much memory as a hundred thousand words, and images with sharper definition take much more. Image compression becomes an urgent necessity, for example, in satellite photos and fax transmissions. Already, techniques are available which involve blanking out some data, that can reduce the images by a factor of 50 without loss of too much detail. A new technique, not yet commercially available, uses the self similarity property of fractals to compress the image memory requirement to a thousandth of its actual volume.

Self similarity is frequently seen in natural form. For example, a tree has branches, with each branch looking like a miniature tree with smaller branches which look like even smaller trees and so on. Once this fundamental pattern is analysed it can be recorded as a computer programme. During transmission only the programme needs to be relayed, along with instructions to duplicate itself in a particular way. The picture created at the end of transmission may not be faithful to the original picture in all details, but may look natural enough to be acceptable. A lot more work needs to be done before this method can be automated.

Fractal applications are possible in another area, that of high definition television. High definition would require sending a TV signal packed with extra detail which is displayed as a much more crisp picture on a special high definition TV set. In an alternative approach suggested by Michael Barnsley of a company named Iterated Systems in USA, a special attachment to a conventional TV set can "create" detail using fractal logic, thus improving the quality of the picture without actually loading more information on the signal. This "fractal forgery" could look quite convincing and for most television programmes this may be more important than realism.

(Based on an article by Tom Waters, *Discover*, March 1989).

to stop the fractal surface generating algorithm at an appropriate point to achieve a natural effect.

Subsequently, the "mountains" can be "illuminated" from a certain direction to give the effect of sunlight falling on the mountains. Addition of a little haze and colour or clouds makes the landscape more realistic. Clouds can be generated using a process that is quite similar. Instead of height, the density of points (water droplets) is altered to create the illusion of a cloud. If lakes and islands are to be created, "water" can be filled in the landscape upto a certain level. The islands created in this way have fractal coastlines. In addition they satisfy an interesting law which says that the number of islands, whose area A is greater than some value a, is proportional to some power of a, i.e.,

$$\text{No. of islands } (A > a) \propto aB$$

where B is a constant for a given set of islands. This relationship, called the Korcak distribution, has been observed for groups of islands in nature with the value of B ranging from 0.5 for Africa to 0.75 for Indonesia.

APART from natural shapes, fractals are also obtained as the end product of repetitive calculations (recursion) which do not contain any specific space related instructions such as in Figs. 1 to 4. For example, a non linear transformation of a complex number $z = x + iy$ such as $z^2 +$ constant $\rightarrow z$, when applied repeatedly on a set of points in the complex plane, generates beautiful fractal patterns. The points in the plane are coloured according to their behaviour under the transformation, specifically, the speed at which $|z|$ approaches infinity. These sets, first discussed by French mathematician Gaston Julia and Pierre Fatou around World War I, and named after Julia, were not rendered as visible patterns till recently. Depending on the choice of the number c, a variety of patterns are generated (pp. 9 & 16)*. The intricacy of the patterns increases as the resolution of the computer is improved. It is amazing how such a variety of patterns are encoded in terms of such a small amount of information!

One can imagine clusters of vegetative form, the shapes of certain types of micro organisms and the branching of lightning in these sets. Scientists think that not only will the shapes emerging out of a study of fractals be akin to nature but through them one may also hope to understand the underlying causes giving rise to the enormous variety of patterns in nature.

*The colour pictures of the Julia sets were generated by the author on an Omega Iris 3100 computer by courtesy of the Centre for Mathematical Modelling and Computer Simulation, National Aeronautical Laboratory, Bangalore. Each frame generates and displays approximately 3×10^6 bits of information arising out of almost 10^8 separate computations.

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FASCINATING INFINITY

Whereas the total number of stars and galaxies, elements and compounds, plants and animals, and even the particles in the universe is finite, *J.N. KAPUR* shows how the number of natural numbers is the only exception

THE concept of infinity arises only in mathematics and religion. However, while in religion, it is subjective and can be understood only after a great deal of spiritual maturity; in mathematics, it is objective and can be understood relatively more easily.

There can be no concept of infinity in physics or astronomy or chemistry or botany or zoology for the simple reason that the total number of particles in the universe is finite (of the order of 10^{82}), the total number of stars and galaxies is finite, the total number of elements and compounds is finite and the total number of plants and animals is finite. All these numbers are very large, but are still finite.

In mathematics, however, the concept of infinity arises very early. In fact, it occurs as soon as the child learns the concept of natural numbers. To every natural number n, there is a successor natural number $n+1$, so that there is no largest natural number indicating that the number of natural numbers is infinite.

This fact is simple and obvious but it still comes as a pleasant surprise to many. When this fact was explained to a clergyman, he saw in it a mathematical proof of the existence of God! He argued that as the sequence of natural numbers is limitless, there is no reason why we should not have an unlimited Being whom we call God. (Do you agree with his logic?)

Now, consider the infinite set of natural numbers and remove from it the infinite set of odd natural numbers. What remains is the infinite set of even natural numbers.

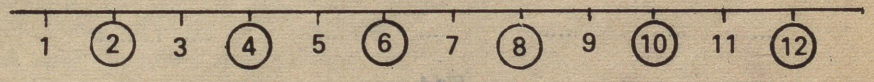


Fig.1 Infinite set of even natural numbers

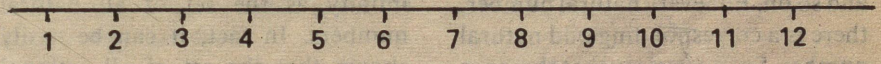


Fig.2 Finite set of five natural numbers

So, a subset of an infinite set can be an infinite set. In fact, an infinite set can have an infinity of infinite subsets.

Ancient Indians declared, on the basis of their spiritual experience: "Om, whole is that, whole too is that. Take away whole from whole and whole remains".

This looks paradoxical if we confine ourselves to finite sets only but becomes clear if we keep examples of infinite sets of natural numbers in mind.

However, consider the infinite set of all natural numbers starting from 6 onwards and take it away from the set of all natural numbers. What remains is the finite set of five natural numbers.

So, when an infinite subset is removed from an infinite set, what can remain can be a finite or an infinite subset.

The Infinity of Natural Numbers

The set of natural numbers and the set of odd natural numbers are both infinite. Which represents a greater

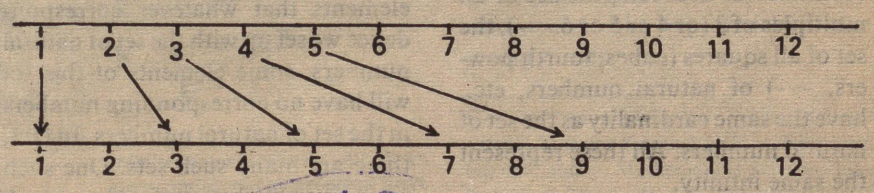


Fig.3

infinity? At first sight, it may appear that the first set represents a bigger infinity than the second set, but let us look at the matter a little more carefully, as we have already seen that the laws of finite sets need not necessarily apply to infinite sets.

To natural number *n*, let these correspond to the odd natural number

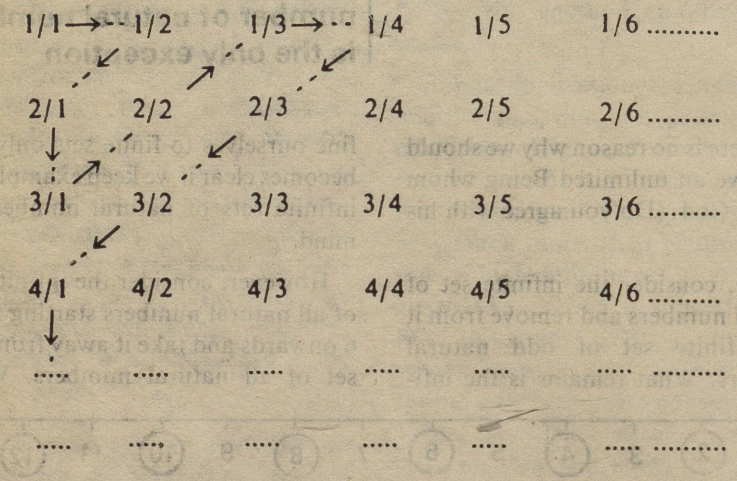


Fig.4

$2n-1$, so that 1 corresponds to 1, 3 corresponds to 2, 5 corresponds to 9, and so on. For every natural number, there is a corresponding odd natural number. So, we can say that there are 'as many' odd natural numbers as natural numbers. We express this by saying that the *cardinality* (or number) of the set of odd natural numbers is the same as that of the set of all natural numbers or that they represent the same infinity. This only means that we can establish a one-to-one correspondence between the set of odd natural numbers and the set of all natural numbers.

It is easily seen that the set of all even natural numbers, the set of all multiples of 3 (or 4 or 5 or 6 ---), the set of all squares (cubes, fourth powers, ---) of natural numbers, etc., have the same cardinality as the set of natural numbers. All these represent the same infinity.

In fact, we can show that even the set of positive rational numbers does not represent a higher infinity. Arrange all positive rational numbers as in Fig. 4, and begin counting them in the order indicated by the arrows in the dotted line. In this way every positive rational number will be counted. To every natural number, there is a positive rational number and vice versa.

So, the set of positive rational numbers has the same cardinality or infinity as the set of all natural numbers. In fact, it can be easily shown that the set of all rational numbers, positive or negative, has also the same cardinality as the set of natural numbers.

We denote this infinite number by N_0.

An Infinity of Infinities

Every set we have countered so far can be put into one-to-one correspondence with the set of natural numbers and has the cardinality N_0. The question naturally arises whether there are sets which have so many elements that whatever correspondence we set up with the set of natural numbers, some elements of this set will have no corresponding numbers in the set of natural numbers. In fact, there are many such sets. One such set is given by the set of real numbers where a real number is any number of the form:

$\pm a_1 a_2 \ldots a_m . b_1 b_2 b_3 \ldots b_n, \ldots$

where a's and b's are digits from 0 to 9. This decimal may be finite and terminating or may be non-terminating but recurring or may be non-terminating and non-recurring. It can be shown that the set of real numbers, if so 'numerous' or so large that whatever one-to-one correspondence with set of natural numbers we try to set up, some real numbers will have no corresponding numbers in that set. We express this by saying that the cardinality (or infinity) of the set of real numbers is greater than that of the set of natural numbers. We denote this infinity by N_1.

Next, consider the set of all real-valued functions of a real variable. It can be shown that the infinity of this set is larger than N_1. We denote this infinity by N_2.

Next, consider the set of all possible subsets of the set of all real-valued functions. It can be shown that the cardinality of this set is greater than that of all real-valued functions. We denote this infinity by N_3.

In fact, let N_k be the cardinality of any infinite set, then it can be shown that the set of all its subsets has a larger cardinality and we can denote it by N_{k+1}.

So, to every set, however large its cardinality, there corresponds another set, viz., the set of its own subsets which has a larger cardinality.

We have therefore an infinity of infinities, viz., $N_0, N_1, N_2, N_3, \ldots$ and we can say that

$N_0 < N_1 < N_2 < N_3 < \ldots$

and $N_k < N_1$, and $N_1 < N_m \rightarrow N_k < N_m$

We have now a ladder of infinity and we can go on climbing to higher and higher infinities along this ladder and there is no limit to the heights to which we can go.

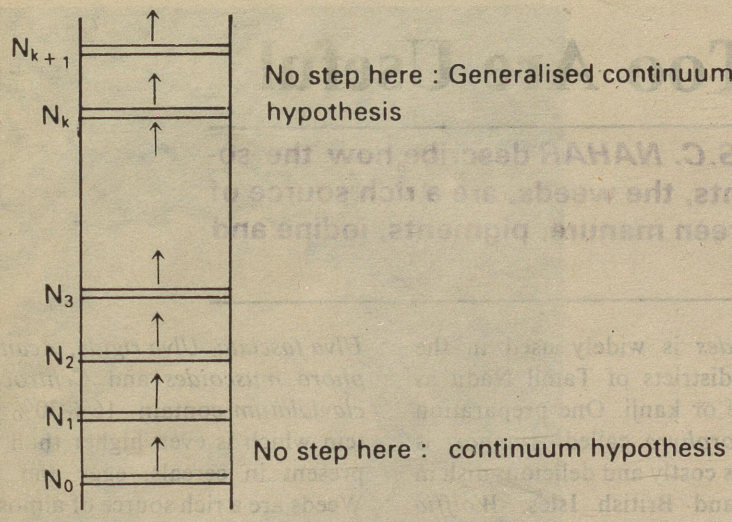


Fig.5 Ladder of infinity

Are There Other Infinities?

Can there be an infinity $> N_0$ and $< N_1$ i.e., can there be an infinity between N_0 and N_1? We do not know but on the basis of our present experience, we make a hypothesis that there is no such infinity. We call this the *continuum hypothesis.*

Can there be an infinity between N_k and N_{k+1}, i.e., can there be an infinity $> N_k$ but $< N_{k+1} (k = 0, 1, 2, 3, \ldots)$? Again, we do not know, but on the basis of our mathematical experience, we have the hypothesis that there is no such infinity and we call it the *generalised continuum hypothesis.*

Hotel with Infinite Rooms

Just as there is science fiction, we also have mathematics fiction. Consider a hotel with an infinite number of rooms, all of which are occupied. A new customer arrives. Does the hotel owner refuse him? No, he simply asks each one of his present customers to move to the next room and his first room becomes available for the new customer.

Now, suppose 100 new customers arrive. Is the hotel owner worried? No, he simply asks occupants of room number n to move to room number $n + 100$ and his first 100 rooms become available for the new customers.

Our hotel owner is not worried even if an infinity of new customers arrives. He simply asks occupant of room n to move to room $2n-1$ and all his even-numbered rooms become available for the infinity of new customers.

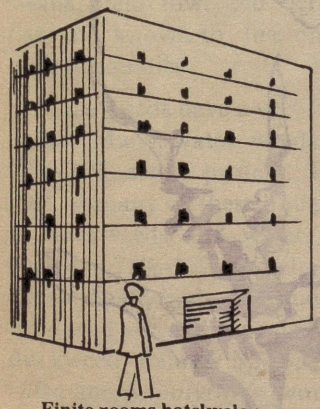
Rules of Game With Infinities

We have an algebra of infinities with its rules which are different from the rules of algebra of finite sets, but the rules are nevertheless there and these are fascinating. Georg Cantor (1845-1918) discovered some of these rules and many new rules have been discovered after that.

'The coquest of infinity' by mathematicians shows the power and dignity of human mind.

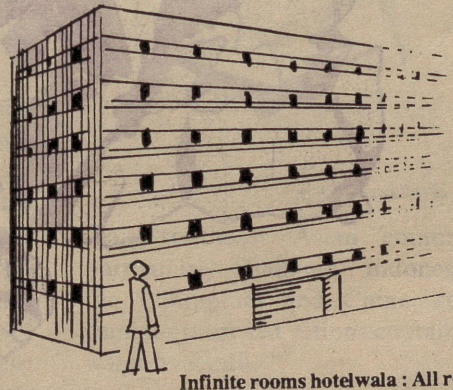
Georg Cantor

Cantor also said "The essence of mathematics lies in its freedom". It is this freedom to create that has enabled us to enter the domain of infinity and has revealed many new continents to be explored by brave young minds.



Finite rooms hotelwala : Sorry, all rooms are occupied, no accommodation

Fig.6



Infinite rooms hotelwala : All rooms are occupied, but no problem; there is plenty of accommadation available

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Weeds Too Are Useful

R.P. RAMAN **and** ***S.C. NAHAR*** **describe how the so-called unwanted plants, the weeds, are a rich source of food, animal feed, green manure, pigments, iodine and industrial products**

THE very name weed suggests a useless and harmful plant that persistently grows where it is quite unwanted. Whether a plant is considered a weed depends not only on its characteristics and habit but also on its relative position with reference to other plants and human beings. Thus a plant of economic crop may also become a weed if it is found growing with other crops where it is not wanted. But for all practical purposes weeds refer to undesirable, injurious, unsightly and troublesome plants which interfere with cultivated crops and affect human affairs.

But inspite of the fact that weeds are notoriously known for harmful characteristics, they are not absolutely useless, but possess some astonishingly beneficial attributes too. The best way to dispose of the weeds is to make use of it.

From the earliest times, man has utilized weeds for food. Weeds can provide three types of food—(i) foliage for use as a green vegetable; (ii) grain or seeds that provide protein, starch or oil; and (iii) swollen fleshy roots that provide carbohydrate, mainly starch.

AMONG the various weeds used as food, mention may be made of *Chenopodium album, Ipomea aquatica, Nasturtium officinal, Nelumbo nucifera* and *Wolffia arrhiza,* etc. which are widely used as nutritious green vegetable. *Gracilaria lichenoides* is widely used in the coastal districts of Tamil Nadu as porridge or kanji. One preparation from *Porphyra* called *Amanori* is served as costly and delicious dish in Japan and British Isles. *Wolffia arrhiza* is regarded as poor people's food which contains 20% protein, 44% carbohydrate and 5% fat. Some green and red water weeds such as *Ulva fasciata, Ulva rigida, Acanthophora muscoides* and *Centrocerds clavialatum* contain 16%-30% protein which is even higher than that present in cereals, eggs and fish. Weeds are a rich source of almost all vitamins. Vitamin C present in *Sargassum myriocystum* is 66.60 mg/100 g of fresh weed which is more than that of citrus fruit.

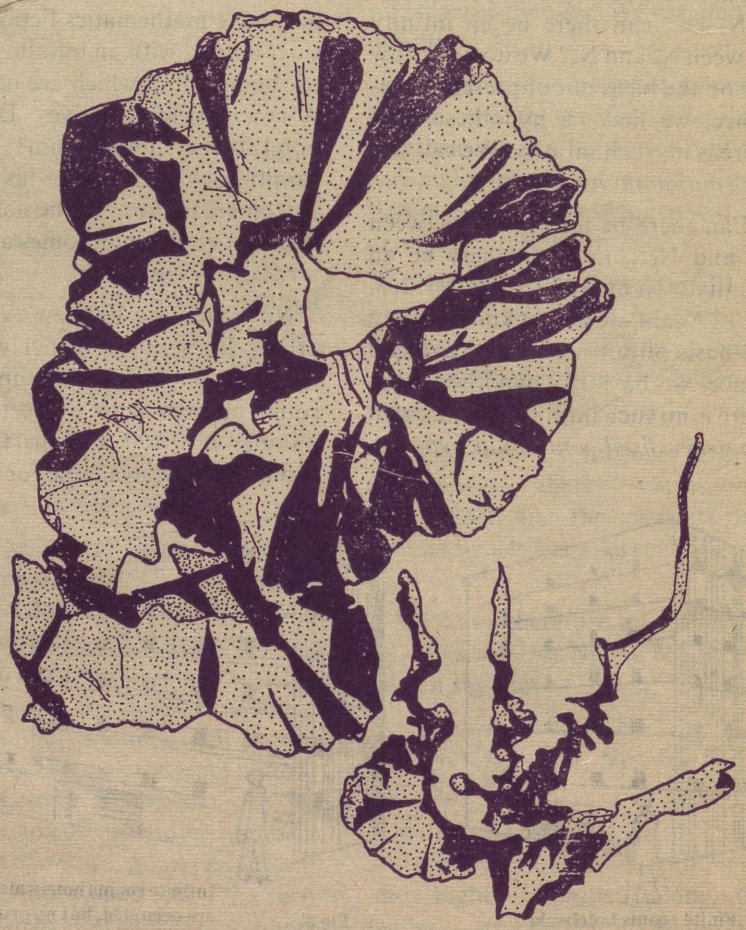

Fig.1. Porphyra teners Kzelln

Fig.2. Eichhornia crassipes (Mart), Water hyacinth

Many of the weeds are potential ruminant and other animal feed. Cattle, water buffalo, ducks, geese, swans, field fowl and herbivorous fish are known to live on weeds, mainly aquatics.

Some weeds have a very high food value. Many water weeds contain 10%-26% crude protein. The leafy part of many of these aquatics such as duckweeds and water hyacinth contains 25%-35% protein which is exceptionally high. The crude protein produced annually by one hectare of duckweed, namely *Spirodela oligorhiza* and *S. polyrhiza*, would equal that obtained from about 60 ha of soyabean if harvested each day. In many southeast Asian countries, particularly Thailand, Indonesia, the Philippines and China, some ruminants are fed rations containing water hyacinth.

Some submerged aquatics, such as *hydrilla* and water milfoil are particularly rich in carotenes and xanthophylls and could become new sources for these commercially valuable pigments, which many countries add to poultry rations.

Weeds can be used as green manure. The plants are either applied to the soil as a surface mulch or they are plough under or buried by hand in shallow troughs. In this way they increase the organic matter of the field and enhance its fertility by increasing nutrient contents.

GENERATION of combustible gases from water hyacinth has opened a new door in energy production. It has been estimated that the water hyacinth harvested from one hectare can produce more than 70,000 m^3 of biogas. Each kilogram of water hyacinth (dry weight) yields about 370 litres of biogas with an average methane content of 69% and

Fig.3. Gracilaria verrucosa (Huds) Papenfass

a calorific value when used as a fuel of about 22,000 KJ/m^3. 10m^3 of biogas has the equivalent energy of 8.6 litres of butane, or 7.0 litres of gasoline. The biogas burns readily. It can be used for virtually every application where natural gas is used for cooking, heating, lighting, etc.

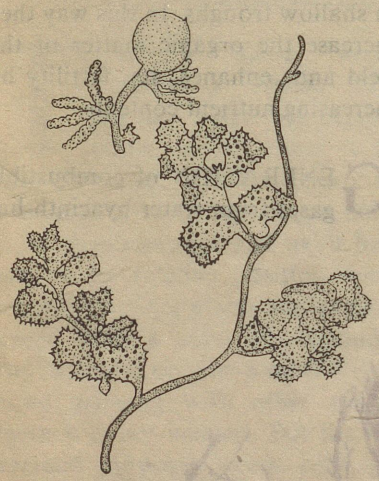

Fig.4. Sargassum duplicatum J.Ag.

Weed's natural filtration system can solve the water pollution problem to a great extent. They can scavenge potentially harmful, or odorous wastes from water including complex inorganic and organic materials like cadmium, nickel, mercury, phenol, and many potential carcinogens. After doing their clean up work the plants can be harvested for animal feed and fermented or chemically decomposed to form biogas, soil additives, etc., providing additional benefit.

One of the greatest economic potential of weeds particularly aquatics is its use as a promising source of pulp, paper and fibre. Many wetland plants such as *Phragmites, Typha, Cyperus* and water hyacinth have been found to produce pulp and other cellulose derivatives. *Phragmites communis* yields about 60% of pulp. The paper produced from *Cyperus* dated back to 3,500 B.C. and a set of books published in 1765 containing pages of *Typha* still exist. The Cyperus stems have no nodes hence the pulp is free of hard particles and even rayon-grade pulp can be produced.

AGAR is the commercial name given to the dried gel extract from the cell-wall of certain species of red algae. Important and commercially occurring agar-producing weeds of India are *Gelidiella acerosa, Gracilaria verrucosa, Gracilaria crassa, Gracilaria lichenoides, Gracilaria corticata* and *Gracilaria follifera.* Agar-agar has various uses. It serves as a stabilizer, emulsifier, thickener, preservative and gelling agent. It is used in sizing fabrics, in paper and glue manufacture, in clarifying liquour, in cosmetics, confectionary, pharmaceutical and cigarette industry.

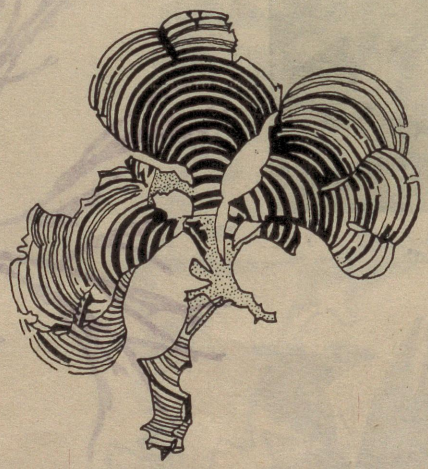

Fig.5. Padina pavonia (L) Lamour

Algin obtained from seaweeds is used in a number of industries particularly as a "protective" colloid, in suspensions and emulsions. Main use of alginates are, as sizing materials, in varnishes, as dyes; in cosmetics, in textile and paper industries; pharmaceuticals, as stabilizer in dairy products and for making fire-proof materials. Recent experiments with algin have shown it as an useful ameliorator of poor soil conditions.

Besides agar and algin, many other carbohydrate forms like laminarin, mannitol, fucoidal and cavrageenon, etc. have also been isolated from green, brown, and red algae.

Medicinal value

Weeds have medical uses too. Species of *Sargassum* are used for cooling and blood cleansing effect. *Hypnea musciformis* is employed as worm expelling agent, and *Centroceras clavulatum* as cathartic agent. Seaweeds such as *Asparogopsis taxiformis* and *Sarconema* are rich in iodine and hence can be used for controlling goitre.

Several kinds of seaweeds are burnt to supply alkali for manufacture of soap and for the preparation of alum and in the manufacture of glass of superior quality. *Macrocystis, Nereocystis, Pelagophycus* and a few others are best known potash yielders containing potassium chloride upto 30% dry weight. *Macrocystis* yields 16%, *Nereocystis* 18% and *Alaria* 7%.

Some of the larger brown seaweeds, such as the species of *Laminaria, Fucus, Ecklonia,* which are commonly known as kelps, are the source of commercial iodine. About 5%-7% of world supplies comes from Japan which produces about 100 tonnes of iodine per annum.

Investigations at the Regional Research Laboratory (R.R.L.), Jorhat have shown that water hyacinth can be moulded into useful and commercially viable cement boards. Use of hyacinth as a substitute for asbestos will eliminate the serious health hazards posed by handling asbestos like asbestosis and even a type of deadly cancer called mesthelioma.

S/Sh. Raman and Nahar are with the Estuarine Biological Station, Zoological Survey of India, Berhampur, Orissa-760 005.

PREVIEW

JUNE 1990

Cover Story : **Voyage to Venus**

Sometime in August the American spacecraft *Magellan* will arrive at the earth's twin to make the most detailed ever radar mapping of the planet's surface.

Does Sun Have a Companion?

Several terrestrial phenomena including the disappearence of dinosaurs 65 million years ago could be explained if our sun had a companion.

Also:

Beware of Polio—Timely vaccination can protect your child from this crippling disease.

Saving the Tortured Primates—The story of Shirley McGreal who has bravely fought for animals and saved many a hapless soul from cruel experiments.

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SKY CORNER


JUNE
Latitudes 0° to 40° N
NORTH
EAST HORIZON
WEST HORIZON
SOUTH
CASSIOPEIA
PERSEUS
CEPHEUS
AURIGA
Capella
Deneb
DRACO
LITTLE BEAR
URSA MINOR
URSA MAJOR
Polaris
Pollux
Castor
GEMINI
CANCER
CYGNUS
NORTHERN CROSS
Vega
LYRA
HERCULES
CORONA BOREALIS
BOOTES
Arcturus
Altair
AQUILA
LEO
Regulus
ECLIPTIC
EQUATOR
OPHIUCHUS
SERPENS
VIRGO
Spica
LIBRA
CORVUS
HYDRA
Antares
SCORPIUS
SAGITTARIUS
LUPUS
CENTAURUS
VELA
ARA
CRUX
SOUTHERN CROSS
TRIANGULUM AUSTRALE
CHAMAELEON
CARINA
MAGNITUDES
MINUS ONE
ZERO
FIRST
SECOND
THIRD
FOURTH
♄ Saturn

June

THE diagram shows the evening sky as seen from latitudes 0° to 40°N. The inner circle represents the horizon as seen from latitude 22°30′ N. The chart has been extended on the northern and southern sides for use all over India. Beginners wanting to use the chart should hold it overhead and turn it in such a way that the North, East and West marked on the chart point to the correct directions. With some experience it would be possible to use it in a more convenient position. With the help of a few known star groups in the sky the remaining stars can be easily identified using the above chart. From a particular place these stars will be seen at about 2130 hrs., 2030 hrs. and 1930 hrs. of local mean time on 1st, 16th and 30th of the month.

The star chart meant for a particular day for a given hour can be used for the next day 4 minutes earlier and for the previous day 4 minutes later. For example, if a chart is meant for 8–30 pm for 16th June it can be used on 17th at 8-26 pm and on 15th at 8-34 pm. In the same way it can be used for other months; for 16th May. It is for 10-30 pm and for 16th July it is for 6-30 pm and so on.

The stars move from east to west in the sky in their daily motion (due to rotation of the Earth) at a rate of 15° per hour. The chart can also be used at other hours in the evening after taking into account the above shift in position of the stars.

Planetary Positions for June 1990

Date	*IST*		*10TH*		*20TH*	
Planets	*R.A.*	*Decln.*	*R.A.*	*Decln.*	*R.A.*	*Decln.*
Mercury	2h 58m	13.2 N	3h 41m	17.0 N	4h 50m	21.6 N
Venus	2h 02m	10.2 N	2h 42m	13.6 N	3h 29m	17.0 N
Mars	0h 05m	1.5 S	0h 29m	1.0 N	0h 56m	3.8 N
Jupiter	6h 56m	23.0 N	7h 04m	22.8 N	7h 13m	22.6 N
Saturn	19h 47m	21.0 S	19h 45m	21.1 S	19h 42m	21.2 S

Adopted from figures supplied by Positional Astronomy Centre, Calcutta.

The Moon

THE full moon occurs on 8th at 4-31 p.m. and the new moon occurs on 23rd at 0-25 a.m. I.S.T. The moon passes about one and a half degrees south of Saturn on 11th, seven and a half degrees north of Mars on 17th, about seven degrees north of Venus on 20th, four and a half degrees north of Mercury on 22nd and about one and a half degrees north of Jupiter on 24th. The moon is at apogee or farthest from the earth on 6th and is at perigee or nearest to it on 21st. The lunar crescent becomes first visible after the new moon day in the evening of 24th.

The earth is in summer solstice on 21st.

The Planets

Mercury *(Budha),* visible in the morning sky, rises about an hour before sunrise during the first three quarter of the month. Thereafter it comes too close to the sun to be visible. It passes about 4° north of the star Aldebaran *(Rohini)* on 18th. It moves from Aries *(Mesa)* to Gemini *(Mithuna)* through Taurus *(Vrisha).* Its visual magnitude varies from +0.6 to -1.2.

Venus *(Sukra),* visible in the morning sky, rises about two hours before sunrise during the month. It moves from Aries *(Mesa)* to Taurus *(Vrisha).* Its visual magnitude is about -4.0.

Mars *(Mangala),* visible in the morning sky, rises about an hour after local midnight during the first half of the month and about half an hour after it during the second half. It is in Pisces *(Mina).* Its visual magnitude is about +0.4.

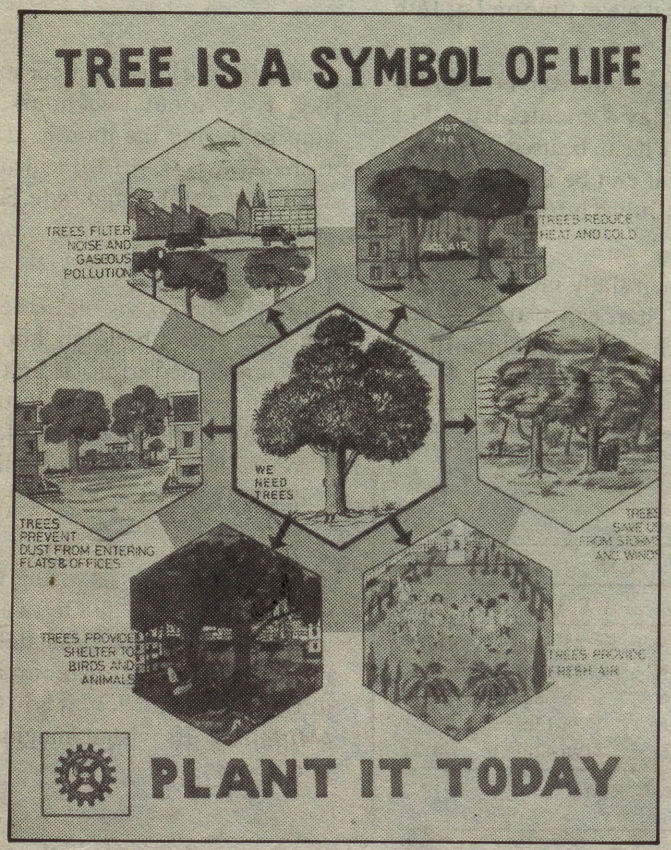
Jupiter *(Brihaspati),* visible in the evening sky, sets about two hours after sunset during the first half of the month and about an hour after it during the second half. It is in Gemini *(Mithuna).* Its visual magnitude is about -1.8.

Saturn *(Sani),* visible in the morning sky, rises about two and a half hours after sunset during the first half of the month and about one and a half hours after it during the second half. It moves from Capricorn *(Makara)* to Sagittarius *(Dhanus).* Its visual magnitude is about +0.2.

(*Source:* Positional Astronomy Centre, India Meteorological Department, New Alipore, Calcutta-700053)

Your Science Project

AS we are heading towards 21st century the demand of highly trained scientific and technical personnel with creative ability is also increasing. This, in turn, depends upon the standard of science education in schools and colleges. The creative ability among science students can be better nurtured if science projects become a part of science education. In recent times, science projects have become increasingly popular as adjuncts to science education. They foster habit of effective planning, attention to detail, careful work, and high performance standards that will serve as well throughout our lives. Better understanding of an area of science is the least that we can gain from doing a science project. However, the successful execution of a science project depends upon several factors like careful selection of the topic, preliminary research, sources from where one gets help, project adviser and techniques of exhibiting the project.



Poster Idea : O.J.Chakre. Drawn by M.V.Pant

PERHAPS, the most important phase of a science project is the selection of the topic for study. The science projects can be classified into three groups : experimental, theoretical and instructional. The first involves the discovery of knowledge by field or laboratory investigation, while the second is concerned with developing new information by the combination or extension of basic principles. By instructional projects are meant those that present information, already known, in a lucid and interesting fashion as instruction to others.

As you will necessarily spend considerable thought, time, physical effort and money on your project, pick a topic from which you can expect to learn something. Before starting a science project, take the time to examine your objectives, abilities, goals and interests so that you don't bite off more than you can chew. Once you are satisfied that your science topic is within your capabilities, time should be the next thing to be considered. Projects require time allotment for planning, research, setting up the project, working through it, assembling results, and drawing a conclusion. You may identify promising topics by going through science magazines, journals and books on the subject of your interest and encyclopedia of science and technology. When a project idea has at last been discovered and you have definitely decided to do your science project on that particular subject, be sure to consult your teachers and other professionals about it. You can have projects on agricultural sciences, botany, zoology, physics, chemistry, biochemistry, biotechnology, mathematics, engineering, earth and space sciences, medical and health, meteorology, pharmaceutical sciences, pollution, energy, etc. A number of project ideas are given (See Box.)

WHILE the choice of topic for the science project is still being explored and many students are undecided, the project adviser must come forward to discuss with the students the methods of collecting information about the science

Project Ideas

1. Agricultural Sciences Projects : Equipment for moisture determination of hay silage; Fungicidal treatment of seeds; Frost and soil conditions; Rainfall disposal by trees; How wood shrinks and swells; Effect of hormones on plant growth; Soil pH and plant growth.

2. Botany Projects : Plant classification; Identification of local trees by their winter buds; Light and transpiration; Response of seedlings to light; Factors affecting the germination of seeds; Plant growth substances; Enzymatic conversion of starch to simpler carbohydrates; Plant breeding; Effect of fertilizer on plant growth; Grafting and budding.

3. Zoology Projects : Soil fauna census; An animal community associated with a species of plant; Substances that attract cockroaches; Effect of tranquilizers on honeybees; Tracing flight pattern of flies; Using fruit fly to study the laws of heredity; Bird migration studies.

4. Chemistry and Biochemistry Projects : Water analysis; Origin of chemical elements; Growth of crystals; Capcity of charcoal for the adsorption of gases; Chemiluminescence; Protective coatings; Chromatography; Manufacture of paints; Effects of solvents on plastics; Spectrophotometric determination of rare earth chelates; Calorimetric estimation of some metal complexes; Polymer chemistry; Biosynthesis of amino acids—key to origin of life; Photosynthesis of amino acids in relation to origin of life; Amino acid assay; Extraction of essential oils; Caffeine from tea.

5. Physics Projects : Electronic velocity detector; Heat conductance through wood and metal; A micro refrigerator; Primary colours of light; Bending of light by obstacles; Pinhole camera; Model of an atomic reactor; Transformer; Construction of a microscope; Refractometer; Archimedes principle; Thermoelectric generators; Solar batteries; New uses for magnets.

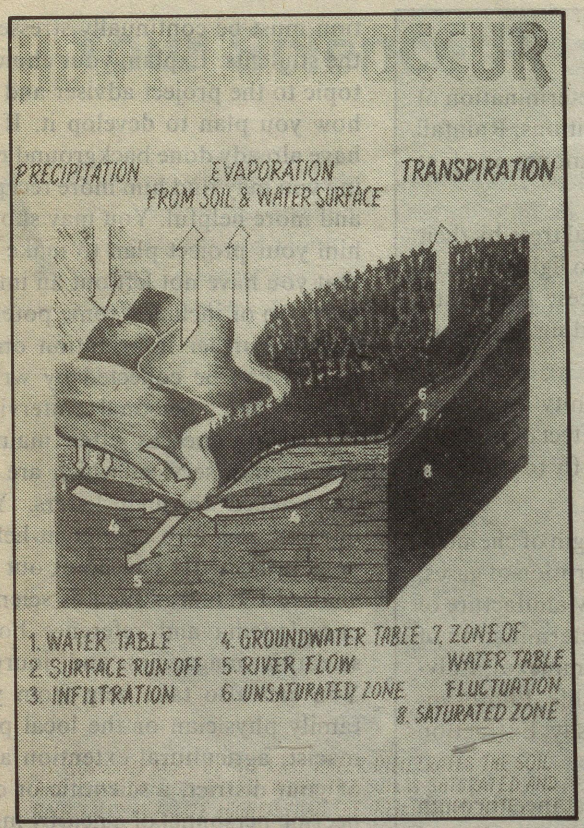
6. Mathematics Projects : Mathematical games and puzzles; Mensuration models; Pythagorean relationships; Computer; Simple manual computer applications; Electronic machine for playing a simple game; The concept of infinity; Calculation in calendrs.

7. Meteorology Projects : Lightning photography; A model of a tornado; Radar storm detection and tracking; A 'Satellite-Eye-View' of India showing weather and reflective conditions; The water of hydrologic cycle in nature; Model of a cyclone or typhoon; Amateur weather station; Natural and artificial cloud seeding; Thermal balance of the earth and atmosphere; Planetarium model.

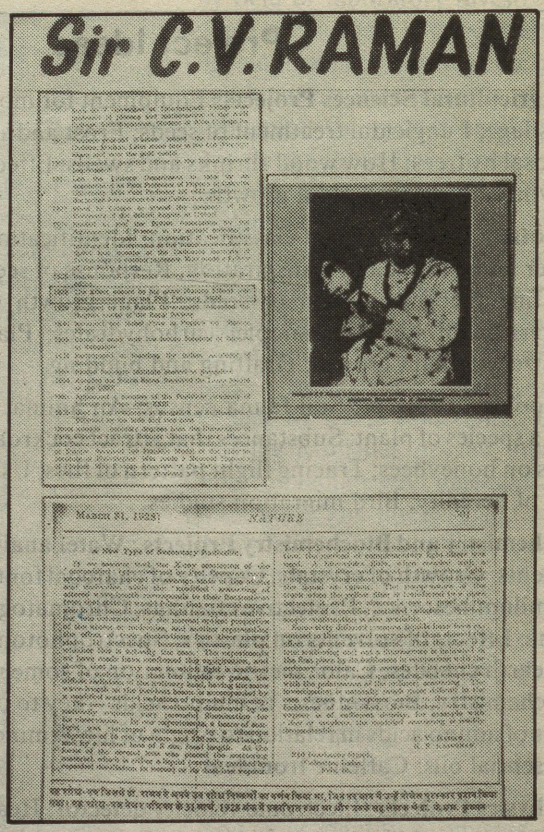
8. Medical And Health Science Projects : Energy metabolism experiment; Specificity of antibiotics; The heart beat; Physiological and genetic studies in colour blindness; Antibodies; Thyroid hormone and obesity; Effects of absorbed chemicals; Electrocardiography; Toxicity in rats; Zone electrophoresis; Effect of tranquilizers.

L.M.

topics. He must explain and possibly illustrate with examples how to collect and collate material from several sources and how to write a scientific report embodying the most useful and interesting information acquired. The importance of keeping careful records of their sources of information must be continually stressed to the students. Explain your choice of topic to the project adviser and also how you plan to develop it. If you have already done background reading you may find him more receptive and more helpful. You may show to him your project plan to make sure that you have not left out an important step or included some potential pitfall. Further information on the project can be collected by writing letters and personal interviews. Industrial concerns often maintain information services which are best approached through letters. Your librarian can also be a great help in your project. He can point out specialized references such as scientific encyclopedia and reference books, scientific magazines and journals. You can also take help from your family physician or the local pharmacist, agricultural extention agent of your district, a scientific or engineering personnel of a nearby manufacturing plant, research laboratory or college. For example, if you want to do a project on agricultural sciences, then you can take the help of agricultural officer of your district or scientists of nearby agricultural institute and agricultural university. A project on energy can be tackled by first going through the journals and books on energy. Much information on energy can be gathered by going through the 'Energy Digests' published by Tata Energy Research Institute Documentation and Information Centre, New Delhi. Each issue comprises abstracts, summaries and digests. Nearly 300 primary journals and other sources such as conference proceedings, technical reports, books, etc., are scanned through these digests. They also publish another journal entitled "Energy Environment Monitor" which can also be of great help in executing a project on energy. In case of projects on environment and pollution, much



Poster idea : N.R.Mankad. Drawn by Mohan Singh



Poster idea : Rajiv Mathur

useful information can be gathered from 'Environmental Review' published by American Society for Environmental History. Another good source is 'Environmental Resources Abstracts' published by Environmental Services Group based at New Delhi. This contains abstracts, news and feature items relevant to environment.

A science exhibit is a piece of visual information and its merit depends largely on its effectiveness in this respect. Try to organize your exhibit content so that it will be meaningful to viewers who know less about it than you do. The following outline may be followed: (1) Title: It should be as brief and as non technical as possible. A subtitle may explain and amplify the main title; (2) The summary message: Give the viewer a capsule information of the project and its significance. Keep it simple; (3) Hypotheses and conclusions: List those briefly in a manner understandable to the average viewer. Those interested in detail can find them in your notebook and project report; (4) Methods and scope of investigation: Hit out the high points, but emphasize instances where you feel you displayed unusual imagination and ingenuity; (5) Observation and data: Both are important but in an exhibit too many data can be dull. Select only those which are essential to the capsule story of your project; (6) Photographs and illustrations: List all photographs you have already taken of your project, ones you can still obtain, and drawings which illustrate or help narrate your story. Don't be selective yet. Later, when you are designing your exhibit layout, space limitations will force you to choose; (7) Handout brochure: An important but frequently overlooked exhibit component is the handout brochure to be distributed to interested viewers. The brochure provides all viewers a reference when they discuss the science exhibition and your exhibit with others.

After completing your project and exhibit, you present your evidence, your deductions and conclusions, explaining the project as shown in visual form and amplifying points of doubt where necessary. If you write a brief synopsis of your entire experiment it may stand in good stead when you are asked to explain your project at the exhibition. If speaking in public is difficult for you, your written notes will offer you a device upon which you can rely.

Lalit Mohan Mathur
Scientist, Publications & Information Directorate
New Delhi-110012

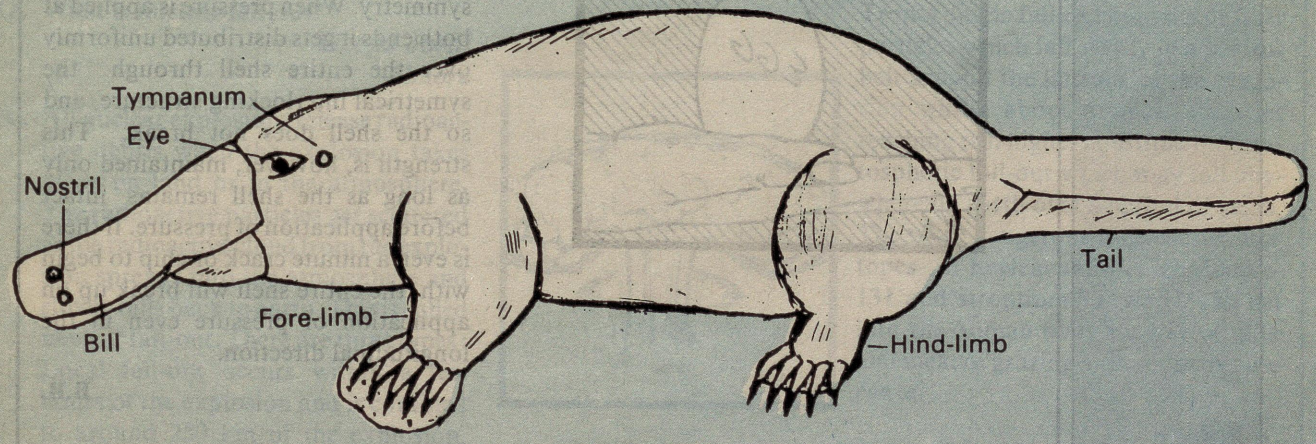
Duckbill Platypus

MOST of the familiar mammals belong to the subclass Theria of Mammalia. However, there is one other group of mammals which is unfamiliar to those not living in Australia; this order is the Monotremata of the subclass Prototheria. These are the most primitive living mammals because they show extraordinary mosaic of reptilian and mammalian characters.

Duckbill platypus, *Ornithorhynchus anaticus,* belongs to the order monotremata. It owes its name 'duckbill' to a black horny bill like that of duck. Ever since the first 'platypus' (meaning a "dried skin") arrived in England in 1798, this animal has been the center of controversies. Initially, the specimen was considered a fake in that a taxidermist had stitched together the beak of a duck and body parts of a mammal! Length and weight vary from area to area, and weight varies with season. Males are significantly larger than females. The young ones are about 85% of the adult size when they first become independent. The animal makes burrows upto 12 meters long in rivers, streams and lakes which have water throughout the year and whose banks are suitable for burrows. It is found in the Eastern Australian coast from Cooktown in Queensland to Tasmania. A platypus spends most of the time either under water or in burrows. It dies in captivity and has only rarely bred outside its natural habitat.

A platypus can roll into a ball. The body is flat, covered with soft brown under fur and harsher outer fur. Upper jaw is covered with soft, shiny, black, hairless skin and has pitted tactile organs; it also bears nostrils. The platypus finds its way and food chiefly by smell and touch. In 1988, a team of scientists led by Uwe Proske of Monash University, Melbourne, Australia, reported the presence of electroreceptors in the platypus bill. The entire bill is studded with electroreceptor cells and is sensitive to both steady and alternating voltages. A platypus uses the electroreceptors primarily to find food by detecting electrical impulses emitted by its prey. The electroreceptors may also be used for navigation. By its very motion, a stream creates electrical fields which a platypus may use to detect the contours of its bottom because while feeding underwater it shuts its eyes, ears and nose. Teeth are present only in the juvenile stage. They are replaced by horny epidermal plates in the adult and are used for breaking and grinding hard food particles. Platypus is semi-aquatic carnivorous mammal; it feeds on worms and molluscs. When animal is underwater, both its eyes and ears (without pinnae) are covered by skin pouches. All four feet are webbed for swimming. The fore-limbs are stronger and shorter than the hind-limbs, and five digits end in claws. The hind-feet are only partially webbed; they are used in water only as rudders while the fore-feet have large webs and are the main organ of propulsion. In male only, there is a sharp, movable, fang-like grooved spine connected with a poison gland

(Continued on page 41)

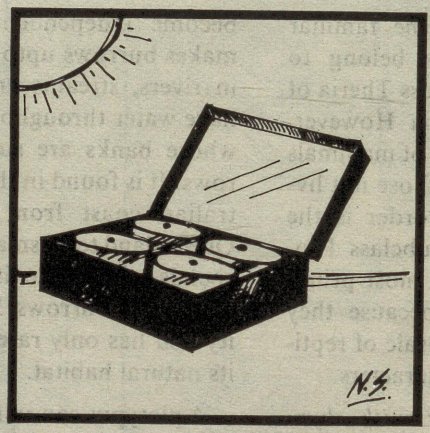


Duckbill platypus.

Q. What is a solar cooker?

Ravindra Mishra
Madhya Pradesh

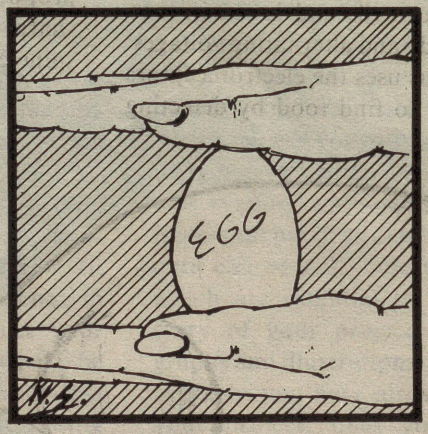
A. A solar cooker is a device which cooks food using the sun's heat. Ordinarily, even on a clear day in summer, the heat generated by sunlight is too weak to be useful for cooking. In a box-type solar cooker, high temperature is produced by trapping sun's heat in a double glass covered insulated box. Absorption of the box and the outside of the cooking container dull black. A mirror fixed on the inner side of the open lid of the cooker reflects additional sunlight into the blacked cooking chamber increasing the efficiency further. The inside temperature of the cooker can easily reach 140°C in bright sun.



Biman Basu

Q. When an eggshell is pressed on both ends between the palms why does it not break?

Umesh Kumar Jha
Bihar



A. An eggshell is made up of minute crystals of calcium salt joined together in an interlocking structure which gives it strength in the direction of the axis of symmetry. When pressure is applied at both ends it gets distributed uniformly over the entire shell through the symetrical interlocking structure, and so the shell does not break. This strength is, however, maintained only as long as the shell remains intact before application of pressure. If there is even a minute crack or chip to begin with, the entire shell will break up on application of pressure even in the longitudinal direction.

B.B.

Q. What is meant by jewels in a wrist-watch?

Debashish Sen
Burdwan

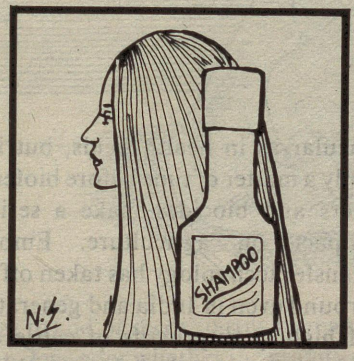
A. A hand-wound or self-winding watch has more than a hundred parts. The durability and quality of a watch depends on the frictionless working of its moving parts. In order to reduce friction and wear, the important moving parts are set in bearings made of synthetic jewls, usually rubies or sapphires. The ends of the escapement lever in expensive watches are also made of jewels. Normally, 17 to 25 such small jewels are used in wrist watch.

K.K.K.

Q. What is shampoo?

Deepa Chawla
New Delhi

A. A shampoo is a kind detergent used specifically for cleaning hair. Available as opaque liquid or cream, it is more effective than ordinary soap. As compared to soap, it has better solubility in water, insensitivity to hard water and high grease-removing power. The basic job of a shampoo is to clean hair by removing greases, such as sebum and oil, that bind dust particles to hair and scalps. Sometimes a shampoo also contains ingredients to meet special requirements of hair such as conditioning of dry or greasy hair or to combat dandruff.

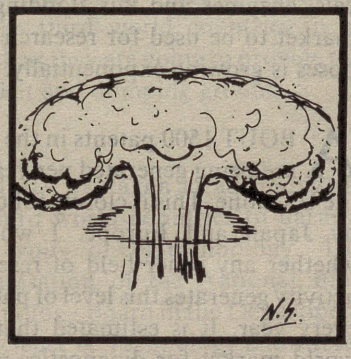


K. K. Kakkar

Q. What is nuclear fall-out?

Deepa Joshi
Almora

A. All nuclear explosions release radioactive debris when the explosion takes place on land or in the atmosphere. The radioactive particles get scattered as the radioactive cloud from the explosion spreads into the atmosphere and slowly falls back to earth. This is called nuclear fall-out. There are three types: Local fall-out occurs within a few hours of the explosion and is confined to around 250 km of the explosion. Tropospheric fall-out consists of finer particles which fall slowly in a narrow belt around the latitude of the explosion within about a week. Particles reaching still higher constitue the stratospheric fall-out which may fall anywhere on earth over a period of years. The most dangerous radioactive isotopes in nuclear fall-out are iodine-131 and strontium-90, which can get into the human body by way of milk and meat of grazing animals and cause cancer.



K.K.K.

BIOTECHNOLOGY IS SERIOUS

G. Padmanabhan

IN some quarters in India, biotechnology is still being considered as a mere land of promise. If one follows carefully the trends in international research, it would become immediately apparent that it has become a reality and would sweep the globe in the 21st century. Let us look at the realities from different perspectives.

HUMAN insulin, growth hormone, tissue plasminogen activator, streptokinase, a couple of interferon species are commercial products and many more are in the pipeline. A host of diagnostics based on a variety of immunochemical techniques for the detection of cancers and other genetic disorders as well as infectious diseases are slowly flooding the market. Besides, production of many conventional biotech products such as amino acids, antibiotics and extracellular enzymes are getting modernized in view of newer strains being made available or due to some of the rate-limiting steps being tackled by recombinant DNA approaches. Modern vaccine candidates for atleast some of the infectious diseases are available. These include hepatitis, polio and measles.

In the area of plant biotechnology, tissue culture is making inroads not only in the area of cut flowers and ornamental plants but also in raising tree species to provide biomass. The generation of somatic embryoids as elite seed stock will catch up soon. True, the achievements in modern plant biotechnology are not as spectacular as in health fields, but it is only a matter of time before biofertilizers and biocides make a serious impact on agriculture. Embryo transfer technology has taken off the ground even in India and generation of high quality herds of cattle and sheep should take place within a decade. Inputs of modern research into aqua-culture have already led to strategies for augmented fish production. The number of fine biochemicals, enzymes and kits flooding the market to be used for research purposes is growing exponentially.

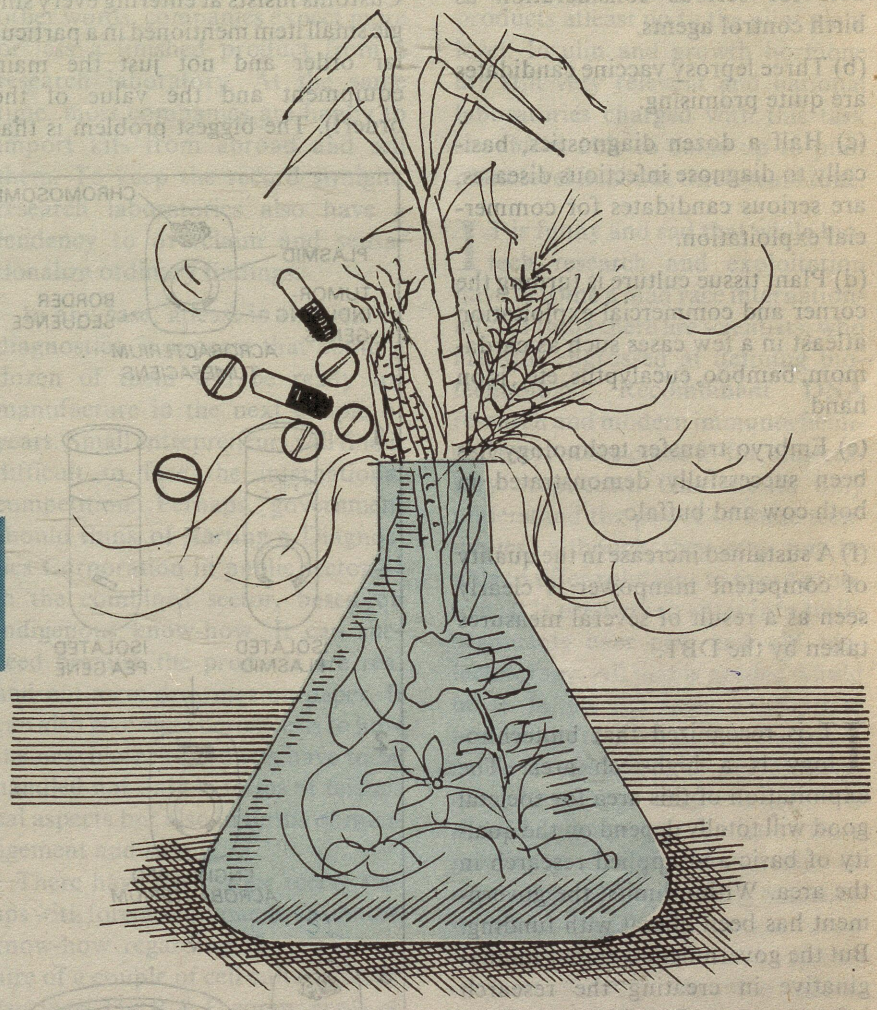
ABOUT 1500 patents in the field are being generated per year by the US alone. This is closely followed by Japan and Europe. I wonder whether any other field of research activity generates this level of patents every year. It is estimated that the world market for diagnostics alone will grow from $ 7164m in 1987 to 13,239m in 1995 (Boston Biomedical Consultants, MA, USA). It is estimated that the European market for DNA diagnostic probes will reach $ 269m in 1992. These figures are quoted just to illustrate how segments of the biotech scenario are developing. I believe, we are living in the midst of a revolution and one does not realise its momentum when one is riding on it.

LET us look at a sample of patents being generated internationally:

1. Diagnostic system for detection of cytomegalo virus.
2. Preparation of cell wall components from archaebacteria.
3. Nitrogen fixation regulator genes.
4. Sterol regulatory elements and positive promoters.
5. Hybridomas and monoclonal antibodies to interleukin 2.
6. Novel superoxide dismutase.

The reason for giving this patent list is to illustrate that every finding under the sun, from the subline to ridiculous is getting patented. The term 'ridiculous' does not cast an aspersion on the importance of the

In the area of plant biotechnology, tissue culture is making inroads not only in the area of cut flowers and ornamental plants but also in raising tree species to provide biomass



S BUSINESS

finding; but refers to a finding that nobody would have thought of patenting a few years ago. In other words, even laboratory protocols of standardisation and elements totally in the realm of basic research are getting patented, because there is likely to be a commercial potential.

This leads to a secrecy element among the scientific community. Free exchange of knowledge and material within the community, except within collaborating groups, is dwindling. The third world countries are at a serious disadvantage, where the entire research and development depends on imported material and perhaps knowhow. If one adds consequences of intellectual property rights, etc., to this situation, the writing on the wall regarding future of these countries in this area is clear. In the 21st century, I believe that the west would dictate the third world as to what detergent to use to remove a laundry stain, or what yeast strain to use to bake the bread, or what brand of seeds to sow to reap a crop. I wonder whether the gravity of the situation is realised in the third world countries. Markets may go up and down for biotech products in the west for a variety of local reasons. These are not of much consequence to the third world countries in as much as they are going to provide the market and dumping ground.

INDIA has taken a lead among the third world countries to harness the fruits of biotechnology. The organisation of the National Biotechnology Board in the Department of Science & Technology and subsequently elevation of this board to a full fledged Department have indicated the importance which the government attaches to the development of biotechnology in the country. The Department of Biotechnology has brought many of the tissues into focus and has taken several measures at generating competent manpower, identifying areas of priority, promoting research in such areas, and organizing measures to commercialise and exploit the research for public good.

Considering that an organized attempt at promoting the new biotech area is taking place only during the last 8–9 years, the progress made in the country is significant. What have we achieved?

(a) Two vaccine candidates are avail-

able for serious consideration as birth control agents.

(b) Three leprosy vaccine candidates are quite promising.

(c) Half a dozen diagnostics, basically to diagnose infectious diseases, are serious candidates for commercial exploitation.

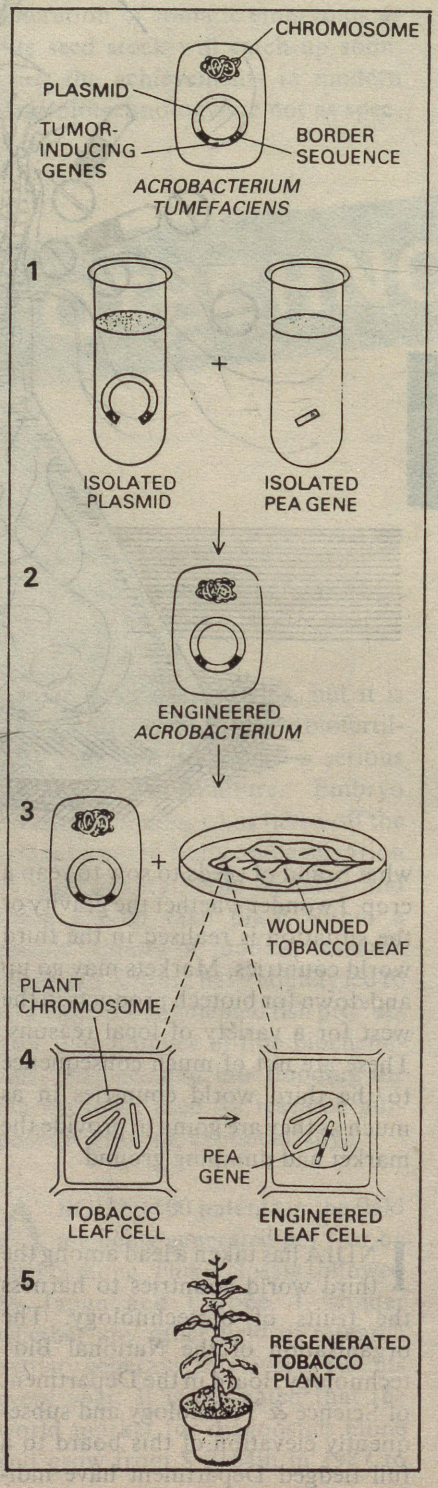
(d) Plant tissue culture is turning the corner and commercial exploitation atleast in a few cases such as cardamom, bamboo, eucalyptus, etc., is on hand.

(e) Embryo transfer technology has been successfully demonstrated in both cow and buffalo.

(f) A sustained increase in the quality of competent manpower is clearly seen as a result of several measures taken by the DBT.

IT is recognized that biotechnology is a high-tech area. The exploitation of this area for societal good will totally depend on the quality of basic and applied research in the area. Within limits, the government has been liberal with funding. But the government is rather unimaginative in creating the research infrastructure. One is not able to effectively use the funds available to achieve time targeted goals. This is because, equipment, research chemicals and other consumables are totally imported. Government concessions at importing these items come in fits and starts. Even the introduction of the recent pass book system, permitting public funded institutions to import consumables up to Rs 50 lakhs and equipment under Rs 5 lakhs up to 1 crore has been done very unimaginatively.

The problems range from the inadequacy of one pass book to big institutions to mode of operation of one book for several items imported, say, by a university at any one time to even the size of the pass book (the Customs insists at entering every single small item mentioned in a particular order and not just the main equipment and the value of the order!). The biggest problem is that the pass book does not eliminate Customs and the Customs has no feel for perishable items (most biotech research chemicals are perishable) or time element. Should the finance pundits look at these concessions only in terms of loss to the exchequer? What is the use of spending all the money and going through the harassment by Customs, if the chemicals have perished or if the clearance of equipment is inordinately delayed? In our country, for a time-targeted 3-year research project, 6 months to 1 year are spent in importing the items necessary to carry out the project. Will the heavens fall and the country's economy collapse, if public funded research institutions are permitted to import directly materials for research without the interference of Customs? If the powers that be in the Finance/Revenue ministry have a clear perception of what the field is heading for and what the stakes are there for the country, then they will not only be liberal in deciding the funds position for the area but also find ways of effectively utilizing this money.



The second issue is more ticklish than the first. If the country depends totally on imported infrastructure to carry out research, is there any hope of achieving supremacy atleast to the extent of achieving self sufficiency? Why no one comes forward to manu-

Moving genes from one plant species to another requires the assistance of the microbe Agrobacterium tumefaciens. The bacterium contains a circular piece of DNA known as a plasmid that ordinarily causes tumors in plants by transferring deleterious genes to its host. Plant biologists remove the tumor-including sequences and replace them with a gene isolated from, say, a pea plant (1). The plasmid thereby created is put back into Agrobacterium(2) and engineered bacterium is introduced into plant cells of a different species through wounds in a leaf(3). The cells the bacterium infects require the pea gene (4). The medium in which the leaf is embedded encourages the growth of cells that have the "transgene" but kills cells without it. In a few weeks the "planetlets" are put into soil(5).

facture biochemicals or equipment for research, while there are hundreds of agents collecting their commission from foreign companies? The standard answer is that these pursuits are not economically viable. But there is grave danger in our total dependence on imports considering the international stakes in the area. Even now certain precious chemicals for research are bought out in bulk by major laboratories in the west. The same will not be made available to us or such products made available to us can be of inferior grade. This together with our import problems can seal the fate of any worthwhile research in the country.

It is recognized that biotechnology is a high-tech area. The exploitation of this area for societal good will totally depend on the quality of basic and applied research in the area

Serious attempts have to be made in the country to manufacture research chemicals and equipment. This can even be done by small manufacturers or as a tie-up with foreign companies. The important point is that manufacturing activity should take place on our soil.

THERE are atleast half a dozen diagnostics developed in research laboratories in the country, more or less ready for commercial exploitation. But there are no takers. Companies have to be goaded and processes given at throwaway prices. Besides, competence for developmental research in the area does not reside in most of these companies. In other words, companies expect more or less a finished product from a research laboratory. At the same time, most companies are happy to import kits from abroad and sell them. To keep the record straight, research laboratories also have a tendency to overclaim and sensationalize ordinary findings.

In any case, atleast in the field of diagnostics, it appears that about a dozen of them will be ready for manufacture in the next couple of years. Small entrepreneurs will find it difficult to face the international competition. Perhaps, government should think of starting a Diagnostics Corporation in public sector or in the combined sector, based on indigenous know-how. It can succeed because the products are real and not mere drawings on paper. It can also give an experience as to how the new biotech products have to be handled not only in terms of technical aspects but also in terms of management and supply.

There have been some recent tie-ups with foreign companies to import know-how regarding the manufacture of a couple of cell culture based vaccines. The R & D components of these deals should be taken up seriously so that eventually the country builds up its own know-how, learning from the imported technology.

In the area of production of pharmaceuticals based on recombinant DNA methodologies, our progress even at the research level is poor. We do not have good expression systems (living cells producing desired proteins) working in any laboratory, that can make an economically viable process. Our own strategies and units for downstream processing of recombinant DNA products are almost non-existent. Progress in this area can be achieved if national laboratories are charged with time-targeted goals to produce specific products atleast up to the pilot plant level. Insulin and growth hormone are still very relevant and national laboratories charged with this task should be able to come up to pilot plant level in about three years time.

IT is funny and sad that while biotech research and exploitation have become a mad race internationally, in India there are scientists, who are still engrossed at defining biotechnology. Recombinant DNA research and modern immunochemical approaches come in for unnecessary scepticism. One should only understand the power of these techniques, although they may not be able to offer solutions to every problem. It is needless to enter into futile arguments over new and old biotechnology. All that is needed would be to follow the most appropriate technology that will deliver the goods in the environment of our country, competence and unique milieu. It should only be realized that we have massive problems to solve, viz., to contain population growth, eradicate infectious disease, increase crop yields, increase nutrition status, increase exports of value added goods. It is obvious that any one strategy is not going to solve these issues. Problems should be looked at in totality and biotech approach is only a component in the overall strategy. Many agencies have to put their heads together to solve these problems. In the final analysis, it should be recognized that biotech is a much cheaper technology than inputs needed for space or atomic energy technologies and atleast has as much potential as the other two to benefit mankind. At the same time, the issues also pose several intellectual scientific challenges.

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ANTARCTIC METEORITES

The story of recovery of meteorites in Antarctic region and how it has challenged the present theory of meteoritic origin is interestingly told by *DEBASHISH SENGUPTA*

APART from planets, satellites of different planets and the sun itself, the solar system is constituted of numerous smaller bodies that move about the sun but are not 'attached' to planets. These bodies are asteroids, meteoroids and comets. The solar system is believed to have origniated from a pre-solar gas and dust cloud, to so-called 'solar nebula'. Our current conception of the early solar system is that the nebula started shrinking after its formation into a disc-like shape with a central bulge and the dust started condensing. The condensed material formed into grains which aggregated to form larger bodies, to so-called 'planetesimals', which in turn formed the planets. The growth at this stage occurred by capture. The larger bodies grew at the expense of the smaller ones. Asteroids represent the left over material from this stage; they in turn gave rise to meteoroids.

ASTEROIDS are small objects (less than about 400 km) lying between the orbits of Mars and Jupiter and form the so-called asteroid belt as shown in Fig. 1. In comparison meteoroids are still smaller bodies, some of which can enter the orbit of earth and can be recovered from its surface as meteorites. It was believed for long that meteorites are only fragments of asteroids removed from them by high velocity collisions with each other. A comet consists of a dense nucleus (a few kilometers in size) surrounded by a gaseous envelope, called 'coma'. In the neighbourhood of the sun, it develops a tail always pointing away from the latter. Comets populate the cold outermost regions of the solar system and are not visible unless their orbits are changed by the action of gravity which sends them into the inner solar system. After a number of orbits close to the sun, the dust in the cometary nucleus forms a broad stream around its orbit known as a 'meteor stream'. Most of this dust burns up in the atmosphere as 'meteors' but some of the smaller particles reach the surface of earth intact, the so called 'micrometeorites'. The earth therefore receives dust from the outermost solar system in addition to meteorites.

METEORITES are representative samples of pre-planetary material originating mainly in the asteroid belt and must have witnessed the various events that took place in the primitive solar nebula. Before the manned lunar landings, meteorites were our only samples of extra terrestrial materials and hence of immense practical and scientific

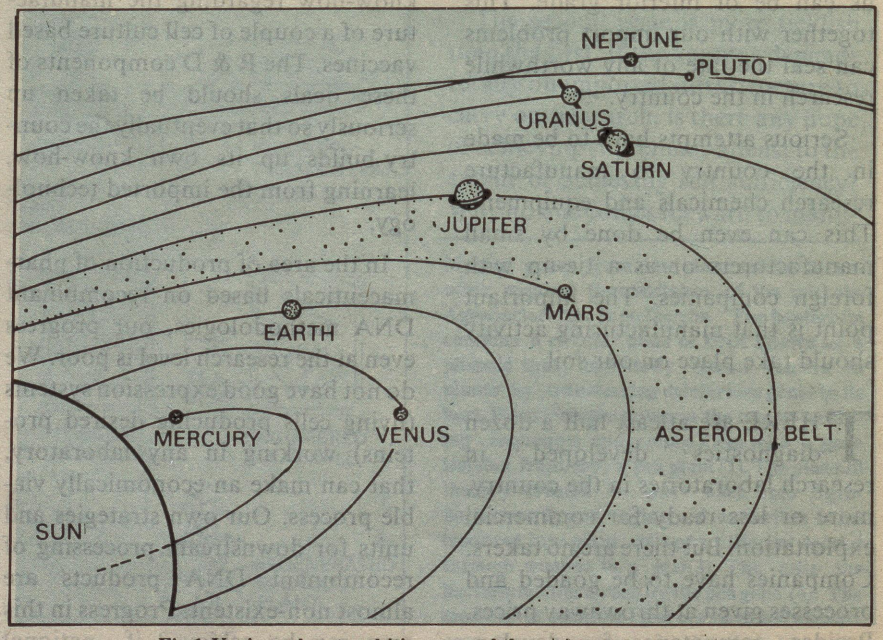

Fig.1 Various planets orbiting around the sun and the asteroid belt lying between Mars and Jupiter

interest. They have been aptly designated as the 'poor man's space probes'. Subsequent measurements on the samples from the Moon and recent observations on Mars and other planetary bodies further stress the need for future meteoritic studies for understanding the formation of the solar system. With the dwindling support to future space explorations, the interesting suggestion of the late Luis W. Alvarez of the Lawrence Berkeley Laboratory, U.S.A. that meteriotic falls had a major impact on biological evolution on earth especially during the Cretaceous-Tertiary period, and the recent findings of a new rich deposit of meteorites in Antarctica, have triggered off research in meteorites.

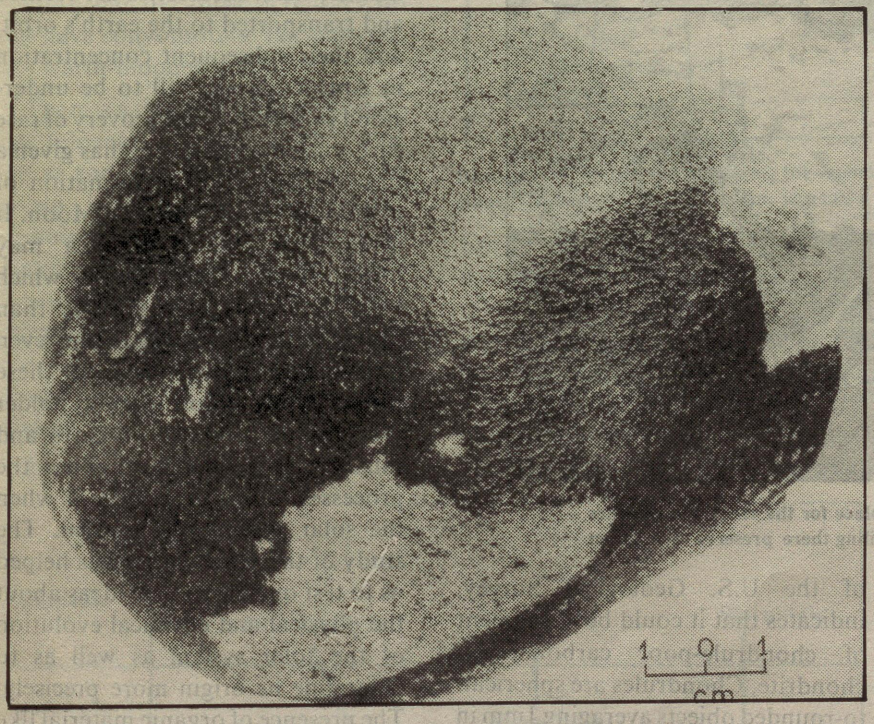

Fig.2 The Shergotty meteorite which fell in Bihar in 1865 and is one of the nine unusual meteorites believed to have their origin in Mars (Courtesy : Geological Survey of India, Calcutta-700016)

In recent years, more than 5000 meteorites have been collected from Antarctica. They have been found mainly on the surface of the blue ice fields close to the Transantarctic Mountains. The large number of meteorites found in the region can be attributed to the feeble weathering of meteorites that occurs under the climatic conditions of Antarctica. Bare ice fields of Antarctica make even a small meteorite (about 1 cm) easy to detect. Moreover, ice movement and ablation leads to the concentration of meteorites at specific sites, the details of which are not yet fully understood.

MOST of the Antarctic meteorites are stony meteorites. They are rich in silicates and poor in metals. However, a few belong to an entirely new species. The recovery of these meteorites challenge the existing theory that meteorites originated when asteroids broke up into smaller bits. They also throw light on how representative they are of the primitive nebular material thereby helping in unravelling the secrets of planet formation and the origin of the solar system.

The Antarctic meteorite, ALHA 81005, resembles the soil 'breccias' from lunar highlands. Recent studies indicate that the pyroxene minerals, $(Mg, Fe, Ca)_2 Si_2 O_6$, within the fragments of aluminium silicates of sodium and calcium in ALHA 81005 have iron oxide-to-manganese oxide ratios (FeO/MnO) typical of lunar materials. Further, the abundance and distribution of rare earth elements, the rare gases trapped in the minerals and the oxygen isotopic ratios ($^{18}O/^{16}O$) all suggest its origin in the Moon. A total of six lunar meteorites have been discovered in Antarctica. These have reached there most probably after having been ejected from the Moon due to meteorite collisions on the lunar surface and subsequent entry into the earth's orbit. These meteorites are extremely valuable since the region of the Moon sampled by space probes from 1969 to 1976 is comparatively small.

RECENT data on a group of nine unusual meteorites, of which two have been found in Antarctica, popular as "SNC's" or Shergottites Nakhlites Chassignites are believed to have their origin in Mars. Shergotty, the lead member of the Shergottites, fell in Gaya district, Bihar in 1865 and is shown in Fig. 2. The isotopic age which represents the time during which the Shergottites crystallised indicates that they are of a much younger age than other meteorites. In other words, they need not have originated in the asteroid belt. Their chemical and isotopic composition and flight through space indicate an origin in a heavenly body other than Moon and asteroids. Moreover, the noble gases trapped within these meteorites are similar in composition to the Martian atmosphere, claims Dr. Donald Bogard of Johnson Space Centre, U.S.A. The findings on these meteorites may also be of significance to studies on the

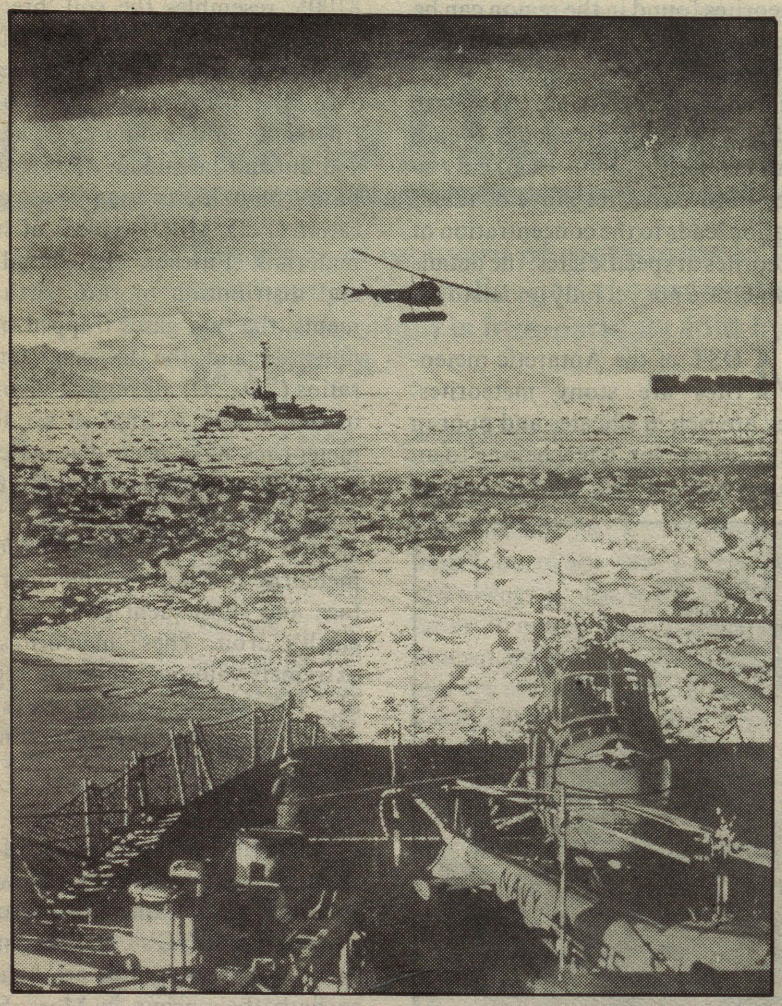

Fig.3 Antarctica is an excellent place for the study of meteorites because the cold conditions prevailing there preserve them intact

mechanisms of meteorite collisions with planetary surfaces. Smaller chunks liberated from the planetary surfaces due to such collisions may find their way to earth in the form of meteorites. This would require high energy collisions as the material has to escape the planet's gravity and reach the orbit of the earth. ALHA 81005 and the SNC's are shocked to much lesser extent as compared to the stresses expected from high energy impacts.

ANOTHER unique meteorite, ALHA 85085, recovered recently in Antarctica and described by J.N. Grossman and his colleagues of the U.S. Geological Survey, indicates that it could be a fragment of chondrule-poor carbonaceous chondrite. Chondrules are spherical-to-rounded objects averaging 1 mm in diameter and consisting of olivine [$(Mg\ Fe)_2\ SiO_2$] and/or pyroxene, which have never been observed in terrestrial rocks. Carbonaceous chondrites are unique among meteorites as they consist largely of hydrated iron magnesium silicates and upto 10 per cent of complex organic compounds. ALHA 85085 also differs from other chondrites in its chemical composition. It is rich in iron, nickel and other elements and is deficient in sulphur, alkalies and other elements that vaporize at low temperatures. The discovery of a chondrite that contains excess metal is significant not only for the chemical evolution of chondrites but also for the origin of planetary bodies like the earth and Moon which also seem to have originated from a typical chondritic material.

Recent studies indicate that Antarctica is a 'treasure house' especially for unique meteorites. It has changed the existing concept about the origin of meteorites that their roots lay solely in asteroids. The manner these meteorites are formed and transported to the earth's orbit, and their subsequent concentration in Antarctica are still to be understood properly. The discovery of rare carbonaceous chondrites has given a fresh insight into the formation of planets, like earth, and the Moon. It is possible that Antarctica may introduce us to rare samples which have origin in bodies other than Moon and Mars, comets and even interstellar space. Most of these meteorites are considerably older than the rocks found on earth and thus would tell us more about the processes that were prevalent when the solar system was formed. The study of these meteorites has helped us to test our theoretical ideas about the physical and chemical evolution of the solar system as well as to determine its origin more precisely. The presence of organic material like amino acids in some carbonaceous chondrites could throw light on the origin of life on our planet. In addition, the understanding of the collision mechanism, which is coupled to the frequency of meteorite falls, could be important for the sustenance of life on earth in future.

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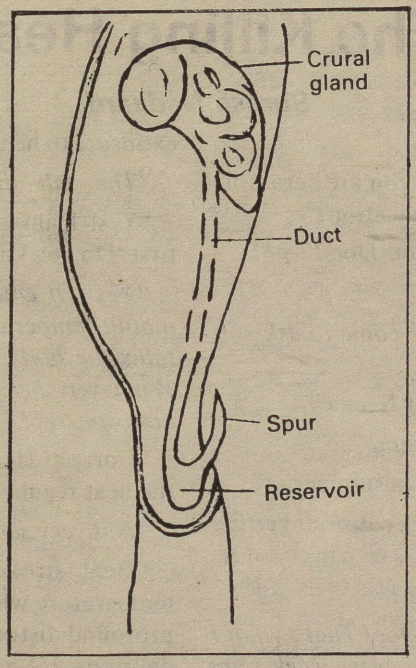
(Continued from page 31)

in the thigh. This peculiar structure is not found in any other mammal. The hollow spine can be erected to deliver poison. When the animal strikes a man, it causes agonizing pain. It can even kill a dog. The tail is broad and is employed as a fat-storage area.

MAMMARY glands, present in both sexes, are simple and devoid of nipples unlike other mammals but their openings are scattered among hairs in the abdominal region. The brain is primitive, quite small, and the cerebral hemispheres are smooth and, like those of reptiles, do not have convolutions. The platypus is a warm-blooded animal.

There is a single urinogenital opening (cloaca) through which urine, faeces and gametes are released. The group is termed "Monotremata" meaning one-holed creature. In males, ventral wall of the cloaca forms penis which is used during copulation for sperm transfer to female's cloaca. Scrotal sacs are absent and testes are retained in the abdomen.

Mating occurs sometime in the

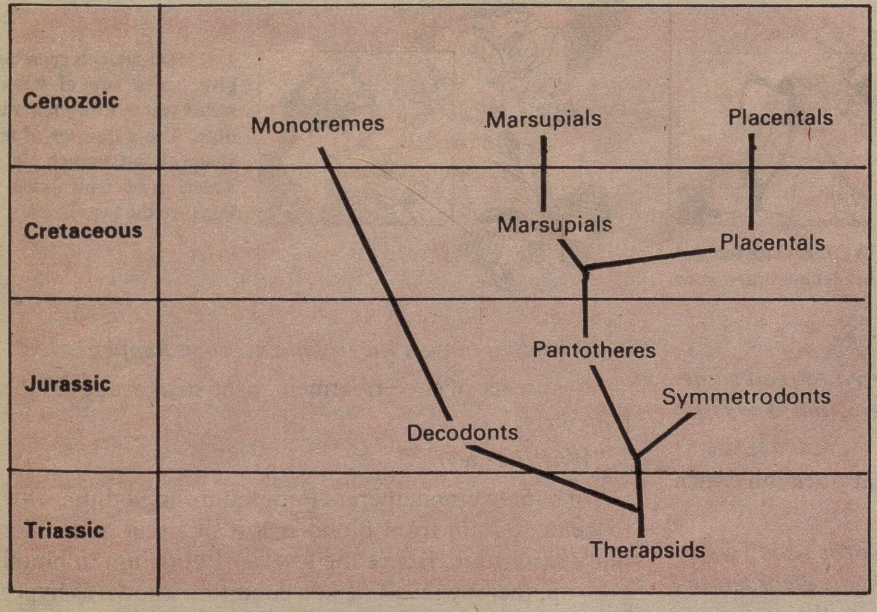


Dissection of the hind-limb showing the venom gland, its duct, reservoir and spine in a male

Spring (August-October). Courtship activities and copulation apparently take place in water, followed by chasing and grasping of the female's tail by the male. Two burrows are made, each having a concealed entrance above the water. One is inhabitated by the couple; the other, about 4 to 18 meters long, is the female's nesting chamber. The nest is made of grass, leaves or similar materials.

Platypus has a development pattern not observed in most of the mammals. During spring season, a female lays one to three eggs after mating. A thin, flexible white shell is formed around the fertilized ovum or zygote. The growing zygote is nurtured inside the uterus by secretions from the uterine wall. The gestation period is about two to three weeks. A freshly lain egg measures about 18mm in diameter. During 14 days of incubation period, the mother confines itself to the mating chamber and exhibits parental care. Young hairless hatchlings are also held by the mother's tail against the abdomen. Young ones lick milk oozing out through the apertures scattered on the abdomen for about three to four months during which they become fully developed platypuses. The young ones emerge from the burrow in late Summer (late January-early March) and continue to lick milk for some time. Babies become sexually mature after about two years. Total life-span of this animal is about 10-17 years.

As only a few fossil remains of this animal have been found, its evolution can only be speculated. Most taxonomists believe that platypus is on a side branch of the evolutionary tree rather than on the main stem leading from reptiles to mammals. Perhaps even before the Jurassic period it may have evolved from a theraspid (mammal-like reptile) ancestor very different from the one that gave rise to therians or higher mammals.



Evolutionary tree showing probable origin

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Keeping The Killing Heat Away

Suresh Nadkarni

"Good Morning Doc!"

"Good morning Neena! How come, you are here still? You have not gone out on a summer vacation?"

"That's exactly I have come for to you Doc.!"

"I am not a tourist Officer Neena ..."

"Don't joke about it Doctor? I have come to ask you about our trip itself ...!"

"What is that you want to ask about Neena?"

"Doc! This time we are going to Nagpur ..."

"A nice hot place chosen by you for a summer ..."

"We have to go Doc! It's a must. My cousin is getting married ..."

"O.K.! O.K.!! What is your question?"

"Nagpur is like an oven in summer Doc! That's what I have been hearing. In addition to that every week I am reading newspaper reports—Three died on account of heat"

1. Remove casualty from the source of heat, preferably to a cool room. Undress her and wrap her in a sheet or towels soaked in cold water. Note her temperature every five minutes and regularly fan her.

2. When her temperature is down to 101 F(38 C), replace the wet sheet with a dry one. Continue fanning. If her temperature rises again, restart the cooling treatment.

..."Young man succumbs to heat stroke."

... "Hence I am frightened Doc! I tried to read something about this summer-heat problem, but I was no wiser. Hence I have come ..."

"O.K.! O.K.!! Go ahead, what is that question which Lingers in your mind?"

"I am confused, Doc, with many words used to describe the effects of heat! Actually how many disorders are caused by exposure to heat? Could you tell me..."

"As far as textbooks go, 14 disorders resulting from exposure to heat have been recognised and documented"

"They talk about Heat-stroke!"

"Yes! I am going to tell you about heat-stroke only first! Do you know that man is a warm blooded animal?"

"Yes! Of course Doc! Warm blooded animals have inbuilt temperature-regulating mechanism which maintains the body temperature at a particular fixed level. Whatever be the temperature of the surrounding atmosphere!"

"Correct! Heat-stroke occurs when there is a failure of the heat regulating mechanism of the body."

"Is it very serious Dr? How does one judge this?"

"Heat stroke is characterised by very high body temperature which may rise to 40°C or above. There are profound disturbances in the body. Patient may become delirious. He may get convulsions. He may have partial or complete loss of consciousness! The skin is dry and hot."

1. Remove the casualty from the source of heat, preferably to a cool room. Check her temperature and pulse. If she is unconscious, put her into the unconscious position.

2. If the casualty is conscious give her a cup of weakly salted water every ten minutes. Use a quarter of teaspoon of salt to each pint of water. Add fruit juice to improve the taste.

"If he does not get the treatment, what happens Doc?"

"In absence of good treatment, heat-stroke may kill the patient."

"Why this death?"

"In human blood, there is Potassium and Sodium. Due to heat, sodium from blood is lost in sweat and other body secretions. Hence the level of Potassium in blood goes up, thereby resulting in a condition known as hyper potassemia. The exact cause of this condition is not known. It may be also due to the release of potassium

from red blood cells which have been injured by heat."

"So, what is to be done in this condition?"

"You have not to do anything much. Call the doctor first. Remember, babies and old people are particularly at risk."

"But are there any other symptoms, which may be complained by the patient before becoming unconscious?"

"Yes! Headache, thirst, nausea, drowsiness are the main complaints expressed by the patient. As the condition worsens, he may become confused and lapse into unconsciousness."

"However, Doc, there must be some first aid measures suggested for heat-stroke!"

"Yes! They ask you to remove the casualty from the source of the heat, preferably to a cool room. Undress the patient and wrap him/her in a sheet or towels, soaked in cold water. Note the body temperature of the patient every five minutes and regularly fan him/her. When the temperature is down to 38°C, replace the wet sheet with a dry one. Continue fanning. If body temperature rises again, restart the cooling treatment."

"Thank you Doc! Some people talk about heat-fever?"

"That is called heat-hyperpyrexia in books of medicine. This is attributed to impaired functioning of the heat regulating mechanism, but without characteristic features of heat-stroke. It is arbitrarily defined as a temperature about 42°C. It may proceed to heat-stroke! Well! You must have heard about heat cramps."

"No Doc! What is that?"

"Heat cramps occur in persons who are doing heavy muscular work in high temperature and humidity. They are painful and spasmodic contractions of the skeletal muscles, e.g., Calf muscles. The cause of the heat cramps is loss of sodium and chlorides in the blood."

"Some people get fainting attacks in summer ...?"

"Yes! This disorder is called heat syncope! This is a common ill-effect of heat. In the milder from the person standing in sun becomes pale, his blood pressure falls and he collapses suddenly. There is practically no rise in body temperature. In this condition shift the patient and make him lie down in shade with head slightly down. Recovery usually comes within 5 to 10 minutes."

"Thank you Doc! But the people talk about heat-exhaustion so often. What is that?"

"Several types of heat exhaustion have been described. This is also called heat prostration. This disorder results from over exposure to heat or to sun. In very high temperatures the body sweats profusely to keep its own temperature at a normal level. This excessive sweating removes large quantities of salt and fluid from the body. When level of salt and fluid in body falls too far below normal, heat exhaustion may result."

"What are the symptoms of heat exhaustion Doc?"

"The early symptoms are headache, a feeling of weakness and dizziness, usually accompanied by nausea and vomiting. There may be cramps in the muscles of the arms, leg or adbomen. In heat exhaustion, the person becomes pale and perspires profusely. His skin is cool and moist, his pulse and breathing, rapid. He may seem confused and find it difficult to coordinate his body movements. Ordinarily he will remain conscious."

"What is the first aid for this condition?"

"Make him lie down in a cool place. Keep him quiet. Give him half a teaspoon full of a salt dissolved in tomato juice or in a half glass of water and repeat this dose every 15 minutes for the next two hours. After he has taken the salt, you may give him hot tea or coffee. If he can't take by mouth, call the doctor who will give intravenous saline. If cramps occur, you may gently massage the painful area by applying firm hand pressure."

"But Doc, can we not have any preventive measures against ill effects of heat?"

"That's a better question! I will tell you the answer. Persons working under conditions of high temperature and humidity should be encouraged to drink cool water. It has been found in India that a man doing hard work in the sun requires about one litre of water per hour. For a sedentary worker the requirement is half this quantity. There is a wide-spread belief that extra salt intake during the summer helps prevent the ill-effects of heat. Studies have shown that normal intake of salt in Indian diet is far more than is actually needed. Therefore there is no need to add salt to water. The duration of exposure to a hot environment should be cut down. There should be periods of rest in between intense work. As soon as signs such as headache and dizziness appear, the person should be removed to a cooler environment and the necessary treatment be given. Clothing worn should be light, loose and of light colours. Protective goggles, shields and helmets are useful. The temperature and humidity in the work environment may be controlled by proper ventilation and air conditioning. When working in the sunlight, wear a hat or scarf to protect head. Eat light, nutritious food taking care to include in diet plenty of liquids, vegetables and fruits."

"Thank you Doc! Now, I think, I am prepared mentally to face the Nagpur heat!"

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The Space Telescope

Biman Basu

ALMOST four centuries after Galileo first peeped at the heavens through his 'spy glass' and revolutionised human perception of the universe, optical astronomy is poised for another revolution, in the shape of the Hubble Space Telescope (HST). Built with precision unparalleled in the history of telescope-making, the HST will give astronomers the sharpest ever images of the heavens. Unperturbed by the turbulence of the earth's atmosphere and unaffected by the vagaries of weather, not only will it be able to see fainter objects beyond the range of earth-bound instruments, but also enable observation over the entire range of wavelengths—from ultraviolet to infra-red, which cannot get through the earth's gaseous veil. Named after the American astronomer Edwin P. Hubble who fathered the theory of the expanding universe, HST is really the first serious attempt to put a large telescope in space, but the idea is not new. As far back as 1923, long before the first satellite was put into orbit, German rocket pioneer Hermann Oberth had described the advantages of lofting astronomical telescopes beyond earth's murky, unsteady atmosphere. But space technology had to come of age before Oberth's idea could become a reality.

BY world standards, the HST is not a very big telescope, however. Its 2.4m diameter primary mirror is only about as large as that of the Vainu-Bappu telescope at Kavalur, which is India's largest. But its light collecting area is a mere one-sixth of the Soviet 6m reflector, the world's largest. When the space telescope was conceived in the early 1970s, it was to have a 3m diameter primary. But its designers soon realised that the shuttle cargo bay from where it was to be deployed in orbit would be too cramped for that size. It would leave no room for support equipment—the nerve centre of the telescope—around the main mirror. The mirror had to be smaller, and so it was.

But there is more to a telescope mirror than its size. And that is the smoothness of its reflecting surface that produces the image of distant objects. The smoother the surface the sharper would be the image produced. It is on this count that the HST main mirror scores over all others built till date. Its surface has been polished to such a perfect finish that nowhere is the unevenness more than 5 millionths of a centimetre, or about 1/78th of the wavelength of neon light. Not one had ever built such a mirror.

Shaped like a "pineapple ring" with a 65cm hole at its centre, the 2.4m dia. mirror is the very heart of the HST. Its aluminium coating is designed to reflect back as much as 80 per cent of the starlight falling on it—another quality unparalleled in mirror technology.

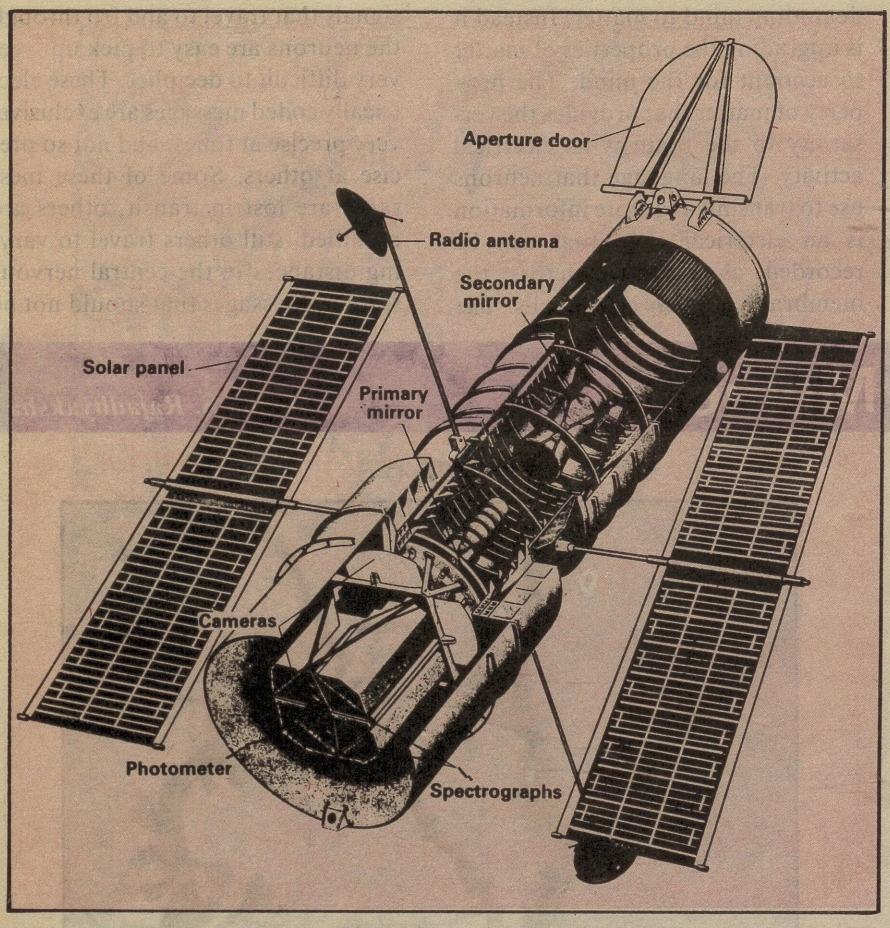
The making of the main mirror was a feat in itself. First of all a suitable material had to be found that had the right thermal properties yet would be strong enough to withstand the rigours of launching and hostile space environment. The material had also to be capable of taking the ultrasmooth surface finish that the HST designers were aiming at. After several tests a special type of ultra low expansion glass was selected.

To make the mirror as light as possible, a novel "egg-crate" design was adopted. Made by fusing a honeycomb structure between thin front and back plates the mirror is rigid yet extremely lightweight. It weighs only about a sixth of what a solid mirror of the same diameter would weigh.

The main telescope support structure, which holds the primary and a 32.5cm secondary mirror apart at a distance of about 5 metres, is another marvel of new technology. To eliminate even the minutest distortion in the structure due to temperature changes in space a new composite was developed. It is a mixture of graphite, which expands with cold and contracts with heat, and epoxy, which expands with heat and contracts with cold.

The entire telescope assembly nestles within a larger compartment called the support system module. Several of the vital components—power supply, electronic systems, computers and telemetry systems—are arranged in a ring around the main mirror. The whole cylindrical assembly measures 13.1m in length and 4.3m across its widest point. Weighing 11.6 tonnes, the HST is the heaviest scientific payload put into orbit by NASA.

The telescope needs more than 4000 watts of power to run its onboard electrical systems which is provided by two large solar panels each measuring 11.8m by 2.3m. Highly efficient nickel-hydrogen storage batteries take over when the telescope passes through the earth's shadow.



TO carry out its stupendous task the HST is equipped with an impressive array of on-board instruments. Even the faintest ray of light entering its portals will be scrutinised by five high-precision instruments: the wide field and planetary camera, the faint object camera, the high-resolution spectrograph, the faint object spectrograph, and the high-speed photometer. The delicate job of pointing the massive telescope accurately at any desired object in space is taken care of by the fine guidance system. With its gyroscopes and star identification systems, the guidance system can hold the telescope's direction steady to three millionths of a degree over a period of up to 10 hours, or a little more than six orbits. This capability is essential for photographing very faint objects down to magnitude 29, or about 100 times fainter than those visible with the largest earth based telescope—which would require very long exposures. For recording the images the HST cameras use the highly sensitive solid-state electronic detectors known in the trade as CCDs (or charge-coupled devices). The programme of observation will be controlled by an on-board computer.

Unlike terrestrial observatories where astronomers have direct access to the telescope console, all operations of the HST will be remotely controlled. Communication between earth-bound astronomers and the telescope, including data retrieval, will be done with the help of a pair of geostationary satellites, one of which will always be in direct link with the HST, and other satellite links. Digitized data from the telescope will be processed and converted into photographic images at NASA's Goddard Space Flight Centre.

ASTRONOMERS have already drawn up ambitious programmes of observation with the HST. It will for the first time give them an opportunity to probe the realm of space and time in early universe when the galaxies formed. Using the telescope's extraordinarily fine resolution, astronomers will survey the cores of other galaxies for supermassive black holes. The HST is also ideally suited for probing the most remote objects in the observable universe. Its unprecedented sensitivity to ultraviolet wavelengths will allow spectroscopists to survey the chemical diversity of white dwarf stars. Indeed, the possibilities with the HST are limitless.

Expected to remain operational for at least 15 years (with servicing missions every five years), the HST will in fact give astronomers total observation time many times that figure. This is because unlike telescopes on earth which can be used only at night, the HST will operate round the clock, day and night, seven days a week, year after year, unaffected by clouds and weather. However, because it circles the earth every 90 minutes, its long term observation of any particular object in space would be interrupted for about half of each orbit.

Already requests for observation time on the HST has been pouring in at the Space Telescope Science Institute in Baltimore, Maryland, which will manage the scientific data from the telescope. For the first year, 162 proposals have been approved out of more than 550 submitted by astronomers from more than 30 countries.

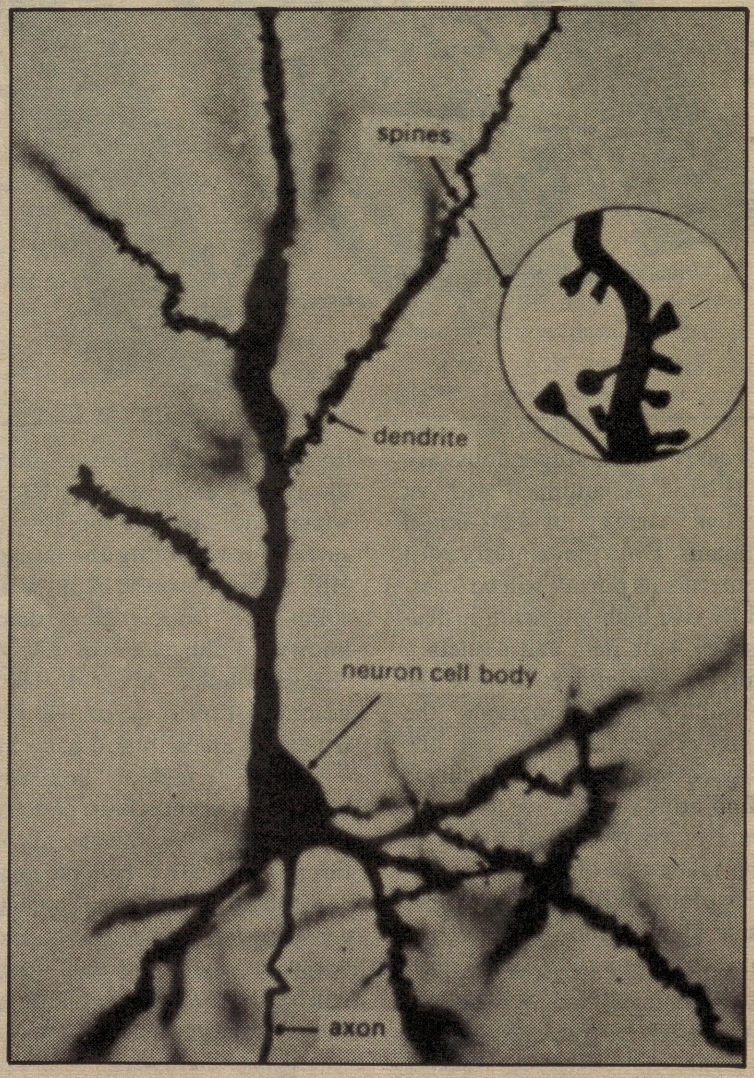
The first detailed images from the HST will be available in about eight months' time. Only then will the second revolution in optical astronomy have begun. □

Molecules For Memory

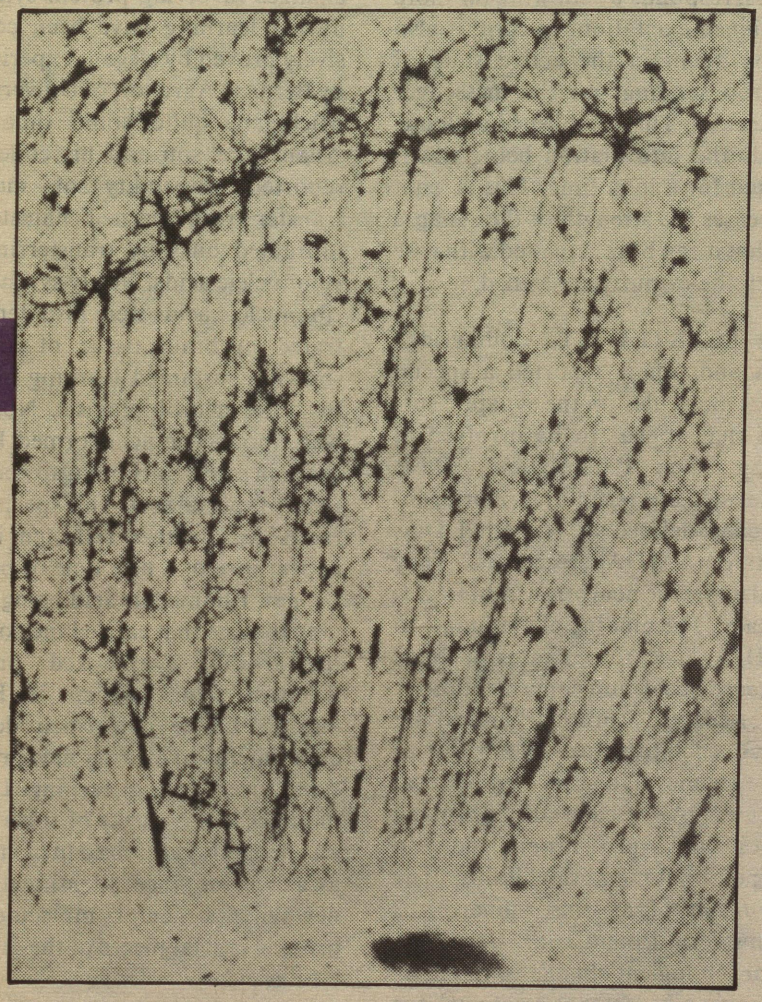
Medha S. Rajadhyaksha

IN the present competitive era, few must have escaped the trauma called 'examinations'—the arbitrary test that ranks you, often for a lifetime, in a forlorn hierarchy of percentages! The subconscious fears and tensions of presenting the proof of knowledge kills more than half the pleasure of the process of learning. Specially when memory is at test one wearily wonders, how long it would take neuro-scientists to come up with a 'memory' pill relieving the young learners of their major burden in life! One awaits such breakthroughs, in fact, for more pressing problems of amnesia, due to ageing, injury or disease. In other words, what we are very naively looking for is an ability to control the ultimate frontier of nature—our brain. Whether the human race is mature enough to tread such frontiers is not a question to be handled lightly—yet the need to keep the search on for such knowledge, especially for relieving human sufferings, cannot be undermined. Research in the field of memory, apart from being of fundamental interest, is a quest in this direction. The question how brain retains its perception not only for a short time but also for years together is unlikely to be the one with a simple answer. The problem needs to be attacked on several fronts. One way of approach is to study it at a very fundamental level—at the level of molecules.

Reducing an experience to the level of molecular interactions, and an individualised attribute like memory to a mere network of neurons makes one a trifle uncomfortable. The 'reductionist' way of analyzing has its own drawbacks, yet, as the well-known Canadian psychologist, Donald Hebb put it—this is not degrading mind to matter. Instead it is upgrading the properties of matter to account for the mind. The property of matter that provides the versatility to the brain is its electrical activity. The language that neurons use to transmit and store information is an electrical code that can be recorded as potential across the membrane of each of the cells. The signals that travel to and fro through the neurons are easy to pick up—yet very difficult to decipher. These electrically coded messages are exclusive, very precise at times, and not so precise at others. Some of these messages are lost in transit, others are modified, still others travel to varying distances in the central nervous system. Messages that should not be



Dendrites of the cerebral cortex have numerous spiny projections, seen in this metallic impregnation of a neuron under a light microscope



The human brain contains about two million neurons supported by an even greater number of glial cells (Electromicrograph photograph)

lost, should be stored instead as memories, need to be integrated some way or the other into this scheme of electrical coding.

IN the year 1897, an English psysiologist, Charles Sherrington very simply proposed the presence of an anatomical junction between cells—that later turned out to be the site of extraordinary importance in screening messages in the brain. Writing a chapter for a revised textbook of neurophysiology, Prof. Sherrington first introduced the term that represented connection between two neurons—the synapse—derived from Greek, meaning to clasp or connect. A giant in his field, Prof. Sherrington further expanded his ideas in his famous book—*The Integrative Action of the Nervous System.* In a simple sentence, a scheme that encompassed the functional plasticity of these connections in the brain was put forward : "Such a surface might restrain diffusion, bank up osmotic pressure, restrict the movements of ions, accumulate electric charges, support a double electric layer, alter in shape and surface tension with changes in difference of potential ...." Synapses have turned out to be junctions where tiny but important decisions are made. Each neuron makes about a thousand synapses with the other neurons. No less than 10^{15} synapses are actively participating in the hectic transmissions that are running the brain.

A SOCIETY flourishes, often not only because individuals are competent, but because they communicate meaningfully with the rest of the group. The same holds true for neurons. A group of neurons that can actively communicate by forming synaptic connections endow the brain with an unlimited flourish for learning and remembering. At these synaptic connections crucial votes are cast! Signals can be nullified at the synaptic locii—ignored by our brain though perceived by our senses. Signals can also be amplified—resulting in a reaction far more intense that what was sensed. Also signals can be sent undisturbed to their destinations—made to run through an appropriate set of neurons forming a neuronal circuit. It is not surprising, then, that neurophysiologists expected synaptic sites to be involved in memory—links that would bind neurons into a firm circuit.

When a rhyme is memorised the input of words initiate a neuronal circuit. On recitation of the rhyme—with recall of memory—this circuit is stimulated with very little effort and the words flow out. With repeated recitation the circuit needs less and less of signaling to send out the string of words. Stronger the neuronal circuit, longer is the rhyme remembered. More the rhyme is recapitulated, more often is the circuit made—strengthening it, making effortless recall possible. No short cuts to hard inputs, with several repeats, for memory to be lasting and accurate. And the strength of the circuit lies in its tiniest connection—the synapse!

The synaptic junctions in the hippocampus have been a target for investigations for memory molecules—obviously as this part of the brain is known to be involved in memory. In the early seventies Tim Bliss and Terje Lomo reported from London, some interesting features of synaptic communications in the hippocampus in respone to strong (tetanic) stimulation. Transmissions in these stimulated neurons were more effective and lasted longer. A scientific phrase 'Long Term Potentiation (LTP)' was coined to express this unusual mode of keeping signals alive for a longer time.

As in the other regions of the brain, the message running through the neurons of the hippocampus is in the form of an electrical code, travelling down the length of the long arm of neuron—the axon. The code needs to be passed on across the synaptic space to the adjacent neuron. The messenger molecules that aid in this transit are known as neurotransmitters carried in cellular bags that burst at cellular junction, on the arrival of an impulse; the neurotransmitters help convey the impulse across the synaptic gap. With every signal that approaches the end of the axonal tip of the neuron, a definite number of neurotransmitter molecules rush out to establish a contact with the neuron that receives them at definite sites. The neuron that receives these molecular messengers—the post synaptic neuron—in turn is fired to carry the message further down. In most other parts of the brain these messenger molecules, after delivering the message fade out—either broken down enzymatically or reabsorbed by cells. In the hippocampal region, however, these neuroactive substances are released at the synapse in larger quantity—they insist on reading out the messages for a longer period of time. The post synaptic neuron, the one receiving the messages, responds by showing far more sustained excitation. In turn, it also helps maintain the active state of neuron sending out the messenger molecules. This established dialogue holds the information being transmitted for a long time. This is what increases the strength of the synapse so that it can be reactivated with ease when the memory is recalled.

RECENTLY G.L. Collingridge and others reported a special set of molecules on the synaptic surface that appear to be involved in 'Long Term Potentiation'. These molecules are receptors, pharmacologically defined as N-methyl Daspartate (NMDA) receptors. They bind a specific neurotransmitter 'glutamate'. The binding of glutamate to NMDA receptors causes a local increase in calcium concentration. A set of enzymes (protein kinases) are provoked into action as a result of this new message generated by local calcium. A cascade of enzymatic alterations of proteins embedded in the neuronal membrane follow. The net result of all this rigmarole is 'Long Term Potentiation'—the electrophysiological change in the neuronal membrane that is crucial for memory recall. The tip of the iceberg is in sight! Rest of the molecular mechanism awaits further investigations.

The insights of the eminent physiologist, Donald Hebb seems to carry more credibility now—with these recent findings at the very molecular level. As early as in 1945, Prof. Hebb postulated 'When cell A repeatedly and persistently takes part in firing cell B, some growth process or metabolic changes take place in one or in both the cells such that A's efficiency, as one of the cells firing B, is increased'.

Reports on synaptic memory molecules is a result of pursuit based on this hypothesis. Metabolic changes involving protein synthesis during learning have been conclusively proved by elegant experiments by Bernard Agranoff of University of Michigan, quite some time ago. Allan Jacobson and his colleagues reported possibility of memory transfer from 'learned' hamsters to untrained ones by transferring the ribonucleic acids. Newly synthesized ribonucleic acids were also demonstrated in brain tissue of animals showing sustained learning activity by other neurobiologists. Not only was ribonucleic acid formed by the brain in e amounts but also was seen to be of special sort. This special synthesis was further reflected in the appearance of a new type of protein the new ribonucleic acid being probably the one that carried the code for the freshly synthesized protein. Scientists from Sweden, H. Hyden and P. Lange performed delicate experiments to identify new proteins synthesized during learning. Details of exact involvement of fresh RNA and protein synthesized in memory is awaited ever since. Identification of new synaptic memory molecules may provide crucial pieces of the molecular jigsaw!

This of course is one approach to the maze of our mind. The complexity of information we daily process and store can barely be understood on the basis of what we know at present. This awareness of how little we know is at times, discouraging. Neurobiologists, however, are very tenacious folks—ready to grope in the dark with utmost patience. And when they see light—the world is going to be different. As Sir Francis Crick aptly puts it—"There is no scientific study more vital to man than study of his own brain. Our entire view of the Universe depends on it".

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The Blueprint Of Life

BY the year 2000, scientists hope to have compiled the "Book of Man" which will identify the estimated 100,000 genes which determine everyone's individual characteristics, from and eye colour to susceptibility disease.

The diseases which cause most of the ill health and early deaths in modern industrialised society—heart disease, many forms of cancer, mental illnesses such as schizophrenia and auto-immune disorders such as arthritis—have a significant genetic component.

The first task for scientists is to decipher the genome. This is spelt out in an incredibly long message—its words, or genes, contain a total of 3 billion letters. However, their alphabet is extremely limited, consisting only of 4 letters, or "base pairs" where bases are conventionally dubbed A, C, T and G. It is the order in which the four allowed pairings of bases appear that determines what they mean. So far, about 25 million of these 3 billion letters have been read. These are held in databases across the world. But comparing new information with that already in the databases in an incredibly laborious process.

At the Imperial Cancer Research Fund in London, scientists are participating in the international project which already involves 220 research groups in 23 countries and is being co-ordinated by the Human Genome Mapping Organisation (HUGO). A star performer in the computational aspects of the project is the British supercomputer, the DAP 610, which can handle 40 billion operations per second. A genetic database which could previously be scanned in hours or even days, can now be scanned in minutes.

At the Fund's headquarters in London, one of the researchers wanted to identify a segment of protein taken from the blood cells of a patient with leukaemia. "We just typed in the new sequence and set the program running", said a researcher. Ten minutes later, out came the results—a previously unheard of speed in output. "Part of the leukaemia protein was strikingly similar to an important family of cancer-forming proteins", he said.

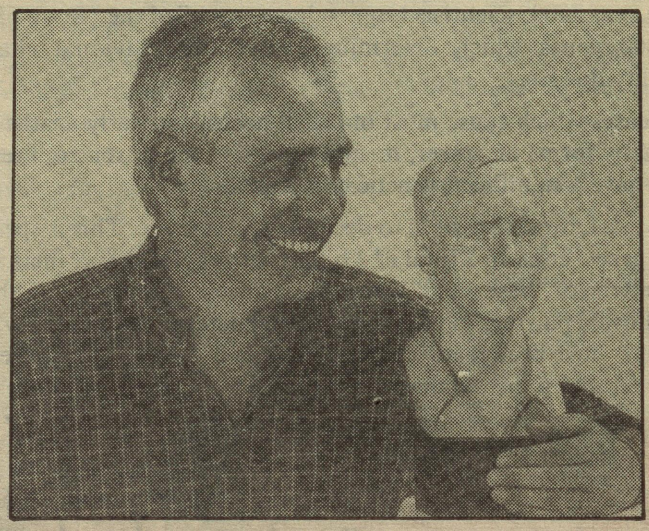
Piecemeal experiments have so far revealed the broad genetic regions responsible for cystic fibrosis, colon cancer and Alzheimer's disease. But the vast proportion of the 10,000 to 150,000 base pairs in each gene remains uncharted territory.

(*Courtesy:* **LPS**)

Video-Sculptor And His Happy Model

MANY inventors have tried in the past to develop mechanised processes and methods of sculpting.

As early as in 1733, La Caondamine, French mathematician and explorer, described a machine for copying on lathe a portrait or a medal in 3 dimensions. The last century witnessed sculpting machines (pantograph applications) producing sculptures either of a reduced scale or of the same size as the reliefs taken as models.



However, these machines were not used for sculpting live models. Producing the bust of a person was a very tedious process. According to a manual written by a famous sculptor and published in 1860, for plaster moulding it was necessary to cover the face of the model with butter. Straw tubes had to be inserted into the nostrils and the mouth for maintaining respiration. The alternative was to resign oneself to long hours of posing. In both cases suffering had to be borne to carry beauty into posterity.

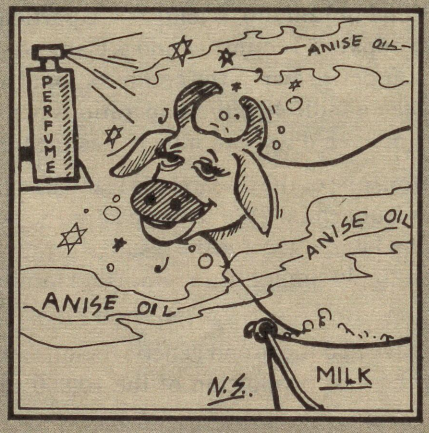
Now, with just 5 minutes of modelling, a person can have his bust delivered 10 days later. This bust will be faithful to the original and will cost around 2,600 to 5,900 francs (Rs. 7,000 to Rs. 16,000) depending on the size of the bust and the quality of wood used. This is possible thanks to the efforts of three French engineers who have recently invented "Video Sculpture". A sample in the form of a bust depicting a famous French rugby player was exhibited last September at a fair in Toulouse (France). The image of the object or the shape to be reproduced is recorded on a film with the help of laser and a video camera. Digitalised data are then processed and fed into a wood-working machine for preparing the rough model.

Then a sculptor puts on his finishing touches to this model as required. While the machines can shorten the period of posing, the personal skill of a sculptor still remains indispensable. □

(*Courtesy:* CEDUST)

Perfumed Cows Yield More Milk

SCIENTISTS looking into ways of boosting milk production have discovered the sweet smell of success in anise oil.



Dairy cows got along better when sprayed with the licorice-scented fragrance, and when cows feel at ease, they give more milk, say researchers Keith Cummins and Lawrence Myers of Auburn University, Alabama.

Cumming said dairy cows must be regrouped every two to four weeks to maximize production and feed efficiency, forcing the animlas to re-establish their "pecking order" that result in biting, pushing and shoving. Cows become nervous and upset, and milk production drops.

Anise spray reduces aggression among cows, Cumming said. As the smell wears off—usually about the third day—the pecking order is already being established.

Does that mean cows like perfume? According to Cumming, this was not because the sprayed cows smelled good. "What we did was make it so the cows could not tell one from the other." □

Hasan Jawaid Khan

Needling Animals To Good Health

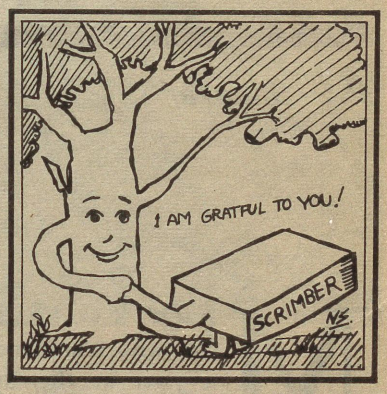
THE 4,000 year-old Chinese art of acupuncture has beenfound to be effective in animals, too. About 450 veterinarians in the United states practice this art combining it with their modern therapies. In an interesting case, three weeks after acupuncture treatment, a stable of losing race horses started winning races. Yet another research group has found that the acidity of a dog's stomach could be lowered by stimulating acupuncture points on its knee.

Earlier, researchers believed that claims of success with needles among humans were due to the placebo effect. But the belief lost considerable support once it was found that 60 to 70 per cent of chronically ill animals got significant relief by this treatment. After all, an animal cannot think that needles will take away its pains. Some researchers now believe that acupunture may work by stimulating the nervous system and provoking the brain to kill endorphins, the body's natural pain-killers. □

Futuristic Space Ride

A futuristic thermonuclear spacecraft designed at the Larence Livermore Laboratory in California, USA, would enable astronauts to reach other planets on a trail of tiny H-bombs. The spacecraft would pierce through space by dropping hydrogen pellets from its tail and zapping them with an onboard laser. VISTA, the Vehicle for Interplanetary Space Transport Applications, should be able to fly to Mars and back in mere 100 days.

The cone-shaped ship would have a landing craft to carry explorers between the planet and the mother ship. Specious living quarters on the wide end of the craft would ensure a comfortable ride for astronauts. The ship would carry enough two-ounce pellets to reach a speed of 48 km a second. And at 30 blasts a second, acceleration would be smoother than the take-off of a typical jetliner. □



Scrimber Replaces Timber

A structural-quality timber product developed in Australia has the properties of high-quality wood but does not require the destruction of native forests. Scrimber is made primarily from pine thinnings and small trees. Logs of smaller diameter are used which can either be plantation-grown or obtained as thinnings, which would otherwise be wasted. Conventional saw-milling techniques used only about 40% of the log; the production of scimber uses more than 85%. So fewer trees face the chop.

In making Scrimber, the bark is removed and tree stems are crushed by a series of rollers in the scrimming mill. This forms bundles of interconnected strands that largely retain the original orientation of the wood fibres. After drying, the bundles of strands are coated with a conventional waterresistant adhesive assembled into the desired shape and hot-pressed to cure the adhesive and develop strength. Because the natural orientation of the wood-fibres is preserved and knots and other imperfections are eliminated. Scrimber has uniform and predictable strength. □

Defence Institute of Physiology And Allied Sciences

P.S. Shankar

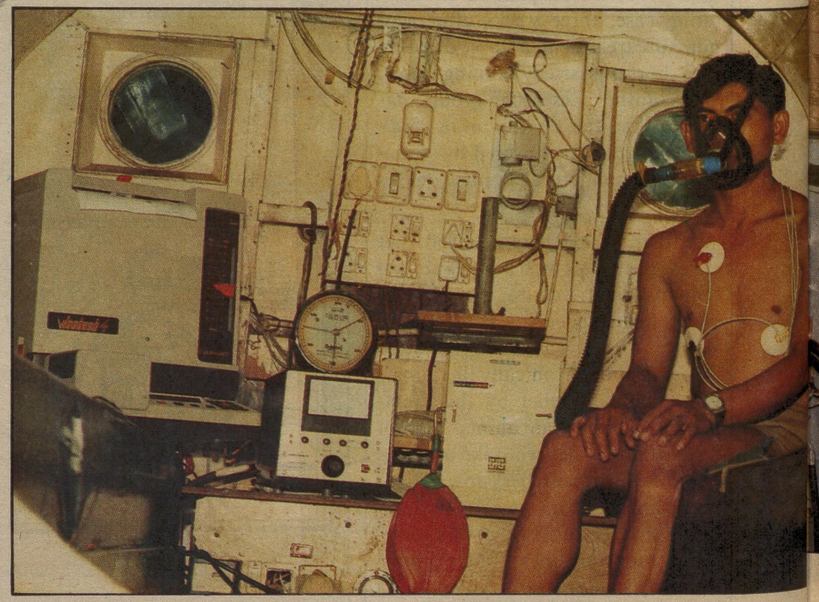
DIPAS scientists look at the "man-behind-the-machine", his fitness and well-being, his physical and mental conditioning to perform the increasingly complex functions in times of conflict, and no less, his health and welfare at all times

MAJOR K.G. Chatterjee, who commanded a post at the Bilafondla complex at a height of 21,000 feet in the Siachen Glacier in September 1987 and won a Mahavir Chakra, was recounting, as recently as in February this year, his experiences to a press reporter. He was in fact narrating the hazards the Armed Forces have to encounter in fighting at such altitudes. This is also the unique problem that the defenders of our subcontinent face—a problem which perhaps no other country faces. The hazards include breathing problems, cardiac arrest, pulmonary oedema and headaches caused by water retention in the brain—a condition peculiar to glaciers. Add to these miseries the reduction of one's physical strength to one-fourth, a steep fall in appetite, temperatures below minus 55°C and wind speeds of 160 knots per hour, which could blow off a man 5 kilometres away, the very survival of humans, not to speak of being fighting fit, is at stake. If this is one extreme, the deserts of Rajasthan pose a challenge of another kind—enduring ovenly temperatures. Making the soldier fighting fit, however, is not so much of a military problem as a scientific one. It is here that the Defence Institute of Physiology and Allied Sciences (DIPS, for short) in Delhi is an ally to the Armed Forces. If the other research institutes of the Defence Research and Development Organisation provide the hardware for defence strategies, DIPAS has specialised in providing the software in as much as it focuses its attention on the "man-behind-the-machine".

The nucleus of DIPAS was a small physiology group in the Defence Science Laboratory which functioned at the National Physical Laboratory in New Delhi in 1952. DIPAS owes its birth ironically to the maxim "Necessity is the mother of invention but war is its real father". It was the Chinese aggression of 1962 that exposed, among other factors, the physiological limitations of the fighting forces who were all too suddenly confronted with the inhospitable snowbound mountains to contend with the enemy.

Over the years, however, DIPAS has grown into what could be rightly described as a national institute of physiology, for 'openness' rather than 'secrecy' has characterised the work of DIPAS.

If you visit the Institute near the Base Hospital in Delhi Cantonment you are not likely to be impressed with the dilapidating barracks in which the labs are housed. Paradoxically, the scientists who themselves are working in none too hospitable conditions are striving their best to make conditions for the fighting forces as hospitable as possible.

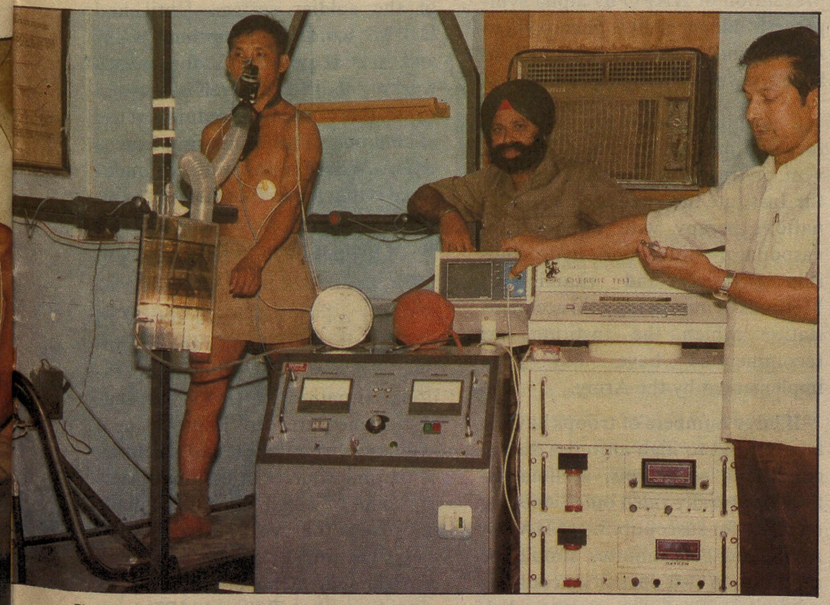


Decompression chamber to simulate high altitude environment

How to make troops adapt themselves to the environmental stresses caused by high altitude, cold and heat is DIPA's centre-piece endeavour. Apart from nature's furies, the troops have to encounter hostile environments, whether they are working in the engine room of a ship, or the crew compartment of a tank, or the cockpit of an aircraft. Here also the Institute strives to provide solutions.

RESEARCH on problems of high altitude assumes special significance in the national context as we have to deploy a large population of troops both on the Eastern and Western Himalayas. The Institute has carried out extensive research to assess the various physiological, biochemical and psychological responses during acclimatisation to altitude stress. As a result, it has worked out an acclimatisation schedule. Before a soldier is posted at an altitude of 4500 metres, he has to undergo three stages of acclimatisation, technically known as staging of acclimatisation. As a result, most of the ill effects of high altitude stress have been minimised and casualties reduced.

Physical efficiency of troops drops, as the work of the Institute has shown, by 10 % at 3500 m, 25 % at 4000 m and 50 % at 6000 m even after normal acclimatisation. DIPAS has therefore formulated optimal work capacity, load carriage and marching speeds.



Exercise test assembly (computerised)

PROVIDING proper nutrition to troops posted at high altitudes is equally important for the extremes of cold and lack of oxygen (or hypoxia, as this condition is known) alter the human physiology. This called for assessing the calorie and nutritional requirements of soldiers performing various types of activity at different altitudes. Researches at DIPAS have clearly established that digestion, absorption and utilisation of carbohydrates and proteins are unaffected in man at high altitudes. Fats, it has been found, are well tolerated, accepted, digested and absorbed to the extent of 96 % in acclimatised low landers, even at an intake of 150-200 grams per day. Furthermore, the

requirement of vitamins like vitamin C does not go up at these altitudes. Food for Armed Forces, which earlier contained 5500 calories and 300 mg of vitamin C, was reduced to 4800 calories and 100 mg of vitamin C, based on the actual energy expenditure of 4300 calories per day. A ration scale for troops operating in glaciers has also been formulated.

To meet the satiety and variety requirements of the Indian dietary, the ratio of carbohydrate: fat: protein in the diet has been maintained at about 65:15:25. The extra 500 calories is sufficient to ward off the extreme cold and to offset the terrain effects. The unified service ration given in plains to the three services provides for 4050 calories. There are however special situations in which the personnel working need different rations. For example, submariners, who have very little space to move about and remain isolated, require less calorie food, so their food provides for 3600 calories but includes fruit juices.

What should be the tenure of posting of troops at high altitudes? Because they have been acclimatised, could the troops be posted indefinitely there? No, is the Institute's answer. A tenure of two years of posting at high altitudes with the normal schedule of work is its recommendation, which has been accepted and implemented by the Army.

PROPER clothing and protective measures are required for preventing the ill effects of cold, solar radiation, snowblindness and the like. An anthropometric survey has helped work out proper sizing of personal equipment and clothing at high altitudes.

No matter how well we plan to acclimatise the troops to high altitudes or how efficiently we equip them with clothing, a few individuals suffer from acute mountain sickness (AMS), high altitude pulmonary oedema (HAPO) and cold injuries. Extensive research on the causes, prevention and treatment of such ailments has been carried out by DIPAS. It has been found that prophylactics like lasix, in vogue till recently, to prevent AMS and HAPO offer no additional physiological benefits. Except in patients who manifest maladaptation syndromes, such medication has been discontinued. This again is a measure which has effected savings in the national exchequer.

DIPS serves two important constituencies—the Armed Forces Medical Services, and the biomedical research community at large.

More recent studies on the cause of HAPO have shown that hypothalamus could be the area of the central nervous system associated with the origin of the ailment. Studies on the prevention of HAPO by alpha sympathetic blockers like phenoxybenzamine and serotoninergic blockers have shown encouraging results.

Cold injury leads to loss of fingers, toes and parts of the limbs. To prevent or treat this clinical condition the Institute has suggested a combination therapy with a peripheral vasodilator—tolazoline hydrochloride (Priscol)—and vitamin C. Methods of improving cold acclimatisation which the Institute has recommended have also been implemented by the Army.

If large numbers of troops have to be inducted to high altitudes during emergency operations, acclimatisation is naturally ruled out. Screening methods for susceptibility to HAPO, AMS and cold injuries should be available so that casualties could be minimised, if not altogether avoided. A chemoreceptor sensitivity test which the Institute has suggested is a fairly good indicator to identify soldiers susceptible to AMS or HAPO. Similarly, tests for screening individuals susceptible to cold injuries have been suggested.

IF high altitudes pose one type of problem to troops, desert conditions pose another type, that of heat stress. The Institute has geared itself to tackling problems of acclimatising the soldiers to heat, and to finding the fluid and electrolyte requirements as well as tolerance levels under various levels of severity of heat stress.

Heat stress occurs also in certain environments such as crew compartments of tanks, engine rooms of ships, cockpits of aircrafts, and ordnance factories. Hot humid conditions are more strenuous than hot dry conditions. In both conditions the body loses fluids and electrolytes (salts) in the form of sweat. Unless the loss is made good through supply of water and salt the work efficiency of the soldier suffers. Until had DIPAS worked out optimal water and salt requirements for troops working at different levels of thermal stress, there used to be redundant use of common salt through supplementation. What the Institute has uncovered is that the Indian dietary has an adequate supply of common salt and hence there is no need to supplement it.

Based on an extensive survey in various ships to identify the magnitude of heat stress in different operational situations, DIPAS has suggested measures to improve heat insulation, ventilation and shielding of thermal sources in various classes of ships, which in turn have improved the work efficiency of naval personnel. Similar studies in crew compartments of various types of tanks, such as T 70 and MBT, have

also helped improve the efficiency of the crew.

ACCLIMATISING soldiers to extremes of weather is one way of maintaining their efficiency. To enhance their efficiency further, DIPAS is turning to the wisdom of ancient systems of medicine like Ayurveda, Siddha and Unani. The substances investigated for enhancing stamina and work efficiency are a group of natural products derived from plant as well as animal sources, known as 'adaptogens'—another name for rejuvenators/aphrodisiacs. Two of the well-known adaptogens are the Siberian ginseng *(Eleutherococcus senticocus Maxim.)* and the Korean (or Chinese) ginseng *(Panax ginseng Mey.)*. Russians have reportedly used the Siberian ginseng for accelerating wound healing in surgical patients, recuperating patients from debilitating disease, professionals working in hazardous conditions, mountain climbers, space explorers and athletes. Working with experimental rats subjected to multiple stresses, the DIPAS scientists have found that the Korean ginseng is an excellent adaptogen. Encouraged by this success the scientists are now evaluating through animal experiments several Indian plants reputed to be powerful adaptogens in Ayurveda.

ASIDE from the natural hazards like extremes of temperature, combat forces have to contend with the menacing noise pollution as, for example, in gunnery. One of the worst effects of noise is the impairing of the hearing power, apart from extra-auditory effects on the physiology and biochemistry of the human system. With a view to providing remedial measures, DIPAS has conducted an extensive survey of the levels of noise exposure at different work environments and identified the source of high-intensity noise. An interesting finding is that exposure to noise increases the fibrinogen levels and platelet adhesiveness. The Institute has suggested changes in the design of certain equipment and vehicles for minimising noise levels. Furthermore, it has recommended protective devices like ear plugs and muffs for use by defence personnel exposed to continuous or impulsive noise in their work environments. More importantly, the Institute is studying therapeutic methods to minimise the threshold shift of hearing and to accelerate the recovery if the shift is temporary. Administering a mixture of oxygen (95 %) and carbon dioxide (5 %), known as carbogen, has been found to restore the hearing power.

With a view to reducing the gaseous pollutants, like carbon monoxide, sulphur dioxide and oxides of nitrogen, as well as dust, inside army vehicles like tanks, the Institute has recommended alterations in the design.

Haemorrhagic shock is a major cause of death among battle casualties and in road accidents. The only solution to this problem is instant transfusion of blood, which is not always possible. In such cases, the Institute has found that xanthinol nicotinate can improve blood flow to the tissues and augment the heart function and can delay the onset of pathological changes leading to irreversible haemorrhagic shock.

THE Institute has also been experimenting with the efficacy of yogic exercises in improving the physiological and psychological functions of the troops. Field experiments with middle-aged soldiers who practised yogic exercises for a period of six months showed a definite improvement in cold tolerance. Yoga has also been found to enhance tolerance to stress which may be environmental or emotional in origin. Based on the findings, DIPAS has recommended that yogic exercises be introduced in selected areas where PT may be tactically undesirable or impossible. Other beneficial effects of yogic exercises, as observed by DIPAS scientists, are the strengthening of the homeostatic mechanism of the body and protection of the individual from unduly heavy blood loss in case of injuries; controlling of the essential hypertension; and enhancing of the concentration and memory.

Partial sleeplessness in soldiers undergoing acclimatisation to high altitudes is a common feature. Neurophysiological research at DIPAS has shown that this is beneficial as it prevents aggravation of hypoxic effects. What this means is that frequent awakening during sleep is an adaptive function and is no cause of worry. However, if the soldier is deprived of sleep for more than 48 hours continuously then medication through tranquilisers may be resorted to.

In recent years DIPAS has extended its research interests into reproductive biology, neurophysiological studies concerning epilepsy and antiepileptic drugs, electromagnetotherapy, climatotherapy, and such other emerging fields, either on its own or in collaboration with other research institutes.

The focus of DIPAS is no doubt on improving the efficiency and performance of the Armed Forces. But the research results are finding wide application elsewhere also. Its findings from research on adaptation and acclimatisation to high altitude environments, for example, has benefited natives of high altitudes, sojourners, tourists and mountaineers.

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Flowers In The House

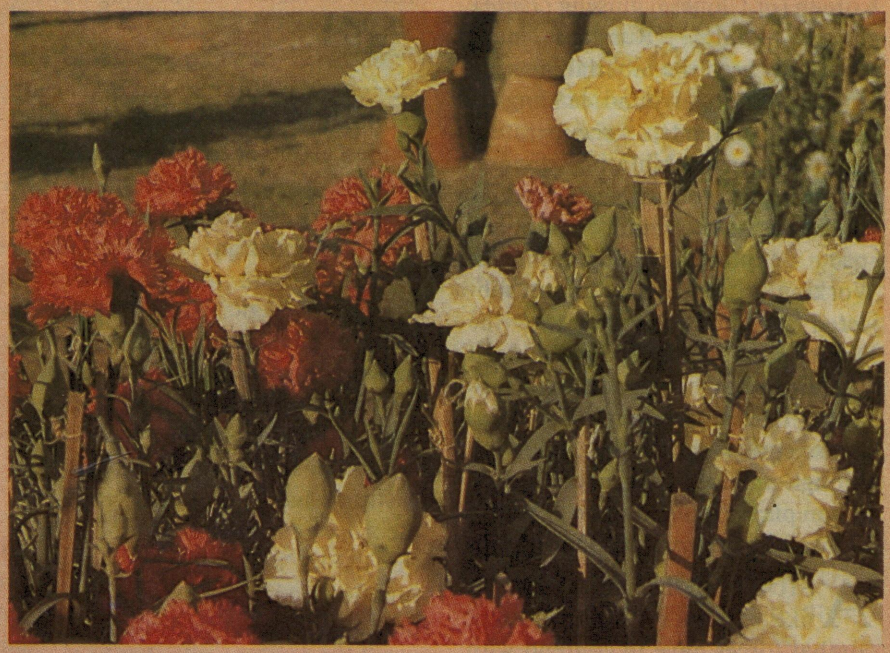
Parul R. Sheth

FOR centuries flowers in India have played an important role in religious rituals, festivals and as an adornment for brides. It is used as garlands or stemless flowers strung together on string or banana pith. Flowers adorn beautiful maidens, gods and goddesses sculpted in wood, stone or metal. Not only in India but in Far eastern and European countries too, flowers are given much importance. None of the synthetic perfumeries can compete with the natural fragrance of flowers. The sweet fragrance refreshes the mind, and reduces tension. Flowers in the house, balcony, terrace gardens emit fragrance and perfume all over.

Several plants have scents in their flowers but there are others which have colourful and attractive flowers. The ones with scented flowers contain essential or volatile oils which evaporate at different rates to give out fragrance. 'Raat ki Rani' or *Cestrum nocturnum* gives out its fragrance only during the night. Likewise, some plants are noticeably fragrant following rains. The fragrances and natural perfumes vary in smell. Some of these are intense. Roses smell sweet. Violets and lavenders emit light scent; lilies, tuberoses and jasmins give out heavier fragrances while sandalwood, champa, and keora are the favourite of the 'attar' lovers. All these fragrances have been classified on the basis of some stable natural odours committed to our memory. Planting of these fragrant plants around homes or indoors presents pleasant surroundings.

PLANTS or shrubs that bear fragrant flowers can be planted either in pots, wooden boxes, tubs or any other containers. These can be placed in the balcony, terrace, front-yard, window sills, etc. wherever there is space and enough sunlight. Trees like champa *(Mimisops elengi)*, Keora or any other tree of Cirus species can be planted in the front-yard. Creepers like rose, jasmine *(Jasmin grandiflorum)* can easily climb over the varandah walls or pillars. Tuberoses, lilies and some species of gladioli too bear scented flowers. Keora *(Pandanus odoritissimus)* requires a sunny corner to grow. Plants like *Cestrum nocturnum* (night queen) or *Jasminum sambac* (mogra) are best suited for plantation near the bedroom window sill or balcony extended from the bedroom. Besides these fragrant flowers, many colourful flowers which do not have scent can also be grown to enhance the beauty of the place. Cacti too look cute and can survive for a long time. Some of these grow fast and they need to be tied up as they are heavy. Cacti have superficial roots which collect water every day. Some varieties of cactus like the Prickly pear or Hedgehog cactus give rise to lovely red flowers which look attractive. Other plants which can adorn the window sill or door arches are Bougainvillea or Poinsettia. These plants have coloured parts that look like flowers but are really a modified form of leaf.

A variety of roses can be grown in and around the house. The rose being a very hardy plant can grow in all kinds of climates but it thrives in cold weather. As such, rose is a favourite of almost everyone and is associated with romance. The most popular variety in India is the 'Gladiator' and 'Hybrid tea'. These plants generally have a single bloom atop a long stem. Then, there are other medium-sized blooms which grow in clusters. Besides, there are miniatures which



are commonly known as button roses. On the whole, roses need a lot of care and attention. They need plenty of sunshine, all day preferably. They do not like shade. The soil should be well-drained and free of stones. Small brick pieces can be put in the bottom of the pot. Prior to planting, the pot should be filled with three parts of manure and two parts of soil. The plants are susceptible to insects and weeds. Fertiliser, insecticide and fungicide are a must. In fact, the commonest thing about growing flowers is that mostly all of them require regular watering, sunlight and spraying of insecticide or fungicide from time to time.

Since plants get water through their roots, sprinkle water onto the soil. The roots will draw water from the soil up into the plant and it will grow strong and beautiful. Drainage of water is another important point to keep in mind. If a flower-pot is not properly drained, the water that collects in it will cause the roots and the plant itself to decay. Also, air cannot circulate freely unless it has both a way in and out. Without a hole in the pot, air circulation is poor and not enough air gets into the soil. The roots which need air to breathe will suffocate without enough of it. So the bottom hole is indispensable to flower pots. Further, pots should be porous so they can contribute to the 'breathing' process.

To prepare a flower pot, place a small stone or a piece of pot over the hole. Fill the bottom with gravel or a hard lump of soil. Strain the soil, mix it with manure and then fill the pot. Plant the seeds or shrubs and sprinkle water. The potted plants need to be repotted after a year or so in order to replenish the nutrients in the soil.

FLOWERS, as they grow, can be plucked along with a long stem and a few leaves and brought indoors to arrange them in a flower vase. Rocks and stones are a great asset to the flower arranger. A collection of interesting shapes will be useful for creating unusual arrangements, as stones and rocks add strong character and only a few choice blooms need be included to make an effective arrangement. Vases of different shapes in brass, bronze, copper, ceramics, clay or stone enhance the beauty of the room. Flower arrangements are influenced by Oriental and particularly Japanese (Ikebana) design. The cave paintings of the Pallava period in Sittavasal near Puddupottai dedicated to the Jain religion have figures in a lotus pool carrying bouquets of lotus. These paintings convey the message of flowers arranged for presentation. Likewise, many of our Rajasthani paintings depicting varied Ragas also depict a definite style of flower arrangement. Flower arrangement is no doubt an art, but there are certain scientific principles involved.

To begin with, cut the flowers early in the morning or after sundown. Immediately place them in a bucket of water. This will prolong the life of the flower. Then, stand them in water for a few hours. This is called the hardening process. Most flowers are treated successfully by this method. Always make a sharp cut with shears or cutters. Always cut the stem at an angle to help the intake of water. Woody stems can be crushed at the ends. Do not allow the leaves to touch water as they will rot and cause bacteria to grow. It will shorten the life of the flower. Clean containers are better. If possible, avoid draughts and fans. Add water to the container before the flowers are placed inside.

Every modern floral design school teaches and follows the five basic principles of good flower design. These principles include focal-point, build-up, balance, relationship of parts and simplicity. A tall flower can be a focal-point with two other flowers at different heights lower than the central flower. Build-up is acheived by repetition of colour, form or texture leading either towards or away from the focal-point. Form and colour are important factors of balance and are closely related. An important point to remember is that dark colours and heavy flowers add weight, while tall, thin stalks and light colours give an impression of lightness. Relation of parts or proportion or scale is necessary to obtain the best and most striking visual effect in the design.

Colour is another dynamic factor in a flower arrangement. Without the beautiful colours there would be little interest in flower arrangements. It is the colour that brings life into a room. But the choice and blending of colour is an art. It depends on personal taste and mood, some combinations being more pleasing than others.

To keep flowers into position you require pin holders which are available in the market in different shapes and sizes. You can choose the right one for the size, shape and type of container you possess. Meshes together with pin holders can be used to position heavy flowers. It is frustrating to complete an arrangement only to have it topple over because of a faulty holder. You can add water everyday to the container. Tired and thirsty flowers will tend to droop.

Remember, you can grow your own flowers decorate your house with them in the way you like. That is what makes it all so varied and exciting.

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In The World Of BASIC-IX

V. Ramshesh

IN the last part, one important branching operation was discussed. At times, one may have to branch to an independent path and after completing execution come back to the main program.

The command word for this type of branching is called GOSUB (GOSUB means GO TO A SUBROUTINE; GOSUB may be written also as GO SUB). When the command GOSUB is encountered in any line, control is transferred from that line to a subroutine. In order to return to the main program after completing the subroutine, another statement, called RETURN, has to be given at the end of the subroutine. There are thus two statements in a GOSUB operation, viz., GOSUB and RETURN. The correct way of writing a GOSUB statement is:

```
20 ----------
30 GOSUB 100
40 ----------
-------------
90 END
100 ---------
-------------
150 RETURN
160 END
```

When the program reaches line 30, it encounters a GOSUB statement. As per command GOSUB 100, it then branches to line 100, where a subroutine starts. Lines from 100 onwards are executed till RETURN statement is encountered in line 150. At this stage the program returns to the first line following the GOSUB statement, viz., line 40. Execution now continues in normal sequence till END statement is encountered in line 90. In a GOSUB statement, END statement must also be carefully placed. It may be placed wherever the program is to be terminated but in any case before the subroutine starts. Otherwise, the program will fall into the subroutine and give an error message. The usual END statement in last line 160 may look reduntant but this is a good programming practice.

Program 1 illustrates the use of GOSUB statement. Line 10 is an Input statement, whose value is stored against a numeric variable N. In the next line 20, a conditional GOTO statement is given. If N<200 execution goes to the next line 30, where GOSUB statement is encountered. Control is transferred to subroutine starting at line 100. Lines 100 to 120 are executed. In the next line 130, as RETURN statement is encountered, execution does not proceed to the subsequent line 140. Instead control returns to main program at line 60 (immediately following the line where GOSUB command is given). As line 60 is END statement, the program terminates.

If N>200, control is transferred to line 50 which is a Print statement. As the next line 60 is END statement, the program terminates. On running the program, depending on whether N>200 or <200, different statements will be printed. The reader may see for himself what happens if END statement in line 40 is deleted from the Program.

It is a good programming practice to start execution of the subroutines at lines 100, 200 and so on (or 1000, 2000 and so on). The appropriate statements will then be GOSUB 100, GOSUB 200, and so on (or GOSUB 1000, GOSUB 2000 and so on). There can be several subroutines in the same program. More important, the program can be made to cycle through the same subroutine repeatedly (see below).

```
10 ----------
----------
100 GOSUB 1000
110 ---------
----------
```

```
5 REM GOSUB STATEMENT
10 INPUT "VALUE OF N ="; N
20 IF N > 200 THEN 50
30 GOSUB 100
40 END
50 PRINT "AS N > 200 PROGRAM SKIPS SUBROUTINE"
60 END
100 PRINT "AS N < 200 PROGRAM GOES THROUGH SUBROUTINE"
110 PRINT "AND EXECUTES LINES"
120 PRINT "FROM 100 TO 120"
130 RETURN
140 PRINT "BUT THIS LINE IS NOT PRINTED"
150 END
RUN
VALUE OF N = ? 300
AS N > 200 PROGRAM SKIPS SUBROUTINE
RUN
VALUE OF N = ? 100
AS N < 200 PROGRAM GOES THROUGH SUBROUTINE
AND EXECUTES LINES
FROM 100 TO 120
```

Program 1. GOSUB statement

```
200 GOSUB 1000
210 ---------
---------
990 END
1000 REM SUBROUTINE
STARTS
1010 ------
---------
1190 REM SUBROUTINE ENDS
1200 RETURN
1210 END
```

In this program, there are several GOSUB statements (only two are shown) in lines 100, 200 and so on. All these take execution to the same subroutine. Apparently, the subroutine processes the same information updating the results constantly. In such cases, END statement must come at the line just preceding the one where the subroutine starts. In this example, as the subroutine starts at line 1000, END statement is placed in line 990.

All conditional GOTO statements are valid for GOSUB command also. These have been covered in Part VIII. To take one example, one can write:

```
100 IF N>200 THEN GOSUB
    1000
```

On reaching line 100, if N>200 control will be transferred to sub-routine starting at line 1000.

So far branching operations have been confined to a single path. At times, it may be necessary to have an option of branching to more than one path. Such multiple branching is possible with both GOTO and GOSUB statements by altering slightly the command words. The command words for multiple branchings are ON—GOTO and ON—GOSUB.

The ON—GOTO statement consists of a line number, the word ON, a numerical expression (which can include variables), and the word GOTO at the end. The computer evaluates the expression, cuts off the decimal point to give the nearest whole number, and depending on whether this is 1, or 2, or 3 and so on the program jumps to the lines marked from the beginning. For example,

```
70 ON P GOTO 100, 200, 300
```

On reaching line 70, execution goes to line 100 or line 200 or line 300 depending on whether P is 1 or, 2 or 3.

Program 2 illustrates the use of ON—GOTO statement. Lines 20, 30, 50, 70, 80, 90 and 110 are mere Print statements and they explain the game. Blank Print statements in lines 40, 60 and 100 leave blank lines to make the printout attractive. Lines 130 and 140 are Print statements implying start of the game. Line 160 is an Input statement asking the person to input a number between 1 to 3 when a question mark appears. This number is stored against the variable N. Line 170 contains the ON GOTO statement and the program is made to go to line 200 if N is 1 or 2 and 180 if N is 3. Lines 180 and 200 are Print statements indicating whether the answer is correct or wrong. The END statement in line 190 is necessary to terminate the program at line 180 in case the correct answer is given. There is a slight catch in the program. If any positive number > 3 is input, execution will still go from line 170 to line 180. This can be easily prevented by inserting a line as:

```
175 IF N<1 OR N>3 THEN 160
```

Line 170 acts as a trap returning execution back to line 160 if the wrong input is given.

The ON—GO SUB statement is similar to the ON—GOTO statement and is written as:

```
100 ON P GOSUB 1000, 2000,
    3000
```

When execution reaches line 100, program will jump to different subroutines starting in line 1000, or line 2000, or line 3000 if the value of P is 1 or 2 or 3. □

```
10 REM GUESSING GAME
20 PRINT "SOME SWEETS ARE HIDDEN IN THIS ROOM"
30 PRINT "THERE ARE THREE POSSIBLE PLACES"
40 PRINT
50 PRINT "IF YOU ARE RIGHT, YOU GET THE SWEETS"
60 PRINT
70 PRINT "THE POSSIBLE PLACES ARE GIVEN"
80 PRINT "AND IF YOU THINK THAT IS THE RIGHT PLACE"
90 PRINT "TYPE THE NUMBER FOLLOWING IT"
100 PRINT
110 PRINT "REFRIGERATOR (1), CUPBOARD (2), DRAWER (3)"
120 PRINT
130 PRINT "*** ARE YOU READY? TYPE YOUR ANSWER ***"
140 PRINT "**** AFTER A QUESTION APPEARS ****"
150 PRINT
160 INPUT N
170 ON N GOTO 200, 200, 180
180 PRINT "CORRECT, YOU CAN HAVE THE SWEETS"
190 END
200 PRINT "WRONG. IT IS HIDDEN IN THE DRAWER"
210 END
```

Program 2. Example of ON GOTO statement

FROM GENES TO CLONES Introduction to Gene Technology *by* Ernst Winnacker, *VCH. Publishers* (Available with VCH Verlagsgesellschaft, P.O. Box 1260/1280, D-6940, Federal Republic of Germany), pp. 634, 1987; Hard cover: DM 120.00/ US$ 76.00.

ONE can find microbes in nature that can break down spilled oil, live in boiling acid and accumulate uranium in their cellular matrices. Although the range of already existing bacterial skills is amazing, attempts have been made to improve on these by combining properties often from radically different species. The trick involves moving genes around and putting them together to a novel specification. For meeting this objective, a number of pre-requisites must be met. One of them is the availability of means of cutting the required specific gene out of the whole genome. The enzymes which accomplish this job are called restriction-endonucleases. These are strain specific-enzymes and enable various organisms to recognize and destroy foreign DNA by causing scissions at a limited number of sites. At the same time, the DNA of cell is protected against its own restriction-enzyme by a specific mechanism.

The diversity of the sequences, which can be cut using restriction enzymes and their specificity to particular nucleotide sequence, makes them an extremely important research tool in recombinant DNA technology. Most of the recent technological advances, e.g., DNA sequencing, chemical synthesis of DNA, restriction mapping and in vitro mutagenesis are dependent on restriction endonucleases. This new gene technology now offers an exceedingly powerful handle on nature. A human gene can now be taken and put into a bacterium or rabbit genes can be mixed with mice genes without any chaos. The living world can now be viewed as a vast organic pool inviting combination, hybridization and continued rebuilding.

The book under review contains 15 chapters which cover basic concepts and strategies of gene cloning. It gives an introduction to the Gene Technology and its various specific unit operations, i.e., isolation and characterisation of DNA and of genes, the developments of cloning vectors and characterisation of recombinant DNA molecules. The book focuses on vector development in a variety of biological systems and discusses various practical applications of plasmids (a circular extra-chromosomal DNA molecule that replicates autonomously), bacterophages (viral vectors), cosmids (plasmids containing lambda cos sites), plasmids (cloning vehicles which combine phage and plasmid properties) and eukaryotic viruses (Simian Virus 40, Papilloma virus and Retroviruses) as cloning vehicles with the respective hosts, i.e., Prokaryotes, Streptomyces, Yeasts, Plants cells and Eukaryotes. The literature in this field is vast and an authoritative and concise account of the various developments in this area would be of considerable value to the novice as well as the expert. The last chapter is devoted to the problems of safety in recombinant DNA work. It not only contains the description of the historical developments leading to the r-DNA debate in the seventies but also deals with more recent concerns and potential risks including large scale industrial production, deliberate release of micro-organisms and plant cells in the environment and issues associated with genome analysis and gene therapy.

Some of the outstanding features of the book are: comprehensiveness, organisation of various closely related topics in the same chapter, an extensive list of updated references, appendices on useful host strains, restriction enzymes, interesting restriction maps, sequencing data, glossary, and a detailed index. An feature of the book is the photographs of pioneers in the field. The book is a fine source of current information. It will be valuable in the library of both students and researchers of this fast developing field of Gene Technology.

Vijay Kaushik
Gulshan Wadhwa
Arun Goyal

THE ROBOTS ARE COMINIG— Stories of Robots *by* Dilip M. Salwi, *Ratna Sagar Pvt. Ltd.,* Virat Bhawan, Mukherjee Nagar Commercial Complex, Delhi 110 009, Pp. 93, Rs. 18.90.

ROBOTS are no longer matter of imagination; they have turned into reality. The word 'robot' is a Czech word which means 'slave'.

Karel Capek, the Czech playwright, first of all used this word in 1923. Doubts are expressed by scientists, thinkers and philosophers as to whether the slave might not one day turn into the master. Others think that large scale use of robots might lead to massive unemployment problems. In spite of these doubts and

apprehensions the robots are coming in a big way. In western countries and Japan, robots are already being used in factories and in various types of industries. Others for use in offices, homes, even restaurants are under trial. Indeed, the day is not far when even our country will witness robots performing important functions in various fields.

Robots have been very popular with the Science Fiction writers, who attribute all sorts of powers and abilities to robots. The book under review is a collection of eleven Science Fiction short stories about robots. The stories are not only entertaining and interesting but they are instructive too. Some stories are about robots of the 21st century while others deal with robots of the far future when perhaps human beings would be extinct. In some of the stories, robots have been depicted as exhibiting strange behaviour. The robot called "Doxie" in 'Robots are becoming clever' surreptitiously fiddles with the knobs in his belly late at night when everybody else in the house has gone asleep! What fate is met by a school child when he engages a robot to do his home work? The readers need to leaf through the story 'Robots are a boastful lot' to elicit the answer. In yet another story, the robot of Sherlock Holmes shows his exceptional detective abilities to trace the missing dog, Jimmy.

Some of the stories have been written in a lighter vein. However, they have a latent message or warning that entrusting everything to robots or unnecessarily meddling with them or not properly using them might lead to disastrous consequences. The author uses simple language to narrate the stories. Children will certainly welcome the stories not only because of their entertainment value but in view of their educative value too.

P.K. Mukherjee

NEUROMANCER *by* William Gibson, *Grafton books*, (Available from *Rupa & Co.*, 3831, Pataudi House Road, Daryaganj, New Delhi-110002), pp 317, £ 3.50

THERE are now definite views on what constitutes a science fiction story or novel. Standardisation of basic elements of a sci-fi story has been in evidence for long and is well

known to authors here and abroad and should be known especially to a reputed author whose work has fetched him Hugo and Nebula Award. One wonders how a story-teller has forgotten the simple writing techniques in the novel under review. The cover and the title of this novel are attractive and one gets the impression that ahead lies a fascinating story. But as soon as he advances further, he finds himself dragging and pressurizing himself into reading this boring novel because either he has spent a lot or has been asked to review it! A few extracts of the reviews of the novel reproduced from *The Time, Times Literary Supplement* and *Washington Post* are fascinating but totally misleading!

It is astonishing or rather bewildering to accept the fact that this novel is a HUGO and NEBULA Award winner. Although this reviewer does not claim to be an expert sci-fi literary critic, he can say with confidence that by reading traditional as well as modern sci-fi he has an understanding of the sci-fi genre to a considerable extent. *Neuromancer* is beyond the comprehension of this reviewer. However, it is not the intention of this reviewer to cast any aspersaions on the decision of the jury which has selected this novel for a Hugo and Nebula Award. But this is an effort to convey sincerely and honestly the impressions about the novel to the prospective buyer/reader. It was very hard to pull oneself to read the novel to the end. The traditional and conventional story is nowhere to be seen in the novel. The novel also does not sounds to be futuristic incorporating evidence of frontier sciences. The whole story appears to be woven or rather pushed around a loafer who has been poisoned secretly by implementing tiny, undetectable sacs full of mycotoxin microscopic substances like fungi, and who is desperate to get rid of this slow killer as soon as some don in the crime world discloses this to him. The boy is on the streets; no home, no relatives and no money. He deploys strange criminal ways to snatch money from harmless people, sometimes killing them. He is operated upon several times; he lives in futuristic high-tech slums in megalopolises, possesses and dispossesses ancient as well as strange weapons, is lusty and fearful.

The author has failed to scientifically substantiate various situations. Perhaps the author presupposes that the reader has an advanced level of understanding. If this is the representative sci-fi of the West, then perhaps the days of the best traditional and well narrated sci-fi is over there. The unusual characterization in the *Neuromancer* is not a healthy trend in sci-fi and would soon be rejected by people. Even the most liberal sci-fi reader won't hold on to the last word of *Neuromancer*.

Ranbir Singh

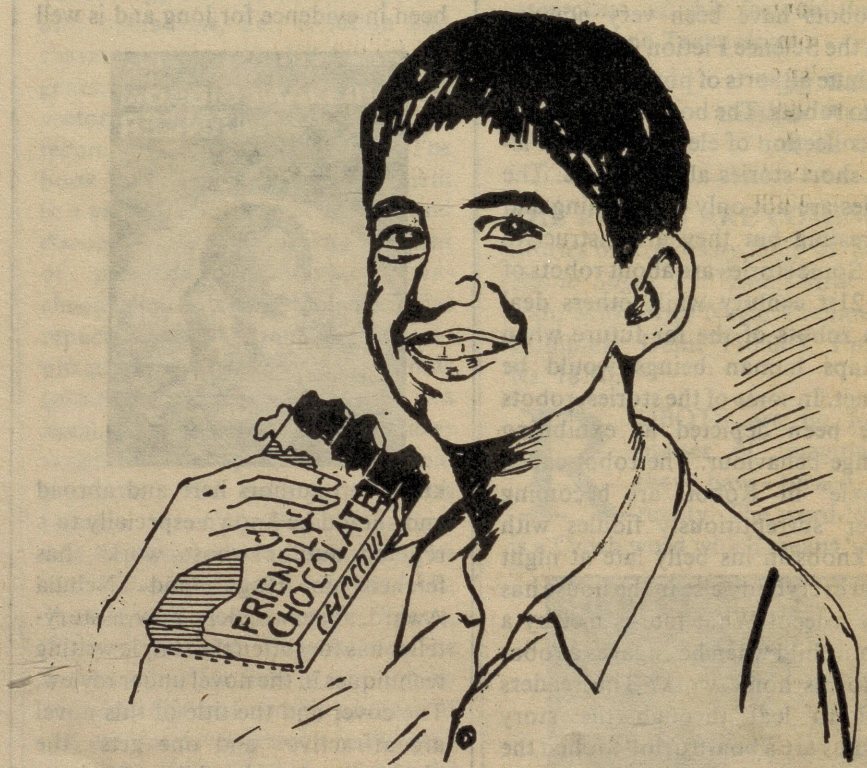
Tooth-Friendly Chocolates

INDIA is one of the largest producers of cane sugar and Indians consume a lot of sweets, especially during religious festivals and in parties. Often these sweets are deep-fried in vegetable oils (vanaspati) or animal fat (desi ghee or clarified butter), e.g. *jelabis*. When eaten in excess, the combination of fat and sugar can cause gastric and other digestive disorders. Even without the fat, sugar alone can cause considerable damage to one's teeth, especially if one does not take adequate care of one's teeth and mouth. No wonder then that a large number of children in urban India—where sweets, toffees, cakes, pastries and chocolates are consumed much more than in rural India—suffer from tooth disorder. A recent study reported in the *New Scientist* suggests that it is better to avoid eating sugar in whatever form on an empty stomach for it can lead to an undue increase in blood glucose levels.

The problem of consuming too much of sugar is even more acute in the affluent countries of the West. For instance, in the United Kingdom five million teeth are extracted annually and 27 million teeth are filled. Such staggering statistics led the Committee on Medical Aspects of Food Policy in London last December to suggest that alternatives to traditional sweets should be developed. A timely and sensible suggestion indeed. The Boots chain of stores in the UK is already selling lollipops which are "kind to teeth". And many sweetmakers including Mars, Rowntree, Macintosh, Suchard and Barker & Dobson are trying to perfect a recipe with sugar substitutes which will match the real thing in taste and appearance. The first batch of sugar-free and tooth-friendly British sweets was on display at the International Confectionary Fair at Cologne, West Germany, held in February 1990.

Firms in Switzerland and West Germany are already marketing tooth-friendly chocolates. These 'kind-to-teeth' goodies are distinguished by a special mark on the packing—a molar tooth protected by an umbrella. Most of these use 'isomalt' a substance derived from sucrose but which does not have the deleterious effect of sucrose or glucose. Of course, the traditional sugar-based sweets continue to dominate the market, but with vigorous consumer awareness movements the market share of sugar-free chocolates can be increased.

In India, except for a few firms which sell saccharin-based rasgullas for diabetics, no major manufacturer of chocolates, toffees and other over-the-counter confectionary products has even thought of making sugar-free products. Nor do the Indian parents seem to care for the teeth—either their children's or their own.



Subbiah Arunachalam

Japanese Forge Ahead in Fusion Research

SCIENTISTS at Osaka University's Institute of Laser Engineering think that they can achieve nuclear fusion using lasers in the next five or six years. They have already succeeded in generating a temperature of 100 million degrees Celsius in a compres-

sion experiment. In this experiment they used a powerful laser beam for the first time to compress fuel pellets (or spherical plastic shell targets) to a density necessary for triggering nuclear fusion.

Nuclear fusion is what causes the Sun to produce so much energy. Unlike in fission, which is the source of energy in all existing nuclear power plants, where the nucleus of a heavy atom like uranium is split into two lighter nuclei, in fusion the nuclei of two lighter atoms are brought together to form a heavier atomic nucleus accompanied by the release of tremendous amounts of energy.

To achieve fusion, first of all it is necessary to strip atoms of their electrons—which can happen only at very high temperatures—to leave a uniform mixture of positively charged nuclei and negatively charged free electrons. This mixture is called a plasma—not to be confused with blood plasma.

To produce a plasma, the Japanese scientists bombarded bullet-shaped plastic shell targets, consisting of carbon, heavy hydrogen and tritium, of one millimeter diameter and a thickness of one hundredth of a millimeter, with a powerful laser beam of ten thousand joule energy. The laser beam heated the target to above ten million degrees Celsius. Later on, the Osaka University scientists added a little bit of silicon in order to measure the neutrons—the charge-free particles present in the nuclei of all atoms except hydrogen released during the experiment.

Using what is called a random phase plate device, the laser scientists have succeeded in compressing the plastic shell targets to a density of 600 grams per cubic centimeter or about 75 times as heavy as an equal volume of iron!

A similar target of three millimeter radius when bombarded with a 100,000 joule laser beam, the Japanese team believes, should be able to cause nuclear fusion to occur.

Announcing the successful compression experiment, Dr Sadao Nakoi, director of the Institute of Laser Engineering said, "It is the largest step forward toward our goal so far. We have already generated a temperature of 100 million degrees (C). The next thing to do is to build a laser system that can produce more powerful beams to achieve the temperature and the density simultaneously."

One will not be surprised if the first successful fusion experiment is announced by a Japanese laboratory before the end of the decade.

S.A.

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- **The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper of at least 10 cm×15 cm size.**
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Do Bedbugs Transmit Diseases?

THE idea that bedbugs may be one's partner in the bed at night is enough to make one shiver. Those who have been in their company for a good long time may sleep undisturbed, but the new acquaintances will have to roll whole night, ceaselessly scratching the bitten parts. Surprisingly, no one likes to divulge the presence of this notorious fellow in his house, a factor very much in favour of the propagation of bedbugs *(Khatmal)*.

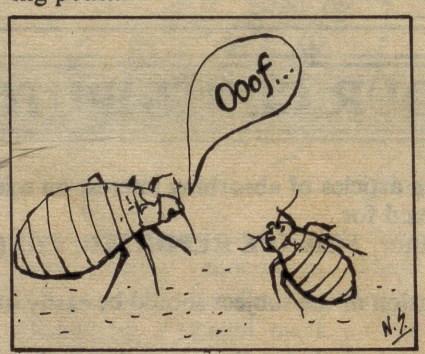
The small, wingless, flat-bodied, rusty brown bedbugs may be seen in the day hidden in the cracks and crevices of walls, in old furniture, under the carpet and behind the wall papers. Not only they inhabit dirty homes, but also clean ones. Bedbugs, in the night, come out of their hiding places in search of human blood. In addition to man, they also parasite on bats and birds.

How does the bedbug locate a human being? Nothing can be said with certainty in this regard, but scientists believe that bedbugs' sensitivity towards temperature change is helpful to them in locating their victim, as is in the case of mosquitoes. The other cues may be carbon dioxide and the smell emitted by the host.

On locating the victim the bedbug pierces the skin with the help of its needle-like tubes and sucks blood by means of pumps in the head. At the same time it injects saliva in the blood which contains an anticoagulant and anaesthetic. It is why the bites are not painful immediately. The symptoms of bite—swollen, itchy sores—start appearing after 24 hours.

A full blood meal lasts about 5 6 minutes. Female sucks more blood than male. It has been estimated that an adult human being, having approximately 4.5 litres of blood, can provide a decent meal to a quarter of a million bugs. According to another estimate, 500 bites a night would be enough to cause anaemia in babies a few months old.

Nature has been very kind to insects. Like cockroaches, bedbugs can also fight unfavourable conditions. They can survive for more than a year without food by entering into a kind of hibernation. Except at poles and rarely at deserts, bedbugs are found everywhere the world over. Some can live for several months even at temperatures as low as freezing point.



"Did I not tell not to suck more ?

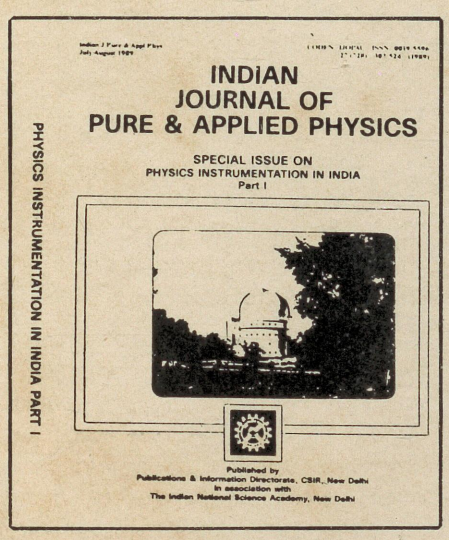
REPRODUCTION is peculiar in case of bedbugs. The female does not have a passage for copulation and the male inseminates the female by piercing the underside of her abdomen. The sperms pass into female's body fluids and travel till a few hours later they reach storage organs. The storage organs are connected to each ovary. The female needs a meal of blood before the eggs can mature. Once the eggs are mature, some of the sperms migrate to ovaries and fertilize them. The females lay about 300 eggs in their lifetime. Eggs hatch after 3 weeks into nymphs which moult five times before attaining adulthood.

The fear that bites of bedbugs may lead to serious diseases has already been lurking in the minds of people. It has however been observed that repeated bites may cause iron deficiency in children. Babies have 75 mg of iron for every kg of their body weight. Out of it, 2/3 is in red colouring matter of blood, i.e., haemoglobin. For every 100 bites by bedbugs the baby will be deprived of 0.73 mg of elemental iron. However it is difficult to know how bites affect iron level as the patient may already be suffering with malnutrition. Can HIV (human immunodeficiency virus) be transmitted from a patient to a healthy person the bedbugs feed on? Scientists have found that though HIV can survive in the bedbug for sometime, it is *not* transmitted to another person.

Then, how to get rid of these bad "bedfellows". Like mosquitoes, bedbugs too have developed resistance against DDT. Moreover, natural enemies of bedbugs are also killed by this insecticide. The traditional method of killing bugs through *Khat Mal* (crush immediately) may also not prove effective, as many will get away. A recent method to do away with bedbugs is to turn bugs' own chemical against them. They produce a scent that attracts them to each other to form congregates. It now becomes easier to eliminate them.

C.B. Sharma

NEW PUBLICATIONS



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