JUNE 1990

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SCIENCE REPORTER

BAMBOO BLOSSOMS

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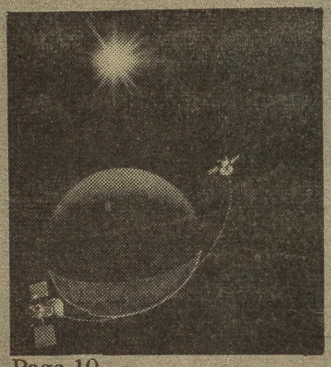

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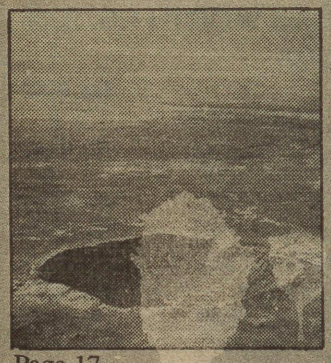

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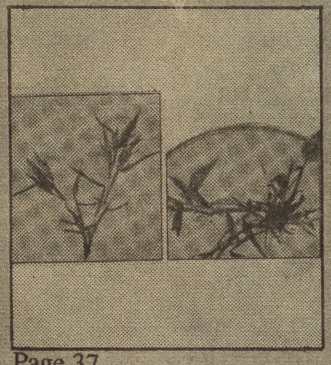

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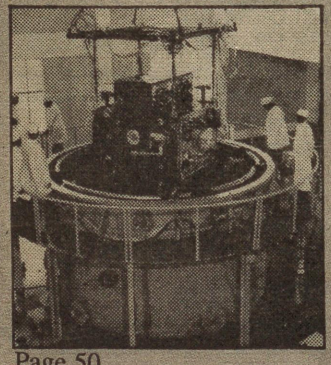

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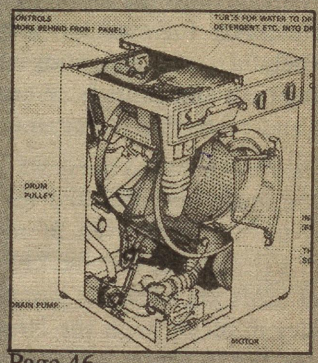

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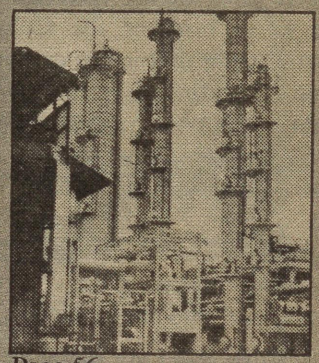

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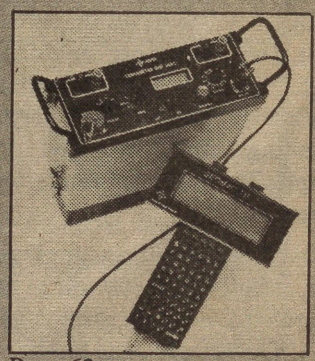

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Helpful Song Birds

Sir, I must thank Ramachandran Nambiar for his informative and educative article **Feathered Musicians** (*S.R.*, March 1990). In the article, author has presented important and useful information regarding bird song, its importance and probable reasoning for their musical notes. The author has mentioned the names of some important American song birds with little information. These birds are loveliest songsters. They are not only the source of music and pleasure for man but they are also helpful friends in fighting insects, saving trees and fruits from destruction and protecting environment.

The rose-breasted grosbeak is one of the most beautiful and loveliest songsters. It sings even at midday during the heat of the summer when most birds are silent. In summer, it resides in all through the Northern States, but in winter it flies south to Mexico and South America. The bird is so fond of the Colorado potato beetle that it has earned the name "Potato-bug bird". It also attacks cucumber beetles and many of the scale insects. Among other pests it consumes are Rocky Mountain locusts, cankerworms, tent caterpillars, tussock, gypsy and browntail moths, plum curculios, armyworms and chinch bugs.

Meadow larks are found all over the United States, even in winter in south. Its value as an insect eater is great. Twenty-five per cent of the diet of the Meadow lark is beetles and another 11 per cent is caterpillars, including cutworms and armyworms. They are very fond of grasshoppers.

The friendly little chipping sparrow, which builds its nest in garden or orchard, is very common all over the United States. One family of this tiny bird consists of mother, father birds and four younger birds. They eat insects including beetles, ants, wasps and caterpillars. Other useful birds of the United States are chickadees, yellow-billed cuckoo and its cousin black-billed cuckoo, downy woodpecker, Bullock's oriole, Baltimore oriole and Bob-white.

P.C. Sinha
Patna University

II

Sir, In my article **Feathered Musicians** (*S.R.*, March, 1990) there is an error in the captions to the colour pictures on pages 14-15. The bird in picture 2 is a Red-winged blackbird, and the one in picture 3 is a Chipping (not chirping) sparrow. There is nothing like a winged blackbird as given in the caption. All birds, except penguins, have wings.

Further, the title of the article was **Feathered Musicians.** It dealt mainly with renowned songsters. What, then, was the idea of showing a parakeet with other songbirds?

Ramachandran Nambiar
3368, Hargrove Road
Missiagua ONT
L5L 4E5, Canada

Why Maximum Compounds Of Carbon

Sir, I read the March, 1990 edition of *SR.* In the column Brains Trust it was stated that due to its tetrahedral nature, carbon compounds are very stable; also that carbon-carbon long chains or rings (or both) are found in a large number in nature and this constitutes the branch/organic chemistry. Agreed. But the question that was asked was not what is organic chemistry or whether carbon compounds are like tetrahedron or a pentahedron. On the contrary, the question was: Why has the element carbon maximum number of organic compounds?

The occurrence of a large number of organic compounds is probably directly related to the property of catenation exhibited to maximum extent by carbon. Although some other elements such as S, Si, etc., also exhibit catenation, though to lesser, rather much lesser, extent than carbon. Since carbon shows maximum catenation—the property of elements to form stable covalent bonds with each other—it has maximum number of compounds. Actually so extensive is this property of carbon that a complete branch of chemistry—organic chemistry—is devoted to study of carbon compounds. Now, the obvious question that arises is—Why should only carbon exhibit such catenation? Some people relate it to the bond strength which decreases down the group (C-Si-Ge-Sn-Pb).

I am writing this letter just to know the plausible answer that plagues us students from the day we start delving into the very large but ordered kingdom of organic chemistry.

P.K. Mukherjee
Banaras Hindu University
Varanasi-5

Radio Source Cas A

Sir, The article **Supernova** by Amalendu Bandopadhyay (*S.R.*, March, 1990) is really wonderful for its lucid presentation. The author has been very successful to explain the basic features of a supernova in a popular language.

I may add one very small point which has not been mentioned by the author. The first supernova, whose observations were recorded by Tycho Brahe, was in the constellation of Cassiopeia and it has been rightly mentioned by the author. But today scientists see the scattered and fading remains of that explosion as a powerful radio source called Cassiopeia A or Cas A, for short. The high-resolu-

tion radio image of Cas A shows what happens when the shredded debris of an exploding star or supernova encounters material in the surrounding space. The roughly spherical shell of the supernova remant marks the ongoing collision between gaseous material ejected from the outer layers of the star and the tenuous interstellar gas. Cas A was discovered in 1942 by an engineer and ham-radio operator Grote Reber, who made the first radio map of the sky.

B.N. Gokhale
Prof of Mathematics (Retired)
Bandra
Bombay-400 050.

Remnant of Supernova 1987 A

Sir, The article **Supernova** by Amalendu Bandyopadhyay (*S.R.*, March 1990) is very interesting and informative and has drawn attention of many readers due to its excellent presentation.

I may add one point which may be helpful to the readers. The star left behind by the explosion of Supernova 1987A seems to have been mimicking the behaviour of man-made particle accelerators, such as the magnetic rings of CERN, the European Centre for particle physics. The evidence for this "mimicry" arrived at Earth in the form of a burst of intense gamma-rays, 11 months after the explosion of a star in the large Magellanic Cloud. V.S. Berezinsky of the Institute for Nuclear Research, in Moscow and Todor Stanev, of the University of Delaware, in Newark have now explained this totally unexpected, belated outburst of energy. They suggest that it happened as a result of a proton beam becoming trapped by the remnant's magnetic field and building up energy for nearly a year before it burst free from its confinement.

S.K. Ganguly
Prof. of Physics (Rtd)
Banaras Hindu University
Varanasi

Corrigenda

1. Ref: *SR*, May 1990, contents p.2. *Read* authors of 'Useful Weeds' *as* R.P. Raman and S.C. Nahar
2. Ref: *S.R.*, May 1990, Brains Trust, p.32 (What is Solar Cooker?), eighth line in the answer: *Read* the sentence as: 'Absorption of heat is further increased by painting the inside of the box and the outside of the cooking container dull black'.

Editor, *SR*

PREVIEW

JULY 1990

Cover Story: **Focus on Weather**

Forecasting the Monsoon

How, using a set of variable meteorological parameters, Indian scientists are able to make reliable forecasts of the monsoon.

The Ocean Connection

Oceans play a vital role in making the earth's weather including the Indian monsoons.

Is There a Sun-Weather Link?

The solar cycle has been claimed to influence a host of terrestrial phenomena including changes in weather.

Also:

Epilepsy:—A Disease, Not A Curse—Individuals with epilepsy can now hold responsible positions and lead practically normal lives.

National Institute of Nutrition—A national centre that cares for the nation's health.

Breaking The Silence—Speech, that unique capability possessed only by humans, involves complex neural functions.

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Cart Before The Horse

IN the nearly two decades since the Stockholm UN conference, environmental concern has grown worldwide. So has the number of activist groups that have taken up the cudgels against what they perceive as anti-environment stance of governments and multinationals in many countries. India could not have remained away from this mainstream. Thanks to popular movements like 'Chipko' and the 'Silent Valley', the common Indian is today more aware of matters concerning environment than ever before.

Unfortunately, like in many other areas of human endeavour, the environmental movement in India too has taken a leaf out of the Greens' books and almost turned a Nelson's eye to the issue most relevant to the country—that of our unbridled population growth. Rather, science and technology have become the favourite whipping boy of our environmentalists for whom all scientific and technological progress is an anathema. Simultaneously, the western style of consumption—of energy and resource—is held responsible for all our environmental ills. The truth is that, it was only science and technology which has helped us sustain our sky-rocketing population over the years.

At present, we are adding to our already teeming millions equivalent of the entire population of Australia every year. The strain that such numbers put on the nation's resources is mind-boggling. Even today, the per capita availability of food and energy in our country is far below the world standards. Millions continue to live in stinking slums under inhuman conditions, and thousands join their fold every day. It is to improve the lot of these neglected sections of our society that we need to grow more food, build more houses and generate more power. All, of course, at some cost to our environment.

One often hears of 'sustainable development strategies'. Such rhetorics appear meaningless in absence of a time-bound strategy for population control. The other alternative is to go back to a spartan and ascetic style of living, without the modern amenities of life. The question then would be: Is society prepared to accept such an alternative? If not, then society has to be convinced first of the acute and urgent need to control population growth.

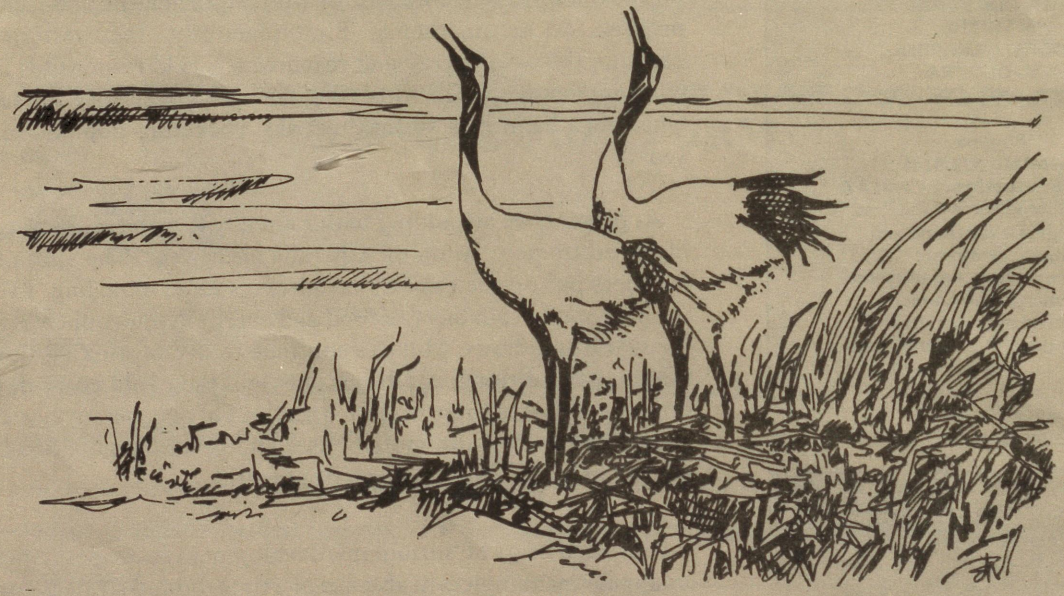
As a recent report of the United Nations Population Fund points out, "the combination of poverty and population growth among the 'bottom billion' is damaging the environment through deforestation and land degradation." Unless this root cause is tackled with utmost urgency, all environmental protests against dams, nuclear power and the likes would be like putting the cart before the horse. □

International Crane Researchers Meet

OVER 130 conservationists from different countries, India, Pakistan, the USSR, Iran, China, Spain and Malaysia gathered at the Saurashtra University campus, Rajkot to participate in the 3 days seminar on Asian Cranes. It was followed by a 3 days post-congress optional tour to Gir sanctuary. The 1989 Asian Crane Congress assignment was taken up by the Gujarat Nature Conservation Society in collaboration with the University of Saurashtra at Rajkot. The main reason for selecting Rajkot as the venue for the 1989 congress in India was because the Saurashtra region in Gujarat attracted not only large populations of the wintering Demoiselle crane but also because the region itself held breeding grounds of the world's tallest flying bird, the non-migratory Sarus crane, common to Saurashtra and its Northern-region. The Congress was formally inaugurated by the President of the Organizing Committee in the Seminar Hall of the Department of Biosciences on the 27th Dec. 1989.

A good beginning was made by reviewing conclusions drawn at the previous meetings held at China and Russia on short and long term plans for crane research and conservation of cranes and especially their wetland habitats in the Indian Subcontinent. Technical papers dealing with wetlands and waterfowl protection including minor irrigation ponds, tanks and reservoirs especially that of Bharatpur Bird Sanctuary were discussed at full length. Observations made on breeding behaviour and the new data on Black necked crane from Ladakh were examined. In all, 18 papers registered for reading on subjects like, Migration, Distribution, Sexual-demorphism, Modification, Egg and Embryo of the Sarus crane and other species inhabiting inner Mongolia were read and discussed. Technical reports and group discussions on needs and opportunities for International cooperation and research on Siberian, Black necked, Demoiselle and Common crane were held.

Over the years, the popularity of crane counting especially the endangered species has gained momentum and currently almost every endangered species has been monitored by researchers from several continents. Even so, volunteer observers and small teams of scientists are still required to organise to survey large areas and to keep track of crane populations and to study their nesting and feeding sites. It is important to mention here that since 1964, USA and Canada worked together to build up the fast dwindling population size of the world's rarest and the most endangered Whooping crane in captivity and it was also the first example to link breeding in Zoo with reintroduction back into the wild The International Crane Foundation has now come forward to take further responsibility of captive management of endangered cranes of Asia. The India crane working group has now taken the challenging task to study the current range, status and the ecological requirements of cranes especially the Sarus and a systematic investigation and improvement of village ponds and their waters which form an integral part of the village development program.



J.C. Uttangi
56/1, Mission Compound
Dharwar-580 001

A New Form Of Hepatitis

AMERICAN scientists have isolated the virus that causes what is believed to be one of the most lethal forms of hep titis in the Third World. They are now preparing a test for the virus before developing a vaccine. The test may reveal whether hepatitis E is a relatively new disease in humans.

Hepatitis is inflammation of the liver. It can be caused by chemical damage, or by disease-producing organisms. Hepatitis A is an acute infectious disease, caused by a virus spread on eating utensils. Hepatitis B is a chronic viral infection transmitted in blood and other bodily fluids, and is linked with a major cancer, hepatocellular carcinoma. Both are common in the Third World and can be identified in simple screening tests.

Hepatitis virus other than A and B have also been identified. Last year, scientists isolated the hepatitis C virus *(New Scientist,* Science, 6 May 1989) and the D virus, both blood-borne. Hepatitis E is much more important. It is spread through water contaminated with faeces from infected people. In Asia, it probably accounts for over half the cases of acute viral hepatitis in adults. Pregnant women are especially vulnerable: a fifth of those who contract the virus die. The exact prevalence of the virus is unknown because there has been no simple way to test for it.

Daniel Bradley, head of hepatitis research for the Centers for Disease Control in Atlanta, says the hepatitis E virus, now isolated by his laboratory, is larger than the other viruses and is not related to them. It was found in faecal samples from patients in Mexico, Borneo, Somalia, Burma, and Tashkent in the Soviet Union. The virus infected macaques and was present in their gall bladders in large quantities.

When a new virus reaches an unexposed population, however, it mainly strikes young adults, and can kill many people, as was the case when measles and smallpox decimated indigenous Americans after the arrival of Europeans. Hepatitis E is between 50 and 75 years old, and has spread from its first outbreaks in India. Nepal and Burma to Pakistan, Afganistan, the Soviet Union and China, then to Indonesia and the horn of Africa. □

Colloquium On Cell Differentiation

THE development of an organism from a single cell to the formation of specialised cells and organs is called the process of differentiation. Maturation and reproduction, as compared to differentiation, are however relatively smaller feats to maintain the fully developed body life long. Yet during evolution, limited life span and mortality have been preferred over eternal youth and immortality. Is aging an inherent component of the developmental history of an organism, or do organisms, like machines, become old with the passage of time? Are there specific genes for ageing or is ageing a result of progressive failure of maintenance?

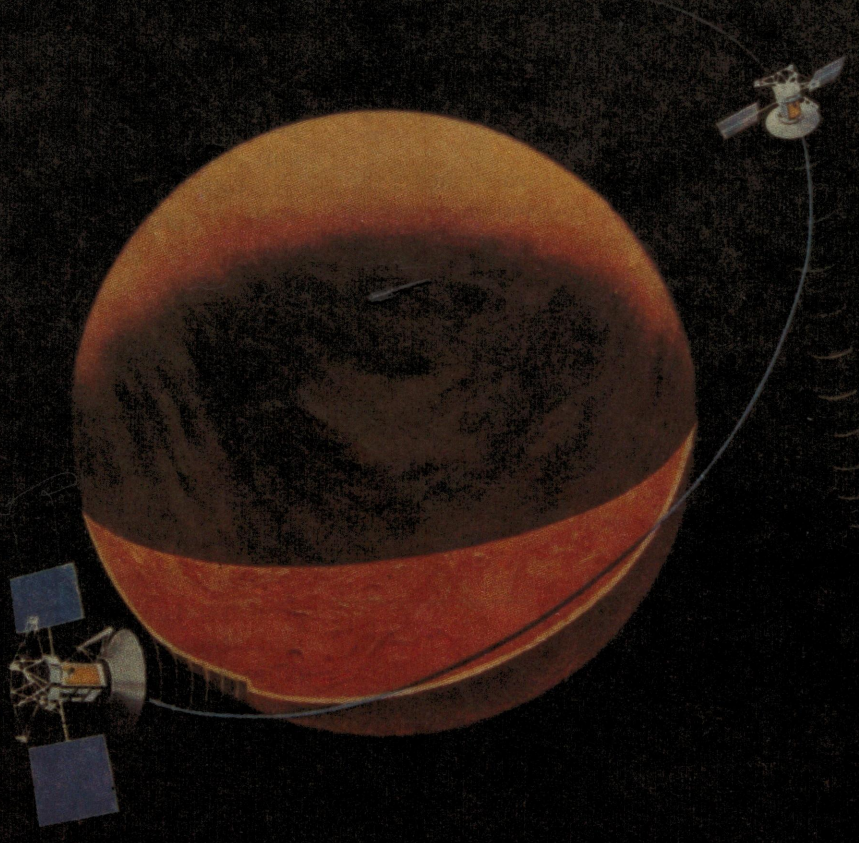
To explore answers to such queries a Colloquium on the Realm Of Differentiation was held at the School of Life Sciences, Jawaharlal Nehru University, New Delhi on 2-3 March 1990. Inaugural ceremony was performed by Prof M.S. Agwani, Vice-Chancellor, Jawaharlal Nehru University followed by a key-note address from Dr. Obaid Siddiqi, FRS. A series of paper presentations spread over two days. The session started with Dr. A.S. Mukherjee of Calcutta University and Dr. F. Schneeweiss and Dr L.E. Feinendegen of Institute fur Medizin, Federal Republic of Germany, who discussed about the high mobility proteins (HMGs) which play an important role in the activation of eukaryotic genes. These proteins reside in the chromatin of the chromosomes. This was followed by discussion on the "Effect of mutations on the maternal genes of the embryos of *Drosophila melanogaster* by Dr S. Chandrashekaran and Dr. R.P. Sharma of IARI, New Delhi. Various aspects of the development and differentiation were discussed at length, such as lytic activity in plant cell differentiation; the factors affecting ageing; abnormal functional differentiation; and mathematical modelling in biology.

Various factors that control the growth and differentiation in various organisms and the various aspects of differentiation in cellular systems were discussed including the growth factors, light hormones, polyamines and amino acids involved in development. Regulation of such factors is usually controlled at the transcriptional level.

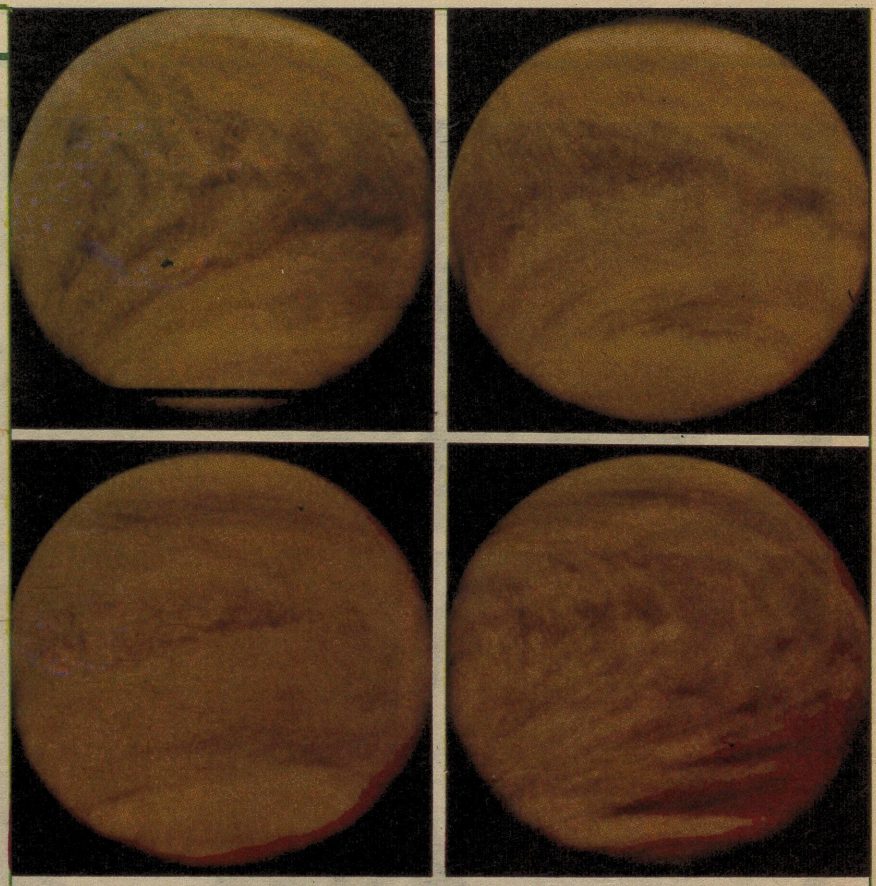
The Colloquium concluded with an open session under the Chairmanship of Dr. Mohan Ram of Delhi University.

Gulshan Wadhwa

MAGELLAN: MISSION TO VENUS



The latest probe to the veiled planet may reveal for the first time the processes that have shaped the surface of our nearest neighbour, says *BIMAN BASU*



The fast moving clouds of Venus. The pictures were taken during the Pioneer Venus mission on 15 February *(top left)*, 16 February *(top right)*, 17 February *(bottom left)*, and 19 February 1979 *(bottom right)*

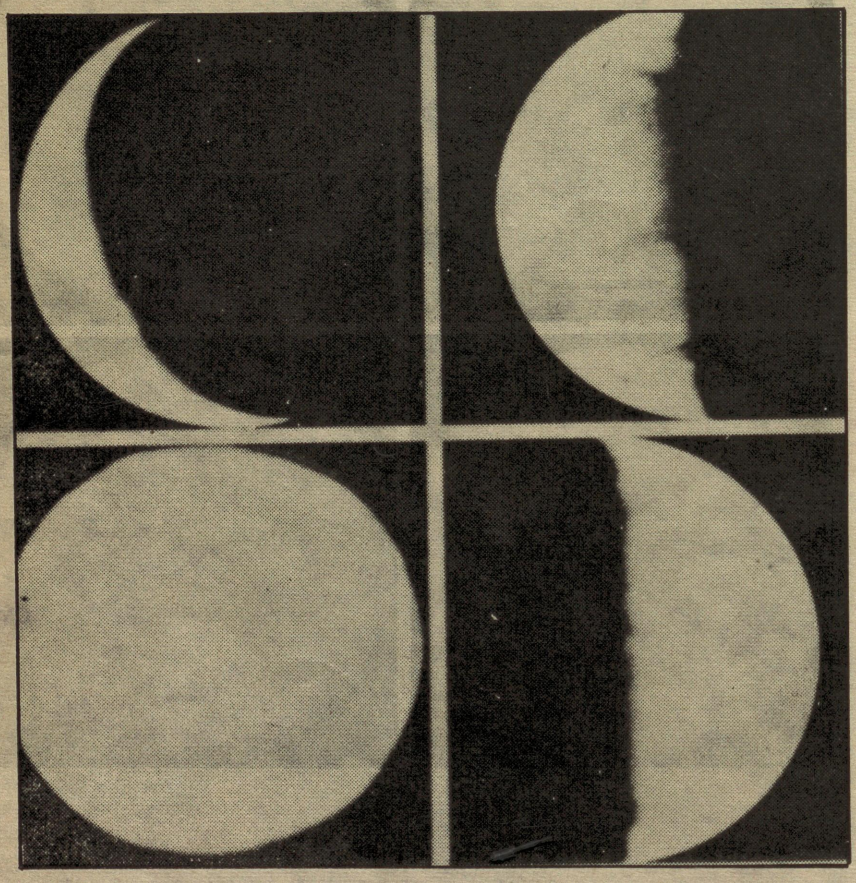
OF all the planets of the solar system none resembles the earth in size, mass and density more than Venus, second from the sun. Like earth, Venus also has an atmosphere and a cloud cover, although unlike our planet, which has plenty of cloudless skies, the Venusian cloud cover is unbroken, behind which the planet's surface always remains hidden. No wonder, speculation has always been rife as to what lay beneath those impenetrable clouds.

One of the most popular visions of the Venusian world that endured until a few decades ago was that of the earth as it was during the Carboniferous era, about 300 million years ago. The Nobel prize-winning chem-

Drawing *(facing page)* shows two views of the Magellan spacecraft in orbit around Venus. For 37 minutes of each orbit, the Synthetic Aperture Radar (SAR) is to image a 24-kilometer-wide swath of the Venusian surface while also acquiring altimetry and radiometry data to determine the altitudes and temperatures of surface features. Then, near the high point of its elliptical orbit, Magellan is to turn its large antenna toward Earth and, for 115 minutes, transmits the radar data to earth receiving stations. Also during this period, gravity data as indicated by small accelerations of the spacecraft will be recorded on earth

Photo : USIS

Surface of Venus photographed by Venera 13 *(top)* and Venera 14 *(bottom)* which landed 900 km apart show different kinds of terrain. The rocks at the Venera 13 site near the volcano Phoebe Regio were small and fine grained. Venera 14 landed in a region of large broken rocks. At both sites the sky was orange coloured



Phases of Venus as photographed by spacecraft

ist Svante Arrhenius wrote in 1918, "The humidity is about six times that on earth, or about three times that in the Congo. We must therefore conclude that everything on Venus is dripping wet.....A very good part of the surface of the planet is no doubt covered with swamps, corresponding to those on earth in which coal deposits were formed."

Almost four decades later, astronomer Fred Hoyle came out with a different scenario. He speculated that the clouds of Venus consist of droplets of oil. If Venus had oceans, he prophesied, they would be oceans of oil. Hoyle saw Venus as a planet "endowed beyond the dream of the richest Texas oil king".

But the reality turned out to be harsher beyond imagination. After close scrutiny by more than 20 space probes, 15 of which actually made it to the planet's surface, the image that has emerged is that of a veritable Hell. As one writer described it, "An astronaut unlucky enough to crash-land on Venus would be simultaneously suffocated, crushed and roasted by the lethal atmosphere..... What little was left of the body would be eaten away by acid in the air." This description is no exaggeration. The surface temperature on Venus indeed hovers around a searing 450°C—enough to melt the common metals lead, zinc and tin. Its heavy carbon-dioxide-laden atmosphere exerts a pressure almost 90 times that on earth at sea level, and droplets of corrosive sulphuric acid make up its dense clouds.

Venus sprang another surprise when astronomers tried to measure its speed of rotation about its axis by bouncing radar signals off its cloud-hidden surface. They found it to be the most sluggish member of the solar family, turning once around its axis in a little over 243 earth-days, and that too in a direction opposite to all others. If the clouds were not there, then from the planet's surface the sun would be seen to rise in the west and set in the east. Its slow backward spin coupled with the fact that the planet goes round the sun once in just 225 earth-days makes a Venusian solar day (that is, from one sunrise to the next) about 117 earth-days long. Its year lasts less than two 'days'.

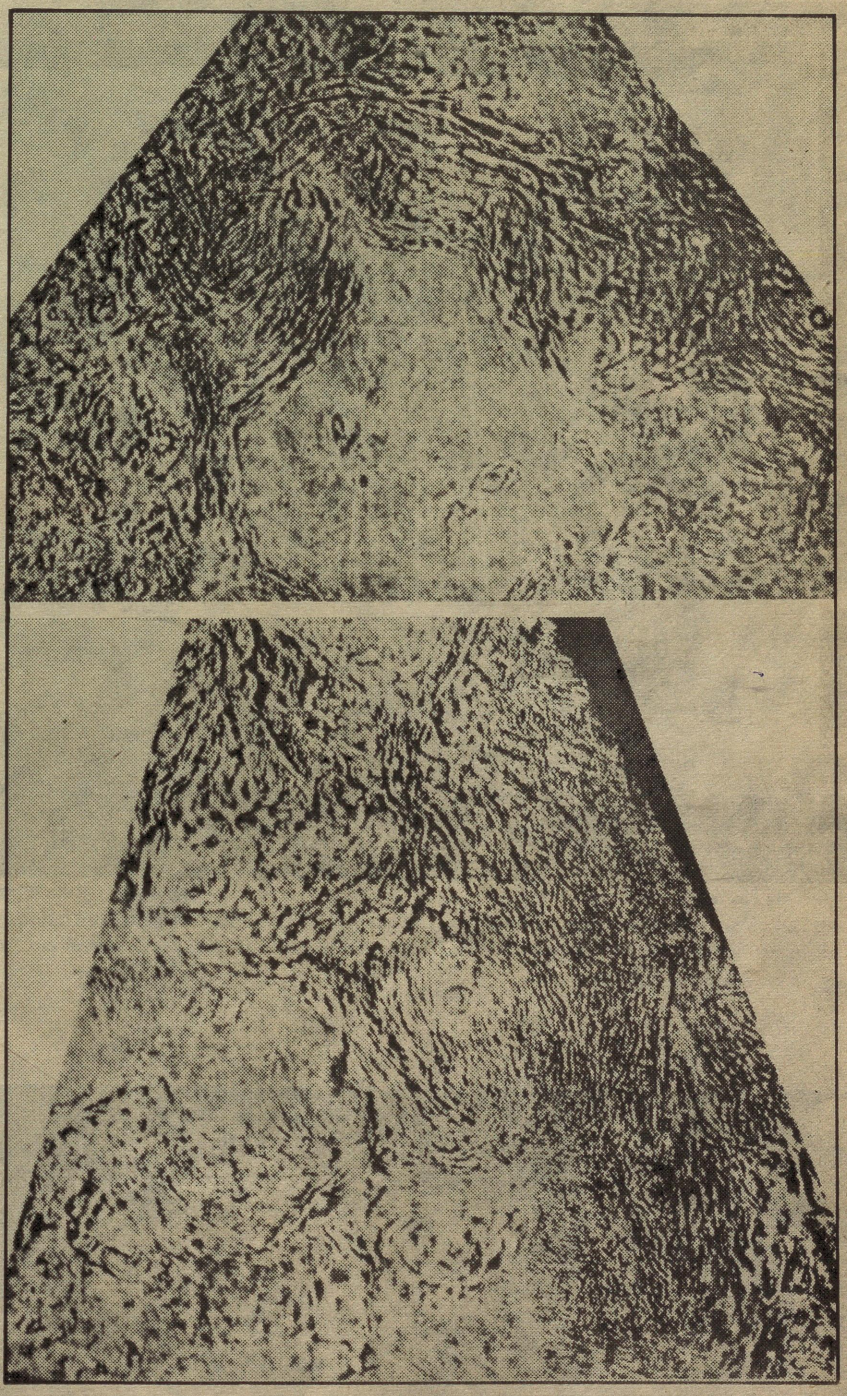
WHILE the backward spin of Venus still remains a mystery, scientists have an explanation for its infernal heat. It is the result of a run-away 'greenhouse effect' caused by solar heat trapped in its carbon dioxide-laden atmosphere. The carbon dioxide probably came from large scale volcanic activity quite early in the planet's history. It is interesting to note that our earth too had a carbon dioxide and methane-rich atmosphere in the past before green plants came in to infuse life-giving oxygen. But earth's atmosphere lost most of its carbon dioxide to water which rained down in torrents to dissolve the gas and turn it into carbonate rocks, out of harm's way. Green plants too mopped up substantial quantities of the gas to spare our planet the infernal fate of its planetary twin.

Being closer to the sun, Venus receives nearly twice as much heat from the sun as earth. Planetologists believe that Venus was originally hot enough for all its water to evaporate into the atmosphere where it was broken down by the sun's intense heat into hydrogen and oxygen. The light hydrogen was subsequently lost

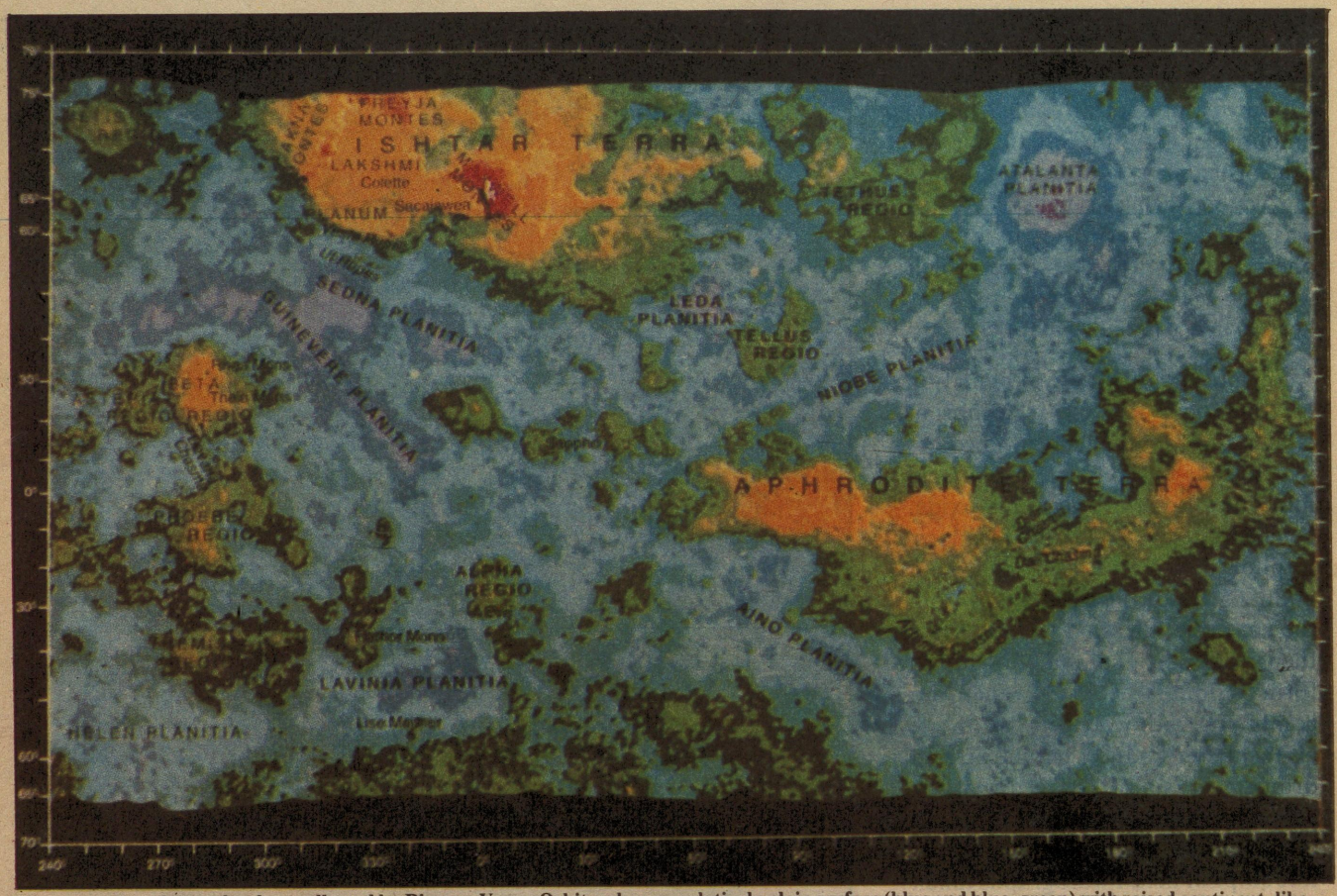
to space leaving the oxygen bound up in Venusian rocks. Today Venus is almost completely dry. Water vapour is present in only minute amounts making up less than 1 per cent of its heavy atmosphere. Lacking water, scientists believe, Venus was unable to get rid of its atmospheric carbon dioxide load which went on building up, trapping solar heat as in a giant solar cooker.

Scientists also have an explanation for the sulphuric acid in Venusian clouds—a photochemical process which leads to the formation of acid molecules *in situ*. Sulphur dioxide, belched out by Venusian volcanoes, is photodissociated at a height of about 65 km by ultraviolet rays from the sun. The liberated oxygen atom then reacts with sulphur dioxide to form sulphur trioxide which on combining with water vapour in the atmosphere produces sulphuric acid droplets. It is also believed that the yellowish colour of the Venusian clouds could be due to presence of free sulphur in it. Photographs taken by Soviet space probes from the surface of the planet show the sky as orange coloured.

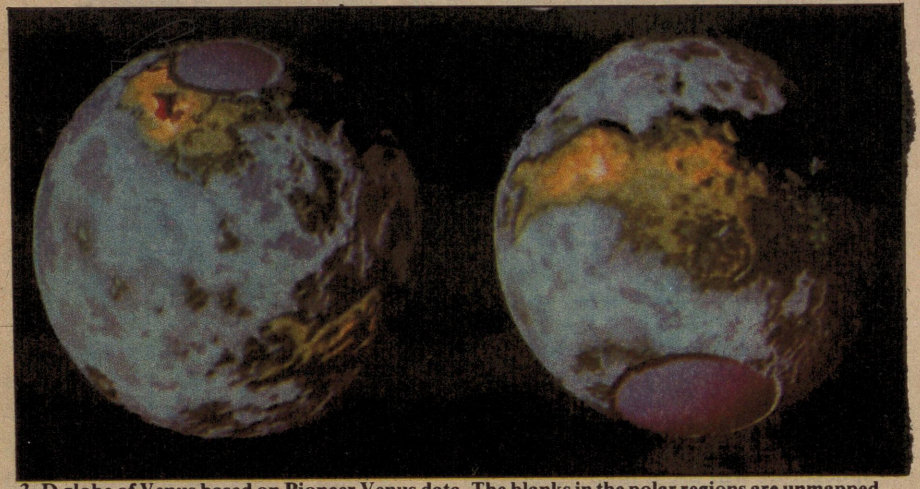
By using radar echo, astronomers have mapped a large part of the planet's surface. These studies, made both from the ground and from orbiting spacecraft, have revealed three continent-like highlands with mountains taller than Mount Everest, and huge volcanoes—some probably still active, but no oceans. However, finer details of the Venusian topography are still lacking as the best radar images received till date do not show up objects less than 2 km across and large chunks of the polar regions still remain unexplored. The latest Venus probe *Magellan*, which goes into orbit around the planet in August is expected to provide the missing details. Launched from the space shuttle *Atlantis* in May last year the spacecraft will use a high-resolution radar from a polar orbit to map up to 90 per cent of the planet's surface. Distinguishing features as small as 250 metres across, the new map would provide astronomers with more details of the Venusian surface



Radar maps of Lakshmi Planum region *(top)* and Maxwell Montes region *(bottom)* based on data sent by Venera 15 and Venera 16 orbits



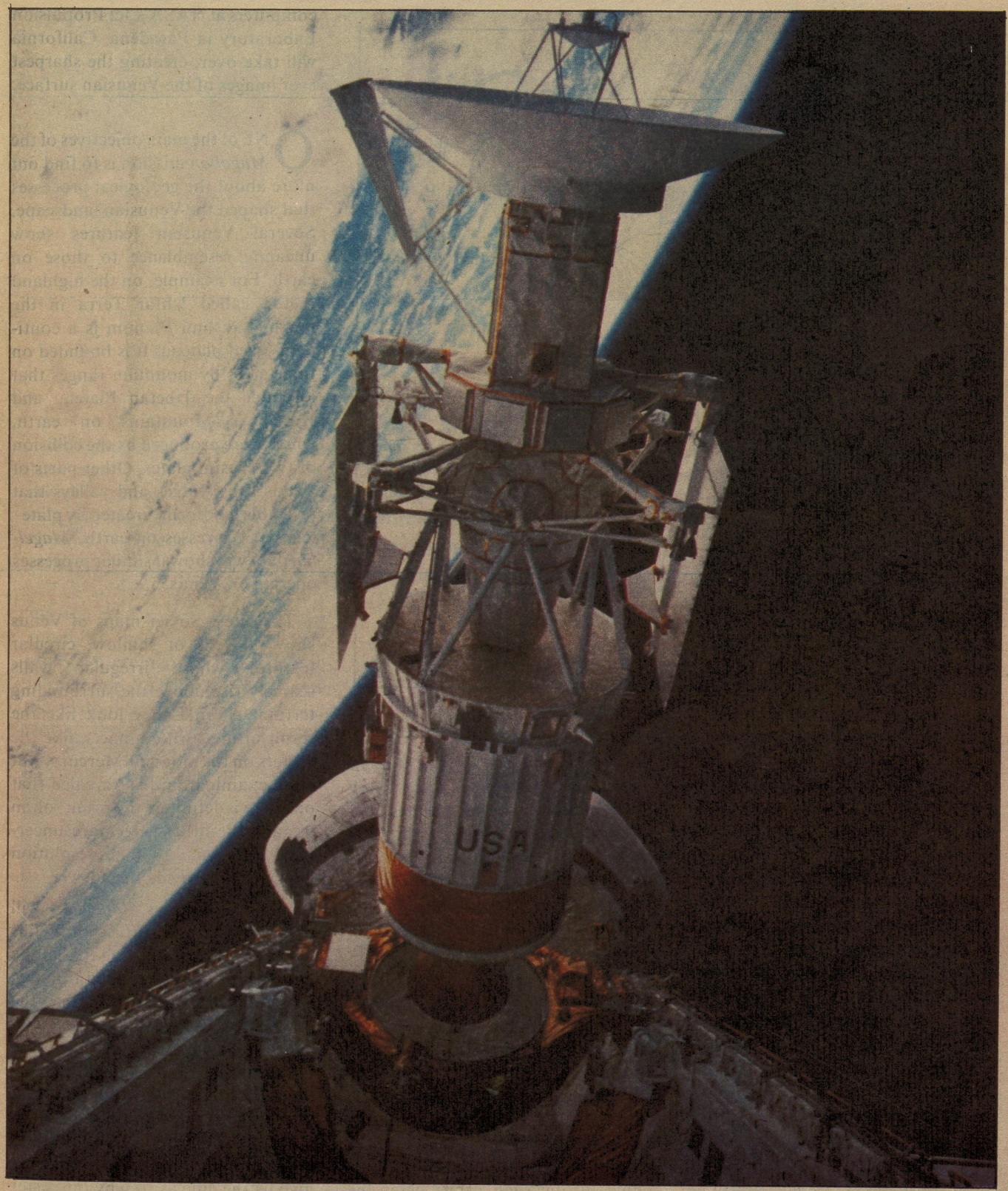
Venus map based on radar data collected by Pioneer Venus Orbiter shows a relatively plain surface (blue and blue-green) with raised continent-like features (green, yellow and red). Ishtar Terra *(top left)* is a vast plateau as large as Australia with 11km high Maxwell Montes *(red)* near its centre. Lakshmi Planum to the west forms a plateau 2500 km in diameter, three times as large as the Tibetan Plateau . Aphrodite Terra *(middle right)* is as big as the African continent



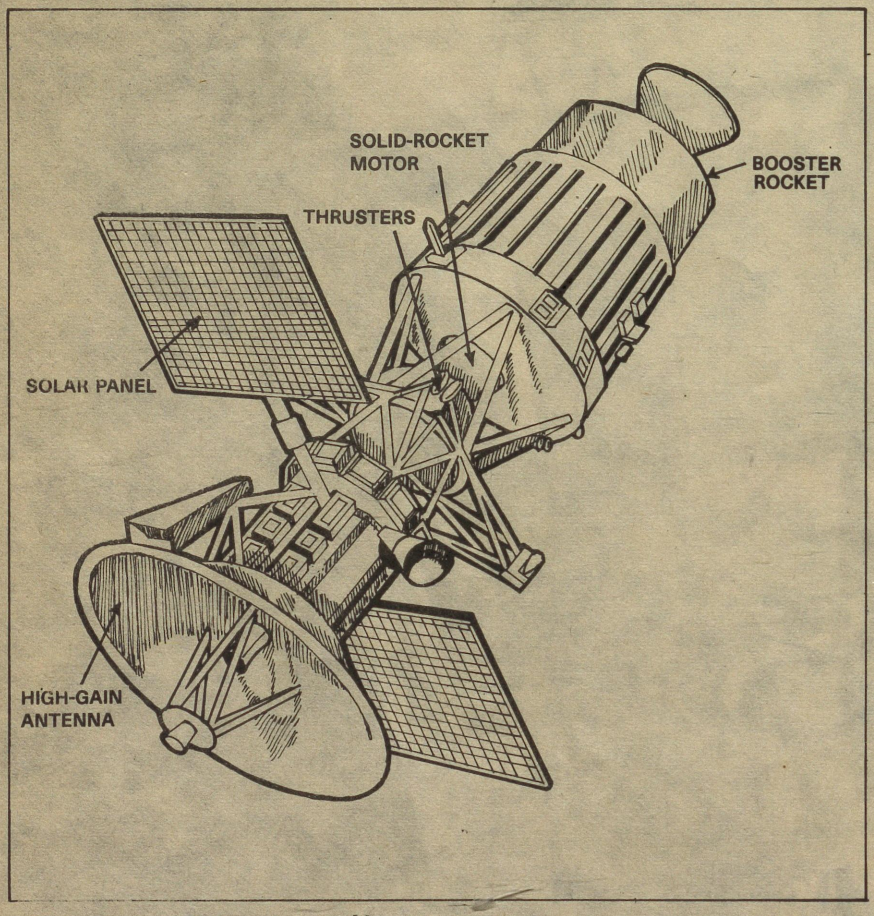
3-D globe of Venus based on Pioneer Venus data. The blanks in the polar regions are unmapped areas which Magellan is likely to cover

than we have of the surface of our own planet, more than two-thirds of which lies under the ocean.

BUILT largely from the leftovers of earlier US planetary missions such as *Voyager*, *Viking* and *Galileo*, the *Magellan* orbiter was originally developed as the Venus Radar Mapper designed to map 90 per cent of the planet's surface with a resolution far better than achieved in any previous mission. Named after the famous 16th-century Portuguese explorer Ferdinand Magellan, the 3.45-tonne spacecraft carries only one scientific instrument—a unique radar system known as 'synthesis aperture radar'. It makes use of an innovative computerised technique



The Magellan spacecraft rises out of the payload bay of shuttle Atlantis at the start of its 15-month journey to Venus Photo : USIS



Magellan spacecraft

which combines radar signals received by the spacecraft's small (3.7 m dia.) dish antenna from widely separated points in orbit into single images created as if by one large antenna hundreds of metres in size. This computerised process, also known as aperture synthesis, is widely used by radio astronomers for getting sharper images of distant radio sources in the sky. It is also the key to the high resolving power of *Magellan's* radar.

One major disadvantage of the spacecraft is its only dish antenna which has to be used both for imaging of the planet and transmitting the data back to earth. In order to meet both requirements, *Magellan* will be put into a highly elliptical polar orbit when it arrives at Venus on 10 August. Going round once every three hours and nine minutes, the spacecraft will swoop to within 250 km of the planet's surface at its closest approach and then sail more than 8000 km away towards its farthest point in orbit. For just 37.2 minutes in each orbit, when it is nearest to the surface, *Magellan's* radar will do the mapping with the dish antenna pointed towards the surface. Then, as it moves away from the planet towards the far end of the orbit, the whole spacecraft will turn around to face the earth so that its antenna can be used to send back the collected data. These maneuvers will be executed during each orbit. After the data sent by *Magellan* are received, computers at NASA's Jet Propulsion Laboratory in Pasadena, California will take over, creating the sharpest ever images of the Venusian surface.

ONE of the main objectives of the *Magellan* mission is to find out more about the geological processes that shaped the Venusian landscape. Several Venusian features show uncanny resemblance to those on earth. For example, on the highland region called Ishtar Terra in the north, Lakshmi Planum is a continent-sized plateau. It is bounded on three sides by mountain ranges that resemble the Tibetan Plateau and Himalaya Mountains on earth, which were produced by the collision of two crustal plates. Other parts of Venus show ridges and valleys that resemble landforms created by plate-tectonic processes on earth. *Magellan* data will show if similar processes operate on Venus.

The latest Soviet maps of Venus show dozens of shallow, circular features whose irregular walls scarcely rise above the surrounding terrain. At first they look like the result of meteorite impacts, like the craters on the moon or Mercury. But close examination has revealed that only one is definitely the result of an impact; the others are more uncertain. *Magellan's* high-resolution images may provide the answer.

In just 243 days, *Magellan* will map most of the surface of Venus with details far exceeding that of the best radar images obtained till date. Planetologists are hopeful that the new images may reveal tell-tale evidence of a whole range of planetary processes such as volcanism, meteorite impacts, and wind and water erosion that may have played a part in shaping the planet's topography and environment. They may ultimately give us the clue as to why our sister planet is so different from our own. □

DOES THE SUN HAVE A COMPANION?

Ramatosh Sarkar

American scientists have proposed a theory according to which the Sun has a companion, named Nemesis, which is responsible for mass extinctions on earth

WHILE wondering all along, for a variety of reasons, about twinkling twinkling little stars, some astronomers for some time now have been particularly wondering about the only non-twinkling and big star in the sky, namely the sun. Why does it appear to be single?

The fact of the matter is that, during the past several decades, as a result of more and more minute study astronomers have been increasingly coming to believe, at least in the world of stars, in the Shelleyan philosophy: Nothing in the world is single; all things by a law divine, in one another's being mingle. Then why not the sun is a twain—why does it not have a companion too? That indeed, under the circumstances, seems somewhat strange.

Admittedly, it is not a proven fact as yet that all stars, other than the sun, do have companions. But such a lack of proof in the case of any other star may be due to other reasons. They are, in fact, on a different footing: they are all very distant—almost breathtakingly so. The nearest one, barring the sun, is at a distance of

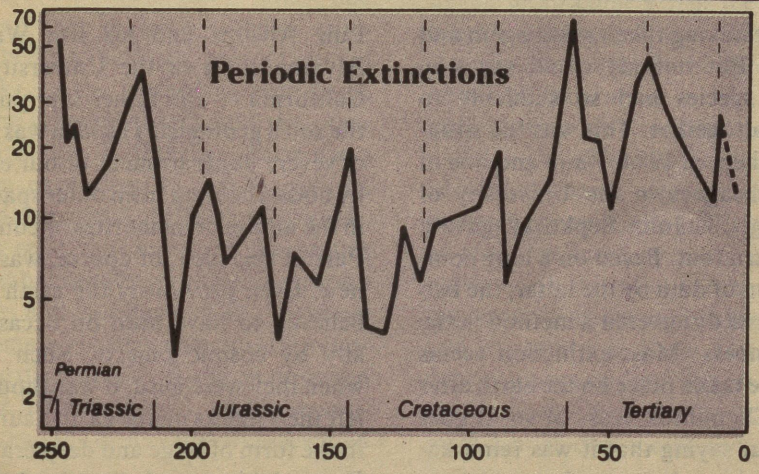
The Barringer crater in Arizona, USA, believed to have been created by a meteorite impact

about 40 million million kilometers; the others are generally much further away. That we can see so many of them at all, whether with the naked eye or with optical aids, is surprising. And of course there are many that we cannot: we only infer about their existence by means of indirect circumstantial evidence. The question of getting any proof of the existence or otherwise of the companion of such elusive stars naturally stands ruled out. And as to the stars that lend themselves to be seen, they also may play tricks. They may appear as single stars while in reality they may be double or triple, or even multiple. Because of their large distances from us but relative closeness amongst themselves, we may be just led to believe that the light comes from a single source. In technical language, in such cases, we cannot 'resolve' the image—and therefore cannot get at the truth.

BUT that is not the whole story. There is another side to it, which may be quite significant and is certainly suggestive. It is narrated by ever-improving instruments and techniques. And the narration has not stopped: slowly but steadily it continues. It all started with the tele scope. It was the telescope that first revealed to astronomers that some apparently single stars were not really single. With the telescope getting more and more powerful, such revelations became more and more numerous. However, the 'resolving power' of even a very high-power telescope is not high enough for many stars. And that is where another instrument takes up the thread—the spectroscope. Unlike a telescope which gives a sharp image of a star, a spectroscope gives us a band of light, i.e., a 'spectrum'. The spectrum of a star is always cut across by many lines—the 'spectral lines', and these lines can inform us, among other things, about the state of motion of the star. If the lines are found to be shifted from the well-known positions that the lines ought to normally occupy, then it is to be inferred that the star is in motion — towards the observer or away, depending on the direction of shift. Needless to say, the lines occupying the normal positions indicate lack of such motion. If, on the other hand, there is shift but not permanently on one side — i.e., if the spectral lines oscillate on two sides of their normal positions — then the star must be alternately approaching and receding away from the observer. And, as it happens, a blend of these two phenomena may be observed in the spectra of many seemingly single stars: some of the spectral lines are stationary while the others are oscillating. Coupled with the well-established principles of celestial mechanics, the ultimate interpretation of such an observation is simple and certain : the star in question is not really one but comprises two or more (depending on the pattern of oscillation) components and the stars involved are executing some revolving motion relative to themselves. That is how the secrets of many stars have been betrayed : they are not single stars as they appear to be.

Whether by courtesy of the telescope or the spectroscope, such find-

The sudden disappearance of dinosaurs 65 million years ago has been ascribed to events following a cometary impact



Extinctions of species have occurred several times in the past

ing out about a star has rarely been easy. The star that has been alluded to earlier as the nearest to us (after the sun) is really one of a triple. But that was not known first and the group, as a whole, was given the name of Alpha Centauri A and Alpha Centauri B. But lo and behold, one astronomer pointed out much later, it has a third member in the group. This last one has been christened Proxima Centauri. (It is marginally nearer to us than the other two and therefore has the distinction of being the nearest to us. Hence the word Proxima).

As already indicated, not all stars as yet are definitely known to have companions; but a good number of our nearby stars are. For the remote stars, many of them may never yield an ocular evidence, one way or the other, but perhaps we may be able to arrive at the right conclusions about them from our knowledge about the other stars. As to the near stars that are still not known to have companies, it may be just a matter of time. More sophisticated instruments and better techniques may sooner or later raise the curtain and show us the pairs or groups that are really there. Many astronomers expect that, and others do not rule out the probability.

But what about our sun? In the normal course of things, there seems no earthly reason why it should have a companion star that would for ever remain unnoticed by us. After all, in accordance with the laws of celestial mechanics, the companion would have to have some sort of orbital motion round the sun, and the sun is so very close to us. So, the orbiter should be, or should at times come within our viewing distance. That is how the wonder comes. Nobody in human history — not since the hoary days of Nile, Euphrates or Tigris — ever witnessed two suns in the sky. Such an astounding event would surely have found its way into archeological records in one form or the other. But the testimony of archaeology is altogether silent in this regard. Why?

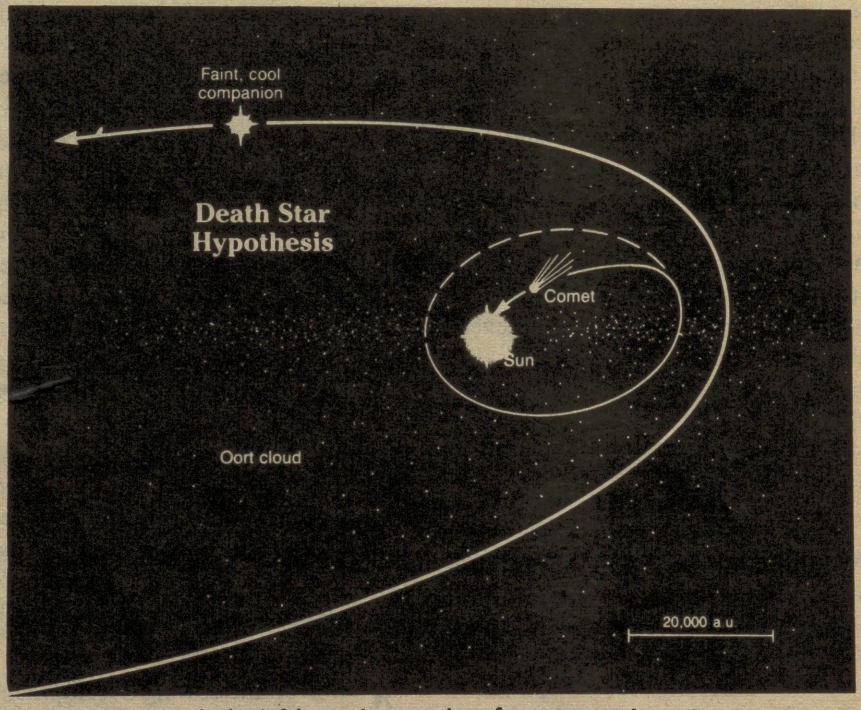
A VERY interesting development has taken place of late. While astronomers, at least some of them, were racking their brains, some fellow-scientists have come forward with some startling evidences. They are geologists, having amongst them such specialists as the geophysicists, the geochronologists and paleontologists. They are ready to agree with the astronomers that there is no earthly reason why the sun should not have a companion visiting it periodically. They do not dispute the archaeologists' views as to the absense of human records of such visitations. But, they submit, earthly records are there for what they are worth. Some such records they have been able to unearth, though they were hardly looking for these. In fact, they themselves have been rather astonished, not quite knowing what to make of these findings.

The geophysicists first. In a way they were first people to ralize that the earth of ours must have had some utterly peculiar experiences several times in the past—with the semblance of some fixed periodicity. It must have been rather regularly exposed to conditions that almost played havoc with it — made things topsy-turvy. The revelation came by way of geomagnetism. For several centuries now, scientists know that the earth behaves as if a huge bar-magnet is lying within it, more or less coinciding with its axis of rotation. But what the scientists did not know was that in the past the earth's magnetic poles were opposite to what they are today — not at one time in the past but hundreds of times, with normality restored in between. Geophysicists came to gather this unsettling information over a few decades, slowly and rather diffidently at first but overpoweringly later on. They were collecting and studying rock-samples consisting of minerals (like lodestone or magnetite) that have magnetism ingrained in them. They believed that when these rocks were in the process of formation, their tiny component parts (that were magnetic themselves) had arranged themselves in accordance with the dictates of geomagnetism—their north-poles turned northwards, south-poles southwards. That is natural to think, and their earlier studies had been in coformity.

But by the sixties of this century, heaps of samples had been amassed showing diametrically opposite orientation. Not from one particular place

only. Not belonging to a particular period of time. Not formed in a particular way either. As a matter of fact, no two rocks could be more different or could have more diverse histories than the volcanic igneous rocks of California and the sedimentary rocks underneath the Pacific. In the case of one, lavas were spewed out by volcanoes which subsequently got cooled and magnetized; in the other, ocean sediments accumulated grain by grain in the cold depths and ultimately got conglomerated. But such widely different types of rocks, it transpired, if they belonged to some specific periods in the history of the earth, would exhibit effect of magnetic compulsions, opposite to what are now operating. The cause could not have been local, as some stupified scientists tried to argue at the beginning. It was global in effect, and it was cyclic — at least approximately so. Using the data available, various statistical methods have been employed to determine the frequency-cycle. Some hurdles are there on the way and therefore conclusions do not entirely converge, but the consensus seems more or less to be reflected by the considered opinion of David M. Raup of the University of Chicago, a doyen in the field of geophysical sciences. According to him, the earth's magnetic dipole has been recurringly turning upside down at an interval of about 30 million years during the past 165 million years.

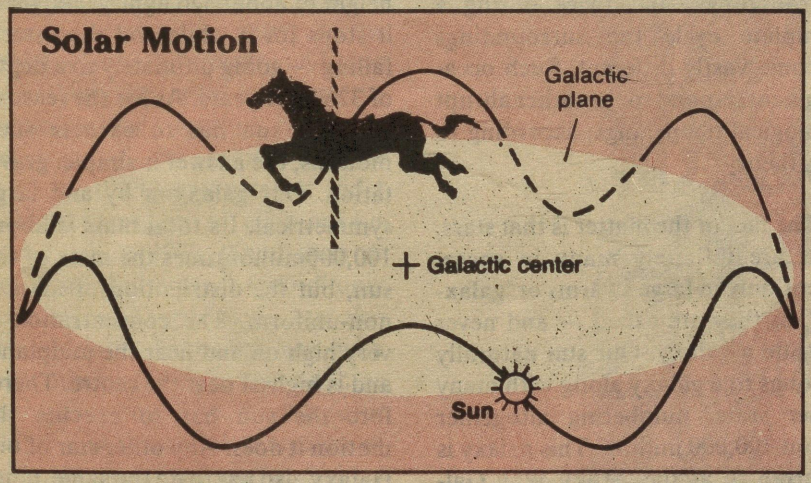
Paleontologists came into the picture shortly after the geomagnetic background got more or less established. One curious thing of course was known to paleontologists for a long time on the basis of study of fossil-remains: down the ages certain species of animals, e.g., the dinosaurs, have strutted and fretted their hours on the stage of the earth, had made exit en-masse rather abruptly, never to stage a comeback again. There was evidence of this dramatic exeunt having taken place again and again. But nobody could say why those species had so suddenly to leave altogether. This was the situation when, in 1984, Raup and one of his colleagues in the University of Chicago, J. John Sepkoski, gave a new turn to it. Based on a long compilation of data by the latter, the two scientists discovered a method in the suddenness. Mass-extinction seems to have taken place on the earth after every 26 million years or so. It goes without saying that it was remarkable finding. It somewhat thickens the mystery, but offers a very useful clue also. The suggestion is loud and clear: we should look for something affecting the earth — its climate, ecological balance, etc. — in a big way at that periodicity, and that could be the denouement.



The death star hypothesis. A faint cool companion of our sun may have played a role in the periodic extinctions by unleashing barrages of comets from the Oort cloud

SHORTLY before the regularity of mass-extinctions was announced, a very radical idea was mooted in 1980 by Nobel-laureate scientist Luiz Alvarez and his son Walter Alvarez, both of the University of California — the father a physicist, the son a geologist. The idea was that of severe bombardment of our earth by bodies coming from outer space— in the nature of meteorites or comets. Part of this idea, of course, was not new. Even previously the earth was believed to have been hit occasionally by cosmic objects. Such hits, when they were hard, it was thought, left their marks on the earth's surface in the form of large and deep craters. But such hits were believed to be isolated ones — ones that could have caused (apart from craters) some local tremors or suchlike, nothing bigger. The idea conceived by Alvarez, Sr. and Jr., on the other hand, envisaged something on a gigantic scale. It was expected to produce global effect for a prolonged period. Some such phenomenon only, the two theorists thought could account for a strange finding that was made by the son first and then by

others in rock-studies. They had found that in some samples sandwiched in between two layers of rocks — the lower one containing some types of fossils and the other almost devoid of them — there was a layer exceptionally rich in iridium. And the metal iridium, they knew, was relatively scarce in the earth's crust but usually very ample in meteorites and comets. This 'iridium anomaly' — after its first rather startling discovery — has been observed later in several places widely separated, and the observations correspond



Periodic extinctions could have also been caused by a bobbing up and down motion of the sun as it went round the centre of our Galaxy

to identical times in geological history.

The time was ripe perhaps to put the different pieces together and try to solve the puzzle. At least some scientists thought so. Three of them were Marc Davis, Richard A. Muller, and Piet Hut — the first two from the University of California and the third from the Institute of Advanced Study, Princeton, USA. They thought that, with a certain periodicity in the past, the earth could have been hit all around by a very large volley of missiles in the form of comets or fragments thereof. It was something like what is called 'saturation bombing' in military parlance. Ordinarily, it is known, about a dozen or so comets visit the earth's neighbourhood per year. But occasionally, according to the hypothesis under consideration, a vast multitude of them rush towards the earth and this sort of fusilade continues for very many years — at a stretch. During such a happening many comets, or their fragmentary parts, directly hit the earth, one after another, causing devastating changes on the planet and its environs. Huge amount of debris thrown up from the ground by the impacts into the atmosphere form a huge dust-cloud and aerosol that cut off light and heat from the sun for several months. As a result temperature falls sharply, photosynthesis comes to a halt. The inevitable consequences follow as a chain-reaction.

But why should the comets go berserk? Instead of lying stored in what is called the 'Oort Cloud', from where off and on they come out in trickles having been disturbed by some external pull, why should they suddenly be flooding out? The answer can be provided by a star — a companion of the sun. Yes, according to the theory proposed by Davis, Muller and Hut, the sun indeed is a binary star and its counterpart executes an elliptic orbital motion round it. In the process the companion star alternately comes to 'perhelion' and 'aphelion', i.e., relatively very close to the sun and then far away. While at or near perhelion, the visiting star may come awfully close to the Oort Cloud and let loose a torrent of comets. The comets then take care of the rest.

The theory undoubtedly is bold and imaginative. *Prima facie,* it seems to satisfactorily fill in quite a few blanks in the great story of Nature. Nay, something more. A good scientific theory not only disposes of some old questions but also answers new questions that it itself may throw up. This theory has done one such feat. Now geochronologists can associate dates, with a fair amount of accuracy, to different parts of the earth's crust. If, therefore, the theory set forth be correct, shouldn't then the large craters on the earth reflect some periodicity — and that of the right order too? Yes, they should and they do, in fact. Muller, one of the architects of the theory and a physicist by training, sought the collaboration of Alvarez, Jr., the geologist. Together they studied more than a dozen large craters with regard to their times of formation. They found that if any two of the craters were not contemporary, they differed by a mean age-difference of 28.4 million years or some multiple thereof. With reasonable allowances given for errors due to various reasons, remarkable satisfying results, no doubt.

THE theory that the sun indeed has a companion star has a strong fascination, all its own. The propounders have even tentatively suggested a name for the hypothetical star. After the Greek goddess of retribution or vengeance, it has been given the name of Nemesis — presumably because it inflicts 'punishment' on earth. But even with a name and having some commenda-

ble merits (both a *posteriori* and a *priori*), Nemesis as yet remains only a conjectural star. The fathers of the theory are all too aware of the risk involved to their personal reputations. They have stated in their first paper in this connection, "..... if the companion is not found, this paper will be our nemesis."

It so happens that Nemesis, almost immediately after its emergence (as a theory), has suffered a set-back. Mathematical calculations reveal that Nemesis must be an impossible star to pair up with the sun. For one thing, its orbital period has to be 30 million years more or less, and its mean distance about 14.4 million million kilometers. Accustomed though they are with all sorts of large distances, astronomers do not know of any pair of stars with such a distant bondage. In fact, they fear that, apart from being extremely extraordinary, such a pair will not eventually last for the simple reason of their failure to exert enough pull on each other. Other celestial bodies, scattered all around, will naturally cast their gravitational spell and break the bondage between Nemesis and the sun. Many possible orbits for Nemesis have been worked out by several researchers (including Piet Hut, one of those whose brainchild Nemesis is), assuming different probable conditions prevailing in the locale; but the results do not make for stability. With such type of a star, only an affair may be possible but not a lasting partnership. In other words, a star like Nemesis may come to the sun just a few times — not many times, as demanded by geological considerations.

AS distinct from the adverse observations against the Nemesis theory, there exists a rival theory also. In fact, the rival theory has to be considered older (by about two months), at least on a technical ground. This theory, proposed by Michael R. Rampino of NASA and a few other scientists, also tries to account for all the happenings in question. But instead of blaming a companion of the sun, this theory lays the blame squarely on the sun itself for all of mischief or pranks or whatever. The sun, in fact, in hopping around in the world of stars and that, according to this theory, gives rise to extinctions, pole reversals, etc. The theory asserts that, as the Sun takes its hops, it has periodically to pass through a succession of different surroundings, and twice during a complete cycle the surroundings become vastly different. Such occasions correspond to the rather abrupt geological happenings, according to this theory.

The fact of the matter is that stars, that are infinitely many in space, occur only in large swarms or 'galaxies', as they are called — and never outside a galaxy. Our sun naturally belongs to a galaxy along with many other stars, numbering altogether about 100,000 million. This galaxy is referred to as the 'Milky Way Galaxy' or simply the 'Galaxy'. It roughly resembles a cart-wheel or a double-convex lens, if viewed from the side. Diametrically it is about 100,000 light-years across (1 light-year being equal to 9.6 million million kilometers, nearly). The thickness in the central part is about 20,000 light-years and it gradually tapers towards the periphery. The sun keeps more or less at a distance of about 30,000 light-years from the centre of the galaxy. It is currently just over 26 light-years away from the midplane on one side (that may be called the northern side, as our Pole Star or North Star is also on that side). But these figures, that have been very ingeniously and painstakingly determined or estimated by astronomers in recent years, do not specify the sun's position for all times. The sun is running and jumping, like a participant in a hurdle race.

But why does the sun do that and how? The sun is revolving round the centre of the galaxy at a rate such that it takes about 250 million years to complete a round. This we may conveniently call the sun's horizontal motion. As to the vertical direction, the sun is bobbing up and down relative to the galactic midplane. This motion — the 'z-oscillation', as it is called — takes the sun to the greatest height of about 326 light-years; there it stops for a while and then starts falling — going ultimately to a depth of 326 light-years. As for the reasons why the sun has to execute such motions, the answer is simple: gravitation. Our galaxy is by and large symmetrical. Its total mass is about 100,000 million times the mass of the sun, but the distribution of mass is non-uniform. The concentration is very high on and near the midplane, and is highest near the centre. Therefore the sun has to execute the motion it does. Any other star of our Galaxy also has to do the same, if not situated at the galactic centre. In fact it is by studying such other stars only that astronomers like Oort and Bahcall have been able to estimate the rate of the jumping motion of our sun.

Figures obtained by different astronomers have been at some variance but not much. Oort's figure is 68 million years, for a complete oscillation; Bahcall's is 62. That means that once in 31 to 34 million years the sun pierces the galactic plane — either while coming upwards or while going down. During both those crossings and for quite some time before and after — may be lasting thousands or even millions of years — the sun has to face exceptional conditions : it has

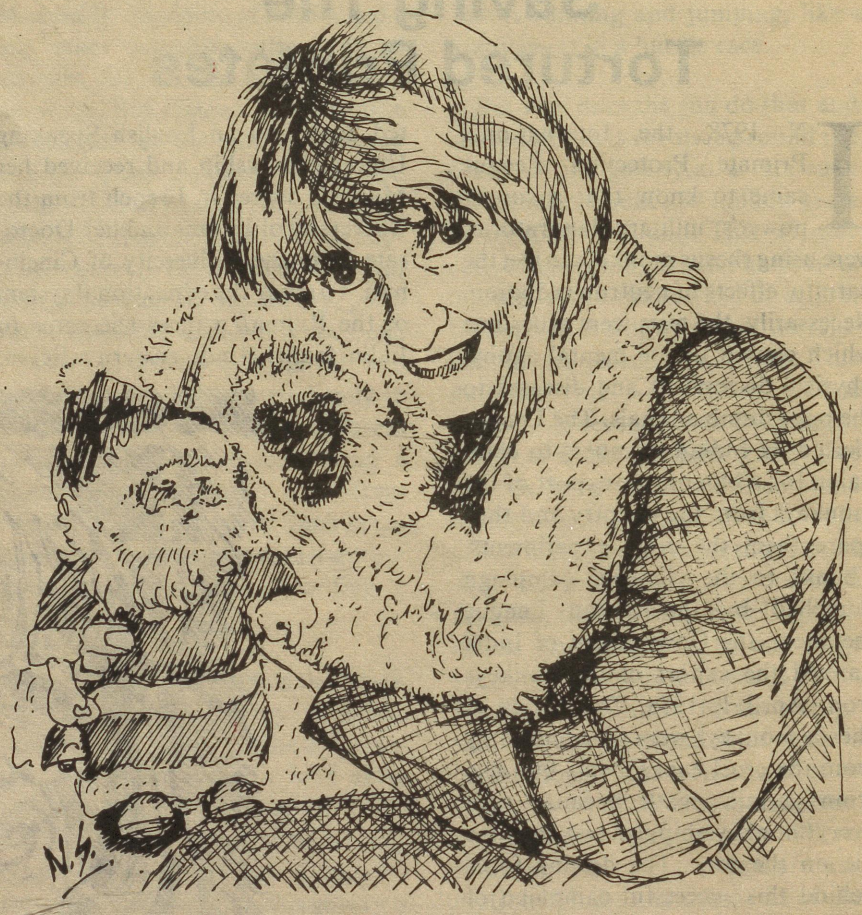
(Continued on page 48)

Saving The Tortured Primates

IN 1978, the International Primate Protection League came to know that a super-power's military laboratories were using rhesus monkeys to test the harmful effects of neutron radiation. Necessarily, the tests were gruesome which caused undue mental agony, physical discomfort and diseases to the poor dumb animals. The League alerted its Indian members to campaign for a ban on the export of the monkeys from the country and thus spare them the cruel experiments. Thanks to the vigorous campaign launched by the Indian League members, the Government of India banned the export of all monkeys from April 1, 1978. Thousands of rhesus monkeys were saved not only from the cruel experiments but also from certain death because with every monkey shipped two to three die on the way. The driving force behind this successful campaign of the League was its founder, Shirley McGreal. And this was just one of the several such campaigns organised by her especially in Asia and Africa for the protection and preservation of the endangered and fast disappearing primates of the world. She has also raised a sanctuary for unwanted or diseased primates. In recognition of her efforts at animal welfare she was honoured with the first Giannino Marchig Animal Award in 1988.

If anyone thought that Shirley had done her early studies on primates or was fond of them since her childhood, one would be utterly mistaken. She has no background in science let alone research in primates. Born in Mobberly, England, she had her basic education in humanities in London. In 1960 she went to the United States on an English Speaking Union Fellowship and received her Master's degree in French from the University of Illinois and her Doctorate from the Univercity of Cincinnati. To study the educational system of the Rajput princes she came to India, learnt Hindi, eastern religion, values and culture, and went on Hindu pilgrimages. Back in the United States, she married John McGreal, an engineer, whom she had met at Illinois. She then taught French to school and college students. The origin of her shift from the secure, quiet and comfortable life of an academician to the turbulent wild-life trade where even her life is sometimes threatened can be traced to Bangkok, Thailand, where her husband had taken up a job. In their neighbourhood lived a family who owned two fuzzy gibbons as pets. Shirley became so fond of them that when the family shifted elsewhere the gibbons were put in her charge. It was in this manner that the love for their kind was kindled in her. So when one day while waiting for a flight at the Bangkok airport she saw a crate of bewildered, frightened and whimpering snow-white baby Macaques being air-freighted to a

New York laboratory her motherly love for them was awakened. She decided to do something to save those innocent beings from being brought in from the wild and sent to laboratories as guinea pigs. She has not looked back since then.



SHIRLEY contacted her friends and even primate researchers like Jane Goodall to find out an organisation which could help her in putting a stop to the illegal trade of primates. But to her dismay none existed. On the other hand, some friends urged her to start such an organisation. Thus came into being the International Primate Protection League in Bangkok in 1973. The next year the League exposed a gibbon-smuggling racket in Thailand. Mother gibbons were shot and their babies shipped to laboratories in the United States for experiments on carcinogenesis. The League brought the matter to the notice of the Thai and the U.S. officials who put a stop to further shipment of baby gibbons. The second success came when Shirley went to Singapore, the world smuggling center for gibbons, as a prospective buyer. She learnt all the trade secrets of the smuggling activity, found out the names of the dealers, the way they operate, and wrote an article on her findings which appeared in newspapers all over the world. Immediately, Singapore took steps to prevent smuggling of gibbons. In this crusade, support came to Shirley from different parts of the world, the strength of the League increasing with every success. Several projects involving cruel experiments on primates went in cold storage before they could even get started. Primates began to receive better treatment in laboratories, zoos and during shipment as the League members began to monitor their living conditions. Shirley also started an action alert service which informed the League members of the activity of any nefarious primate trade anywhere in the world. The members responded by sending letters against the illegal trafficking to the concerned authorities supplementing Shirley's personal intervention in the matter.

During her forays into the primate trade, Shirley found that orangutans, chimpanzees and baby gorillas fetched a handsome price from zoos, pet-keepers and laboratories all over the world. It was seen that the primate smugglers also deal with drug trafficking. Naturally, these primate smugglers could not be expected to have any feelings for the animals when they have none for the human beings. The primates are transported in cramped and unhygenic conditions and are ill-fed. The mortality of primates during shipment, etc., is therefore high; as many as two to three monkeys die for one that eventually reaches its destination alive. Moreover, once experiments on monkeys are over they become a burden to laboratories; so they are destroyed. Shirley therefore always felt the need for a home, a sort of orphanage, where unwanted or diseased primates from laboratories, zoos or homes could live in peace and comfort. So, in 1981, when she shifted from Bangkok to Summerville, South Carolina, U.S.A., where in a technical college her husband had secured a job, she raised a sanctuary in her own home, which has grown over the years. Today, it is spread over ten acres and is surrounded by woods. It contains six pets, one zoo resident, two newborns, and eight research primates.

AMONG the research animals, the story of two gibbons\ Igor and Arun Rangsi, is pathetic. Igor had spent 21 years of its life in a research laboratory where it was used for testing cancer-causing agents. It had such traumatic experiences in the laboratory that it would, at the mere sight of another gibbon, go into a smouldering rage, and even bite its own arms till they bled. It was about to be destroyed when Shirley intervened and saved it from certain death. Today, after coaxing and caring over a long period it has become a happy, lovable, acrobatic gibbon, though its long arms still show scars of its traumatic past.

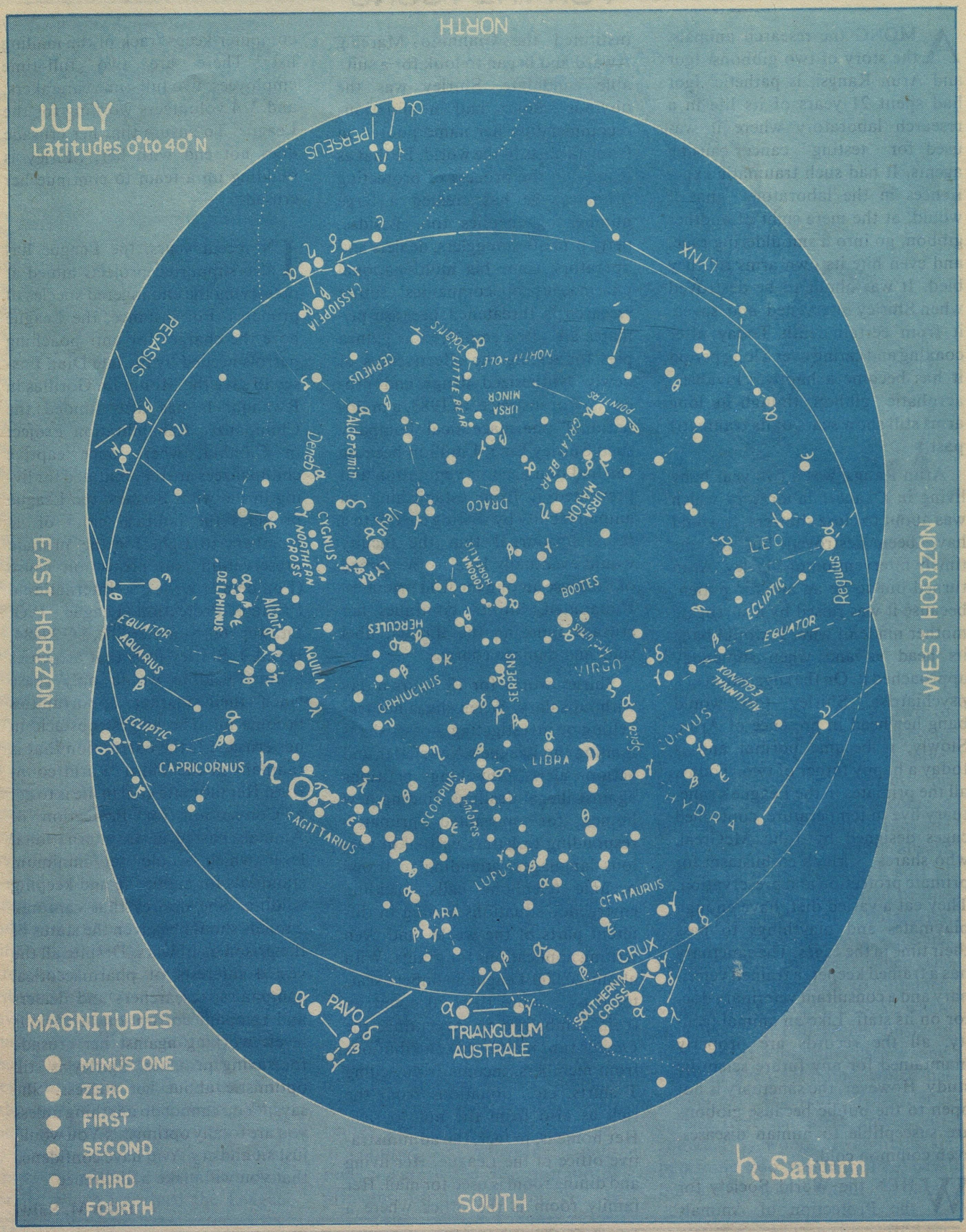
Arun Rangsi was a two year baby living in a cancer laboratory which was about to close shutters. It would have been destroyed but for the timely intervention of Shirley. Arun turned out to be an autistic patient because it was raised by a surrogate mother made of wire. It would bang its head as and when somebody approached it. On the suggestion of a psychiatrist, Shirley too would bang her head in presence of Arun. Slowly, it became normal and is today a happy father of two. Today, all the primates in the League's sanctuary live in temperature-controlled cages designed by John McGreal, who shares Shirley's enthusiasm for primate protection and preservation. They eat a varied diet, have enough playmates and playthings to pass their time in the cages. The sanctuary has a trained keeper, a trained veterinary and a consultant veterinary doctor on its staff. Like an animal facility, all the records are properly maintained for any future scientific study. However, the sanctuary is not open to the public because gibbons are susceptible to human diseases, even common cold.

WHEN the World Society for the Protection of Animals instituted the Giannino Marchig Award and began to look for a suitable candidate, Shirley was the obvious choice and nominations recommending her name poured in from all parts of the world. Be that as it may, in the process of protecting primates she has created a large number of enemies too. Besides, petty primate smugglers, dealers and operators, some big multi-national pharmaceutical companies' future research is threatened because primates are often employed as guinea pigs for testing the effectiveness of newly synthesized drugs and products. For instance, in 1983, a multinational pharmaceutical company sued Shirley for $ 4 million because she had damaged its reputation and prevented it from establishing an animal facility by writing a letter to a research journal that the facility would eventually lead to the spread of a disease among the wild primates. Undaunted, Shirley continues her crusade ignoring the threats, libel suits and damage charges.

Shirley works for 18 hours a day without salary. When she is not travelling or investigating a case, she is mailing the League's Newsletter and action alerts, invoking petitions against illegal dealings, finding new homes for unwanted primates, responding to letters written in various languages, attending to trans-oceanic telephone calls, tackling emergency situations arising in different parts of the world, and even writing applications for grants. With about 20,000 League members scattered over more than 70 countries from Zimbabwe to Argentina, the League runs mainly on contributions from members, income from selling T-shirts, etc., donations from the rich as also from the not-so-rich. Her home is, in fact, the administrative office of the League. Her living and dining room is used for mail. Her family room is the office where a computer keeps track of the mailing list. There are two full-time employees, two full-time caretakers, and 3-4 volunteers working for the League. To ensure that her crusade does not end with her, Shirley is building up a team to continue her crusade.

IN recent years, the League has also supported projects aimed at preserving the endangered species of primates. For instance, the League bore the charges for anti-poaching patrols needed by the late Dian Fossey to save the Mountain Gorillas in Rwanda. It has also funded the Chimpanzee Rehabilitation Project in Gambia, where once captive chimpanzees are rehabilitated for living in the wild. Besides, the League provides the political clout of its members to fight for the primate preservation and protection cause (For details write to: International Primate Protection League, P.O. Drawer 766, Summerville, SC 29484, U.S.A.). Shirley feels that atrocities against wildlife would only cease when their market opportunities become nil. The biggest obstacle in her crusade is the corruption that is rampant in the Third World countries. Her ultimate goal in life is to get a Convention for Protection of Animals passed at an international level which would set minimum standards for capturing and keeping wildlife. She desires that captured animals should be given the status of the prisoners of wars. Despite all the vested interests of pharmaceutical companies, researchers and dealers and rampant corruption at various levels working against her crusade for saving primates, Shirley is still optimistic about her success. She says, "You cannot do anything unless you are totally optimistic. You would just sit and cry. You have confidence that you will make a difference".

Dilip M. Salwi


NORTH
JULY
Latitudes 0° to 40° N
PERSEUS
CASSIOPEIA
CEPHEUS
PEGASUS
LYNX
NORTH POLE
POLARIS
URSA MINOR
LITTLE BEAR
GREAT BEAR
URSA MAJOR
Alderamin
Deneb
Vega
DRACO
CYGNUS
NORTHERN CROSS
LYRA
CORONA BOREALIS
DELPHINUS
Altair
AQUILA
HERCULES
BOOTES
Arcturus
LEO
Regulus
ECLIPTIC
EQUATOR
AQUARIUS
OPHIUCHUS
SERPENS
VIRGO
Spica
AUTUMNAL EQUINOX
CORVUS
HYDRA
LIBRA
CAPRICORNUS
SAGITTARIUS
SCORPIUS
Antares
LUPUS
CENTAURUS
ARA
CRUX
SOUTHERN CROSS
PAVO
TRIANGULUM AUSTRALE
EAST HORIZON
WEST HORIZON
SOUTH
MAGNITUDES
MINUS ONE
ZERO
FIRST
SECOND
THIRD
FOURTH
h Saturn

July

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, South, 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 July 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 June it is for 10–30 pm and for 16th Aug 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 July 1990

Date	1st		*10th*		*20th*	
Planets	*R.A.*	*Decln.*	*R.A.*	*Decln.*	*R.A.*	*Decln.*
Mercury	6h 30m	24.4 N	7h 53m	22.7 N	9h 11m	17.8 N
Venus	4h 22m	20.0 N	5h 08m	21.7 N	5h 59m	22.7 N
Mars	1h 25m	6.7 N	1h 48m	8.9 N	2h 13m	11.2 N
Jupiter	7h 24m	22.3 N	7h 32m	22.0 N	7h 42m	21.6 N
Saturn	19h 39m	21.4 S	19h 37m	21.5 S	19h 33m	21.6 S

Adopted from figures supplied by Positional Astronomy Centre, Calcutta.

The Moon

THE full moon occurs on 8th at 6–53 a.m. and the new moon occurs on 22nd at 8–24 a.m. I.S.T. The moon passes about one and a half degrees south of Saturn on 8th, about eight degrees north of Mars on 16th, about four degrees north of Venus on 20th and about two and a half degrees south of Mercury on 23rd. The moon is at apogee or farthest from the earth on 3rd and again on 31st and is at perigee or nearest to it on the 19th. The lunar crescent becomes first visible after the new moon day in the evening of 23rd.

A total solar eclipse occurs on 22nd. It is not visible in India except the extreme northern parts. The earth is in aphelion or farthest from the sun on 4th.

The Planets

Mercury *(Budha),* is too close to the sun to be visible during the first half of the month being in superior conjunction with the sun on 2nd. Thereafter, it is visible in the evening sky and sets about an hour after sunset. It passes very close to the star Regulus *(Magha)* on 29th. It moves from Gemini *(Mithuna)* to Leo *(Simha)* through Cancer *(Karkata).* Its visual magnitude varies from –1.1 to 0.0.

Venus *(Sukra),* visible in the morning sky, rises about two hours before sunrise during the month. It passes about 4 degrees north of the star Aldebaran *(Rohini)* on 3rd. It moves from Taurus *(Vrisha)* to Gemini *(Mithuna).* Its visual magnitude is about –3.9

Mars *(Mangala),* visible in the morning sky, rises at about local midnight during the first half of the month and about half an hour before it during the second half. It moves from Pisces *(Mina)* to Aries *(Mesa).* Its visual magnitude is about +0.1.

Jupiter *(Brihaspati),* is too close to the sun to be visible during the month being in conjunction with the sun on 15th. It moves from Gemini *(Mithuna)* to Cancer *(Karkata).*

Saturn *(Sani),* rises about half an hour after sunset during the first half of the month and sets about an hour before sunrise during the second half being in opposition with the sun on 14th. It is in Sagittarius *(Dhanus).* Its visual magnitude is about +0.1.

(*Source:* Positional Astronomy Centre, India Meteorological Department, New Alipore, Calcutta–700 053)

The Learning Times

Medha S. Rajadhyaksha

A SMALL girl of seven stood expectantly on the porch, awaiting her teacher's arrival. As she described it in her later years, her tormented mind felt like a ship lost in a fog — without a compass or a sounding line — unable to know how far the harbour lay. She was special in many respects. Lost in her silent darkness, she had an urge to learn, grope out towards light and communication. This urge made her life a miracle. With a teacher, who kindled her spirit, time and again, as she struggled through most unusual ways of learning, she became a legend. The young girl was Ms. Hellen Keller and her teacher was Ms. Anne Sallivan Together they set an inspiring example to many young learners who struggle against odds. Inspit of total breakdown of audiovisual signals, the development, not only of language and speech, but also communication of abstract ideas was a triumph both for the teacher and the taught.

Those who have consciously followed the learning pattern in normal children would definitely notice the role played by visuals and words supplied by the adults and would appreciate the incredible achievements of Ms. Keller. For the little 'copy cats' learning is often nothing but following and imitating the parent. These early signals provided by the parents 'imprint' faithfully in the nerve nets of the young developing brain. Unlike most other higer animals, the human race has been endowed with a prolonged childhood. We are also blessed with an instict of strong parental contribution to our developing young ones. This extended helplessness of infancy together with a strong sense of responsibility towards our children make us excellent learners and untiring teachers. This combination will continue to enrich our generations to come. Learning in human beings, however, does not end with the end of childhood. We are learners for a life time!

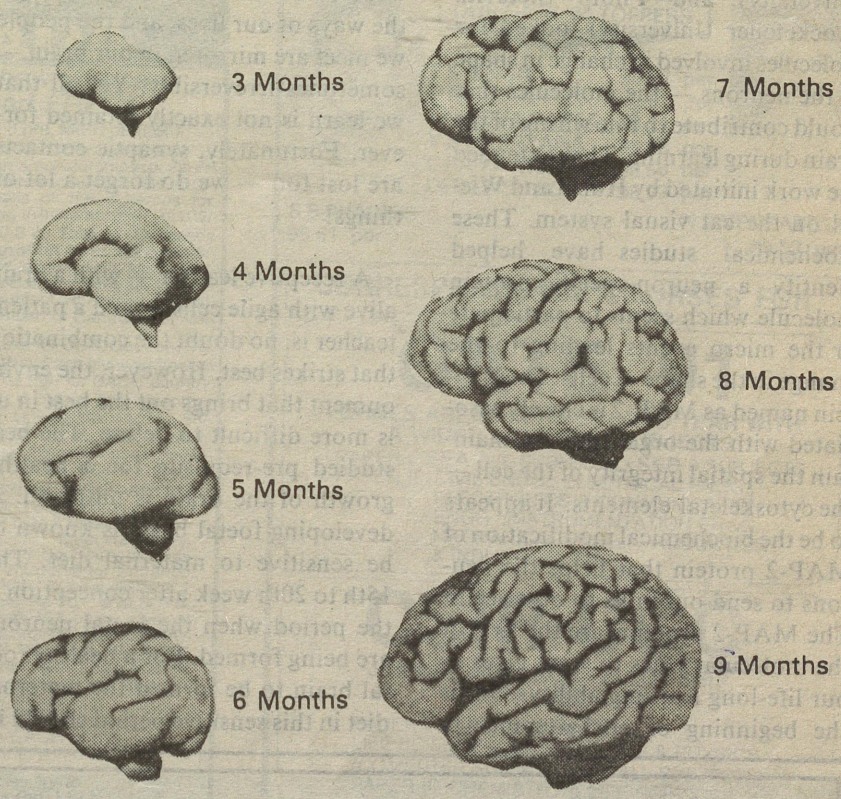
THE legend of 'Mahabharata' tells of many stories that find scientific possibility. An interesting episode is that of 'Abhimanyu' who is supposed to have acquired special skills while in his mother's womb. Though one finds no direct explanation for this, it is now well known that neurons do form basic neural circuits in response to the molecular environment provided to them during development. The neuronal cells in the foetus divide at a very high rate—averaging no less than 250,000 per min. These large number of cells generated in early foetal life, start moving towards their destinations within the developing brain. Giving young cells a helping hand are star-shaped 'astrocytes' that act as a cellular scaffold. As they approach their legitimate location the cells overhaul themselves biochemically and settle down as mature neurons. The membrane of the cells get ready to conduct the signals — a tall demand has to be met — the freshness of the functional ability acquired has to be sustained throughout the life, with very limited repair. No more cells are added now — on the other hand ones that do not contribute to any of the brain function are lost. And during all this hectic activity of settling down a social awareness among cells is also developing. Firm relationships are established with some neighbours, while preliminary dialogue is initiated with others. Topographic positions with respect to each other are identified. As the cells become more and more specialized, acquire characteristic shape and functional ability they become a confirmed part of a nerve net. The cerebral hemispheres that lodge the nerves nets for the important function of the brain acquire characteristic convolutions fairly late in development.

At birth, a complete, preliminary complement of neuron network is already acquired. The raw material is ready, fundamentally the same in most of us, except for little natural variations. What is now left is moulding — experiences that will give us our individual qualities and capacities. At this stage, the brain is very labile. Though not many new additions can be made in the cellular components, the quality of junctions among neurons, the synaptic connections can be continuously remoulded. Retention of this brain plasticity together with enrichment of early neural network lay a foundation for learning ability. The natural potential is unlimited, it is for the environment now to strengthen certain neural circuits and dissociate others. An adequate nurture of the flourishing nerve nets often overcomes the constraints of genes within. So much for providing equal opportunities for learning to each one of us!

IN the early sixties David H. Hubel and Torsten N. Wisel, both then at Harvard Medical School, performed a set of elegant experiments that would fetch them the

Nobel Prize in the years to come. Using the visual system of cat as an experimental model they demonstrated, electrophysiologically the role played by environmental factors during development of neurons. They identified neurons in the visual cortex — the area in the brain where visual information is processed — that developed only in response to stimulation of eyes by light. When vision in one eye was artificially blocked, the number of neurons in the visual cortex that responded to stimulation of that particular eye alone, declined in number. As a result the binocular vision was lost. This failure was found to be persistent. When the artificial block was removed and the eye was allowed to see, it remained 'blinded'. Neurons of both the eyes were able to send in the signals yet the brain could not process the ones of the deprived eye. Though the cat had both the eyes functional only one eye could see! The genetic potential that was — could never be realized — it was lost, once for all.

Carl R. Olson and Ralph D. Freeman of the University of California, Berkeley, added a new dimension of time to this study. Based on electrophysiological experiments it was possible to demonstrate that stimulation of eye by light was very important at a particular stage in development of the visual cortex. If signals don't arrive on time — the bus is missed forever. Anatomical and electrical links between neurons that carry information from retina to visual cortex fail to develop. If appropriate connections are not made in the critical period — none develop. This failure persists even after the deprivation is overcome at a later stage. The neuronal outlay in the 'critical period' is open to sensory inputs. If no inputs are available, not many synaptic connections are made.



The development of the brain

On the other hand, if information is allowed to permeate, the anatomical modulations can develop to assimilate it —making neurons further receptive to newer connections. A good analogy for how neuronal plasticity operates is that of rain water flowing down a wet terrain. Small multiple rivulets originate, to begin with, in large numbers. If water continues to flow through these, deeper furrows appear and a bubbling stream is formed — now able to allow the flow of more and more water. If water flows as a trickle through these rivulets only a feeble water way is made, sensory inputs at specific moments help, like the flowing water, to establish good synaptic connections — the deep furrows for ample water to flow through.

THIS most important unit of brain plasticity, the synapse, has been a focus for molecular analysis. As a new pathway for information flow is laid out, the liaison between two neurons has to be initiated. Each neuron begins with sending out numerous microscopic branches — some that are able to facilitate a contact while others reach out in vain. Outgrowths of neurons that are unable to establish a definite dialogue with other neurons are often retracted. The branches that firmly initiate communication are strengthened. How many possible arborizations of the cell can appear in the first place is what determines how receptive is the brain to learning. More the cellular spikes available for putative neural pathway, better is a chance of a fruitful contact which would allow flow of signals. A receptive brain is probably the one with large number of neurons ready to change their shape and size to reach out as much as possible. Recently Chiya Aoki (Cornell

University) and Philip Sietevitz (Rockefeller University) looked for molecules involved in change in shape of the neurons — the molecules that would contribute to fine wiring of the brain during learning. They extended the work initiated by Hubel and Wiesel on the cat visual system. These biochemical studies have helped identify a neuron-specific protein molecule which seems to participate in the micro events leading to the change in the shape of cells. This protein named as MAP-2 is closely associated with the organelles the maintain the spatial integrity of the cell — the cytoskeletal elements. It appears to be the biochemical modification of MAP-2 protein that helps the neurons to send out links to other cells. The MAP-2 proteins are the first of the molecular clues to what gives us our life-long learning ability. This is the beginning of our attempt to understand how our surroundings, the ways of our lives, and the people we meet are mirrored in our brain — sometimes irreversibly. Yet all that we learn is not exactly retained forever. Fortunately, synaptic contacts are lost too — we do forget a lot of things!

A receptive learner — with a brain alive with agile cells — and a patient teacher is, no doubt the combination that strikes best. However, the environment that brings out the best in us is more difficult to define. The best studied pre-requisite for a healthy growth of the brain is nutrition. A developing foetal brain is known to be sensitive to maternal diet. The 15th to 20th week after conception is the period when the foetal neurons are being formed. For a healthy foetal brain to be formed the maternal diet in this sensitive period should be of high nutritive value — rich in protein. Deprivation at this stage can leave scars on the mental capacities of the child forever. Malnutrition in the first 18 months of the baby has been reported to cause permanent damages — causing loss of neurons which cannot be replaced. At a later stage, an empty stomach makes a child a poor performer — a good diet can immediately improve the situation substantially. Apart from a good protein rich meal, the freedom to explore, invent and express is probably what is most needed for the development of a brain most receptive to learning. Unburdening the children of continuous bookish inputs and stimulating them to ask questions will, most likely, make them the best learners!

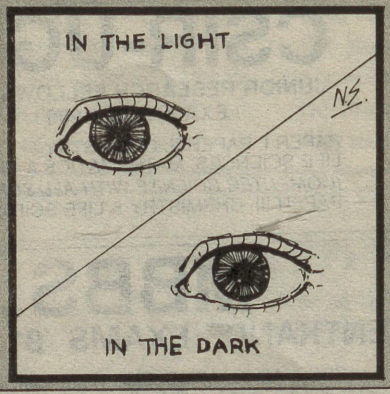
Dr. Rajadhayaksha is a Lecturer in Deptt. of Life Sciences, Sophia College of Women, Bombay.

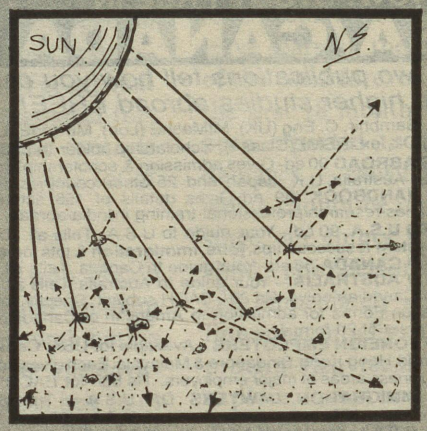
Q. Why can't we see clearly in a dark room after coming in from bright daylight?

Dhirendra Kumar Singh
Chandausi (U.P.)

A. The reason for this phenomenon is quite simple. In bright daylight the pupils of our eyes contract to allow only sufficient light to enter the eye for comfortable vision. In the dark the contracted pupils do not allow enough light to enter the eye to enable us to see things around. Therefore, when we enter a dark room after being sometime in the open daylight, we are unable to see anything immediately. But after a while, when the pupils dialate to allow more light in, visibility becomes better.

Diksha Bist





Q. Why does the sky appear blue?

Rajesh Kumar Pandey
Katras Dhanbad (Bihar)

A. The reason for the blue appearance of the clear daytime sky is scattering of sunlight by gas molecules and fine dust particles in the atmosphere. Blue colour being short in wavelength is scattered more than red or yellow and imparts a blue colour to the sky. At sunrise or sunset, the sunlight has to pass through layers of larger dust particles which scatter yellow and red colour. This makes the sky colour yellow or orange to sunset and sunrise.

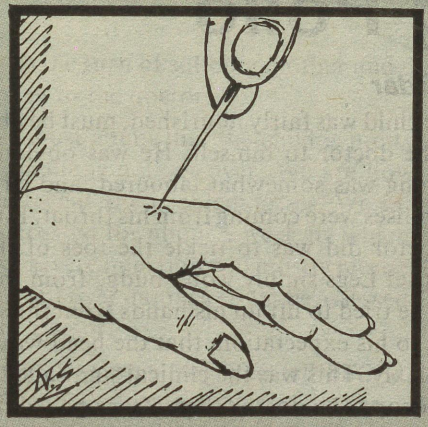
K.K.K.

Q. Why do we sneeze and why do our eyes close while sneezing?

Mohd. Ilyan Ansari
Hussain Nagar
P.O. Jharia
Dhanbad (Bihar)

A. The main function of our nose is to provide pure air for breathing by filtering out dust and other particles from the atmospheric air. Whenever some undesired particles escape the filtering mechanism and enter the nasal cavity, they cause a tingling sensation which causes the body to react violently to expel them out in the form of sneeze. The spasm is so vigorous and instantaneous that our eyes close as a reflex action.

K.K. Kakkar



Q. Why do we feel pain?

Deepak Tiwari
Barrielly (U.P.)

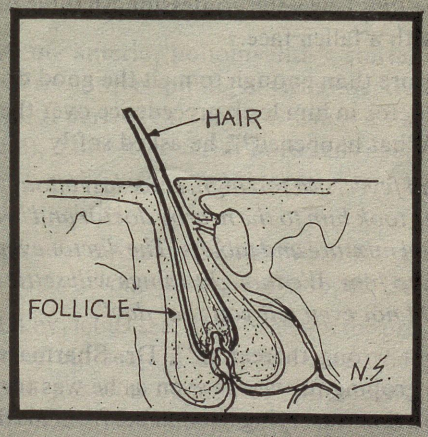
A. We feel pain through the pain receptors on the skin surface. These receptors are the end points of sensory nerves which convey the pain stimulus to the brain. Such stimulus originates when skin is injured, pricked or burnt or for that matter, any sensory nerve ending is injured. Many of our internal parts do not have pain receptors and therefore are unable to experience pain. One such organ is brain. If any part of brain is cut with knife, no pain will be sensed by it.

If somehow we stop the pain stimulus from reaching the brain, no pain would be felt. It is done by certain drugs called pain-killers. This, however, gives only a temporary relief. Permanent relief for pain can only be got when the source of pain is removed or treated.

D.B.

Q. Human hair grows even after death, Why?

Vivek Kumar Khare
Purani Tehri
Teekam Garh (M.P.)



A. The growth of hair depends on the activity of the cells of hair follicles which provide necessary stuff for growth. All cell activities in the body, including those of hair follicles, stop after death. Therefore it is wrong to assume that there is any growth of hair after death. However, due to contraction of skin in a dead body, the inconspicuous small hairs become conspicuously visible giving the impression of hair growth.

K.K.K.

Ask The Best Question
And
Win a Prize

COUPON

Readers are invited to send questions for Brains Trust. The reader whose question is adjudged the best would be given a Prize

Editor

[Please attach this coupon with the question(s)]

Paralysing Polio

Ramesh D. Potdar

TODAY, was the third day that Shabbir, the faithful driver of Dr. Sharma, had not turned up. This was rather unusual and Dr. Sharma was feeling both angry and handicapped, at the same time. Motor car being one of the tools of his profession he was at a loss without a driver. In view of his absent mindedness, albeit arising out of his preoccupation with thoughts of his patients and their ailments, Mrs. Sharma had forbidden him from driving his car on the mayhem that the city roads were. He was tired of avoiding calls and calling for cabs during last three days and was on the verge of taking the driver's seat himself in his old jallopy when he saw Shabbir doubling up to reach him.

About to fire a volley of questions freely interspersed with some unparliamentary vocabulary, Dr. Sharma paused to hear what Shabbir had to say about his absence.

"Sorry, Doctorsaheb, I did not come since Tuesday. What could I do? My 9-month old child is very sick. I couldn't leave him", was the confession Shabbir offered voluntarily with a fallen face.

This was more than enough to melt the good doctor's wrath. The doctor in him look precedence over the master in him. "What happened?", he asked softly.

"He has had fever, not too high, since last about 5 days or so. My wife took him to the nearby doctor and brought home the usual mixture and tablets. The doctor even gave one injection to him. We thought things will settle down soon. So I did not even tell you that day".

"What went wrong thereafter?", Dr. Sharma asked. Shabbir was groping for words even as he was trying to suppress a sob that was trying to emanate from his throat.

"He stopped moving his legs, Sir, since last 3 days, and today he can't even drink his milk. He brought it out twice since morning, mainly through his nose", said Shabbir and added, *"he is already admitted in a small hospital near our house but I wouldn't feel satisfied unless you have a look at him"*.

Oh God, mused doctor to himself, as was his age old habit, must be an attack of bulbospinal poliomyelitis. He did not show his anxiety on his face lest Shabbir would break down further. He simply said, "Let's go"...

Shabbir took the wheel and took Dr. Sharma to the hospital within fifteen minutes. Instantly they were at the bedside of the child.

The child was fairly nourished, must be about six kilos said the doctor to himself. He was obviously feverish, breathing was somewhat laboured, and stridulous gurgling noises were coming from his throat. First thing that the doctor did was to tickle the toes of the child. No response! Legs simply won't budge from their position. Next, he tried to lift up his hands from the shoulder and found to his expectation, that the head would not come up reflexly. This was the clinical sign called Head lag or Neck drop. The doctor thereafter opened mouth of the child and put a flat tongue-depressing spatula in it. Worst that he had anticipated had already taken place. The child's palate (roof of his mouth cavity) was as immobile as a statue. It would not move back and cover the larynx in its usual manner. It freely allowed everything to be regurgitated through the nostrils. This was what is termed as "palatal palsy" in medical jargon

The doctor had made up his mind on the diagnosis. It was "Acute Bulbospinal Poliomyelitis" a disease caused by polio virus and responsible not only for paralysis of muscles but also vital centres of respiration and swallowing situated in the medulla oblongata. A long struggle for survival as well as a permanent residual handicap lay in wait for the poor little fellow.

In his usual manner he demonstrated all the different clinical signs he could elicit to the young house-physician who was in attendance with him during the entire physical examination. The doctor provided him with the important bit of information that the child had not been vaccinated ever and had already received two injections within last two days mostly of an antibiotic.

"You will have to keep an eye for evidence of respiratory paralysis in this child in view of the bulbar involvement. If you don't keep on alert ready, you will put both yourself and the child in lot of trouble", advised Dr. Sharma to the intern.

The intern was a smart guy. He replied, that he had not only kept a respirator machine ready but had also informed the anesthetist on call that he may have to drop in any minute to put an intratracheal tube.

"Good show, doctor", Dr. Sharma was obviously pleased, "alert anticipation and preparedness go a long way in our profession. I am sure you have in yourself makings of a good Clinician, keep it up".

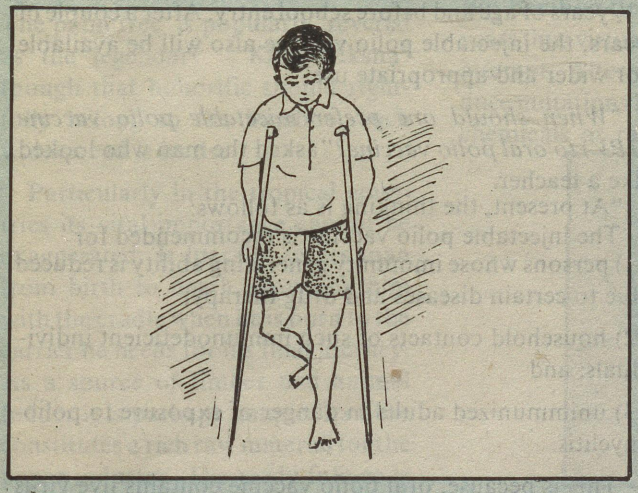
This gave the junior a feeling of satisfaction. After all,

he was appreciated by one of the more famous seniors of his.

Now it was the turn of sobbing mother and distraught father to listen to the doctor.

"Well, we must admit that the child is pretty sick and danger to his life is not yet over. We are however well prepared to face if any problem arises. We should keep our fingers crossed for about a week by which time this tidal wave of severe infection will mostly recede. It is only then that the left over damage could be assessed," was the advise of the doctor.

He did not, however, forget to tell both of them to attend his health education classes in the afternoon. Today's topic would automatically be "Acute Anterior Poliomyelitis".



The famous waiting-cum-class room was already filled to capacity showing that Dr. Sharma's educative sessions were becoming popular day by day. "Polio or Acute Anterior Poliomyelitis", started the doctor, "is the major cause of lameness or motor handicap in the world. No other disease can cripple man as does this one.

"At what age do we get this disease, doctor?" asked a young student.

"Though it can strike at any age, depending upon immunity developed by a person or a group of people, it is mainly restricted to children of age between 4 months and 2 years. In India, most children are exposed to poliovirus fairly early in life, thanks to poor sanitary facilities as well as total lack of cleanliness in our day to day practices of ablutions".

"Did not quite understand, doctor," said a kid who was about 12 years of age, *"could you please explain again?"*

"Of course. What I meant was that poliovirus is a virus which works through our digestive system, mainly the small intestine and is excreted through our stools. It is the contamination of the water, milk and foodstuffs with fecal matter that spreads the disease. Common water supply for cleaning as well as drinking, unprotected wells and lakes, unclean habits of food makers and eaters, all cause higher incidence of polio in our country. Therefore, by the age of two years, all children of our country come in contact with this virus, and either develop their own immunity or fall prey to the disease if the immunity is low or absent".

"Thank you, doctor," said the boy gratefully, *"now I will take extra care to be clean and I have really understood all the facts they mentioned in our Community Living textbooks. I never realized that cleanliness was such a serious matter".*

"Well, the other aspect of polio is that by immunization it can be totally prevented. Some countries have eradicated it completely. There is no reason why our country should not be able to do it".

"Could you tell us about this disease in greater details, doctor, so that we could really grasp its ways of harassing and handicapping man?" requested an elderly gentleman whose demeanour appeared to be that of a teacher.

"Acute anterior poliomyelitis", started the doctor, "is one of the most crippling of virus infection diseases in the world. It derives this name because it has an acute onset (acute), it affects anterior horn cells of spinal cord (anterior), is polio virus caused (polio), and affects the spinal cord (myelitis)".

"Slowly, doctor, please explain. We can't keep up with you so fast," one young boy stopped Dr. Sharma.

"Okay, let us see, now", the doctor projected a picture slide of cut section of spinal cord and pointed to the ventral position of anterior horn cells. These are the lower motor neurones in the spinal cord which supply the nerve filaments to various muscle fibres of the body. The virus of polio affects these cells and damages them to various degrees. Some of them are not affected, some become swollen with a possibility of recovery in due course, and some get totally destroyed".

"What does this mean to the patient?" asked the father of our patient.

"Good question, Sir", replied the doctor, "Since each of these cells supply to muscle fibres we find asymmetry of paralysis in poliomyelitis as against an other similar looking disease called polyneuritis where paralysis of

muscles is symmetrical. Secondly, this fact is important from recovery point of view also. The muscle fibres which are supplied by anterior horn cells that are completely destroyed do not recover at all but only waste and become thinner and shorter giving the limbs their wasted look. The cells which are swollen may, in due course, be damaged completely or recover. If they recover, the muscle fibres supplied by them also recover within a period of a month to about six months. Those cells which escape the onslaught of the virus keep muscle fibres supplied by them ready for more work to take over from the fibres which are completely destroyed. It is these muscles which continue, albeit abnormally, all the movements of the body even in worse types of poliomyelitis."

"I see, that is why the cure of polio changes from person to person," said a wise old looking young person.

"Yes", added the doctor, "but remember, it is not cure in the true sense of the word but only the functional and partial recovery that takes place in polio".

"My God, doctor, you really mean to say there is no cure? What will happen to my child who was admitted yesterday?" asked Shabbir, the doctor's driver.

"Well, remember, your child has involvement of the higher parts of the brain and for next one week he could be in danger of paralysis of respiratory muscles which can jeopardize his breathing. But I hope that we shall manage him well till he recovers. Keep cool, Shabbir and also reassure your wife".

"How long will it take him to recover Doctor?" asked Shabbir's wife through her burqah.

"The recovery will start after 7 days of beginning of paralysis and go on very fast within first three months and then slowly over a period of one year. This means that you have to plan properly for his management within the entire next one year. The exercises will be commenced passively after 10 days and actively after 3 weeks. In due course if necessary, appliances, shoes, etc. will be developed for him to literally stand on his own feet".

"Thank you, doctor I appreciate", said Shabbir's wife with gratitude.

"Will the child become completely normal?" asked Shabbir's brother.

"Yes, and no. Yes, in the sense, that with continuous untiring physiotherapy, appliance application and surgery, if needed for tendon transfers, we can functionally bring him to near normal function of his limbs. No, in the sense, that the polio-affected limb will always remain residually somewhat thin and short".

"Is it not better to prevent it, then?" said the young smart boy.

"Right you are, it is not only better but absolutely a must, now that prevention of polio can be done hundred per cent sure", said Dr. Sharma.

"You see", he continued further, "polio vaccine comes in two types, by mouth and by injection. The first one is known as Sabin and the other one is Salk named after the scientists who developed them. Both contain antigens of all three types of polio virus type 1, 2 and 3 and hence are termed trivalent".

"Which one is better?" enquired a man who appeared from a higher economic class judging by his apparel.

"Both have their plus points. However, in our country, currently it will suffice if we give our children one oral polio dose at every 4-week interval for three doses starting from six weeks of age. Repeat the same as boosters at 1½ years of age and before school entry. After a couple of years, the injectable polio vaccine also will be available for wider and appropriate use".

"When should one prefer injectable polio vaccine (IPV) to oral polio vaccine?" asked the man who looked like a teacher.

"At present, the thinking is as follows:

The injectable polio vaccine is recommended for

(1) persons whose immunity generating ability is reduced due to certain diseases and drug therapy;

(2) household contacts of such immunodeficient individuals; and

(3) unimmunized adults in danger of exposure to poliomyelitis.

This is because, oral polio vaccine contains live virus and injectable vaccine is made of killed virus. All live virus vaccines are contraindicated in individuals whose immunity is impaired due to certain disorders and drug therapy. It is best to ask your doctor in a given situation".

"Are there any adverse reactions?" asked the well-dressed gentleman.

"Hardly any, if given properly. It must be remembered that polio vaccine is very sensitive to heat and hence it must always be kept between 2°C to 8°C till it reaches the child's mouth. As far as adverse reactions are concerned, there are no adverse reactions in normal children whose immunity is not impaired", assured the good old doctor.

It was time to wind up because sick patients and children had started trickling in to present their woes and sufferings to Dr. Sharma, the healer who combined faith and medical scientific knowledge in a unique manner for betterment of his clients.

Dr. Potdar is a Pediatrician and Health Consultant; Address: 69, D.V. Pradhan Road, Dadar, Bombay-400 014

Bamboo Blossoms

BAL PHONDKE

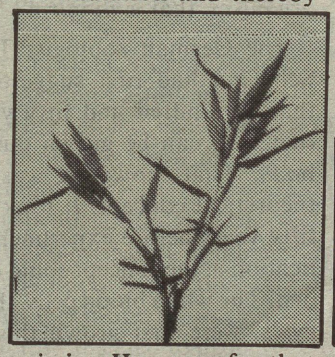
Number Fifty-four
A House with a Bamboo Door
Bamboo Roof and Bamboo Walls
It even has a Bamboo floor

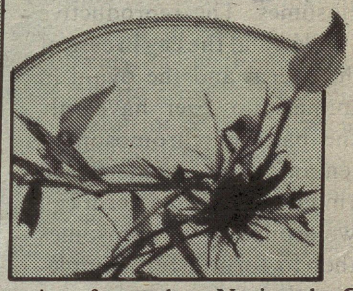
THUS went a fairly popular song of the mid-sixties. Waxing eloquent of the virtues of this tropical reed the lyricist nonetheless expressed his astonishment in no unclear terms. That is the misfortune of this structural material so versatile in its utility. The palm tree is popularly revered as the legendary "Kalpavriksha" though that honorific should rightfully belong to the bamboo, such widespread is its use.

Particularly in the tropical countries its vital importance cannot be exaggerated. It literally serves man from birth to death providing him with the cradle when he is born to the carrier he needs for his final journey. As a source of timber and animal fodder it is parhaps unique. Its fibre constitutes a rich raw material for the paper industry. The reedy foliage is useful to the cottage industry for making baskets and other essential kitchen equipment used by a village housewife. The cane is used to make the "House of Bamboo" which despite its vulnerable appearance turns out to be strong and rot-resistant. The tall scaffoldings that provide the inital support to the high rising skyscrapers are built of bamboo sticks. And finally its grass as well as the tender shoots contain such high amounts of protein that they constitute a nutritious delicacy for man as well as animal, particulary the giant Panda.

Considering this economic value of the plant one would have thought that the techniques of biotechnology which ushered in the green revolution have long been harnessed to produce several improved varieties of bamboo. Alas! That is not the case. Not for want of trying though. Biotechnologists who ventured to do so have been frustrated by some peculiar characteristics of this plant.

To produce a hybrid variety it is essential to cross two existing varieties, each with a desirable characteristic. The crossing, sexual mating in the plant breeding parlance, can be achieved only at the flowering stage. But bamboo flowers only once in 30 years thus virtually blocking any such attempt. Alternatively, one can induce mutations by treating seeds with chemicals or radiation and thereby get new varieties. However, for that purpose enough seeds have to be available which in turn depends on the flowering rate. Moreover, subsequent selection of a useful mutation from among the myriad that are generated and its further nurture requires a follow-up extending over at least three to four generations. That approach, therefore, becomes a non-starter since the generation time is 30 or 60 or even 120 years.





There are other curious incongruities that the plant displays. On the one hand, it is one of the fastest growing tree. The growth rate is known to be as much as 4 cm an hour. But it takes as long as 120 years to flower and set seed. It grows even as tall as 40 metres or as thick as 30 cm in diameter. At times it throws underground rhizomes in all directions from which new shoots can grow with the result that thick and widespread jungles spring up. But when the trees flower after a very long time all of them flower together irrespective of the stage of growth of the individual trees. And worse, soon after all the trees die together leaving a barren wasteland where once a green forest reigned.

This plant species thus had posed a defiant challenge to plant breeders and biotechnologists. No one was able to successfully pick up the gauntlet until recently. But the plant finally met its match in three scientists from the National Chemical Laboratory, Pune, who have coaxed the unwilling plant to flower precociously and yield quite a handful of seeds. That too in the laboratory or in the test tube to say it in a popular lingo.

RAJANI Nadgauda, Varsha Parashrami and Tony Mascarenhas had set themselves a tough task. They wanted to speed up the internal biological clock of the bamboo plant without having a clue to its working mechanism. Nor had anyone else succeeded earlier in making the haughty plant flower in the confines of a laboratory.

Undaunted, the team of scientists got hold of seeds of two bamboo species, *Dendrocalamus brandisii* and

What Is Tissue Culture?

EVERY living organism, be it a plant or an animal, is made up of a varying number of constituent cells. There are basically two types of cells, somatic cells which come together to form the various tissues and organs, and genetic or reproductive cells which participate in giving birth to the offsprings.

One major difference between the two types of cells lies in the total amount of genetic information stored in a coded form inside them. The somatic cells have the full complement of chromosomes which occur in pairs. So these cells have all the pairs of chromosomes. The reproductive cells, the pollen and the egg in case of plants, the sperm and the ovum in case of animals, however, have only one of the pairs of chromosomes. Only when an ovum gets fertilised by a sperm giving rise to a germ cell do the two groups of chromosomes get together to form a full complement of genetic information.

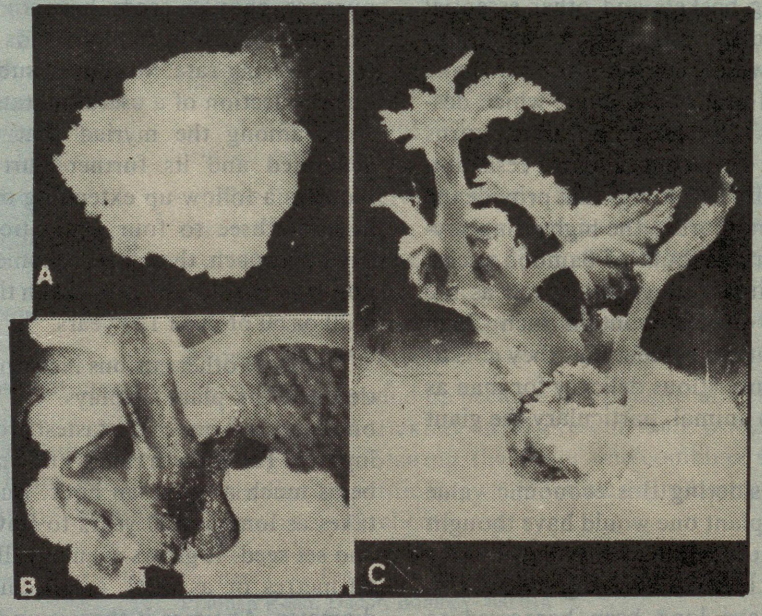
The germ cell divides giving rise to daughter cells each faithfully carrying the entire and identical amount of genetic information in the form of the complete set of chromosomes. The cell number keeps on increasing in this fashion during the growth phase. At a pre-determined stage some of the cells start specialising so that they can become constituents of the various organs that make up the multi-cellular, multi-organ living being.

In a mature organism the different specialised cells carry on the specific functions entrusted to them. Though each one of them possesses the entire gamut of genetic information only a part of it is utlised to enable the cell to perform its allotted function satisfactorily. Each of these cells possesses the same amount of genetic information as the germ cells from which the whole organism had developed. Thus, in principle, each of these somatic cells has the potential of being a germ cell. If certain restrictions imposed on these cells by nature in the overall interest of the survival and well-being of the organism can be lifted and conducive environment can be created, this potential of the somatic cell can be realised. The technique of tissue-culture attempts to do this and that too outside the organism, that is *in vitro*.

The German zoologist Theodore Schwann had first suggested more than a hundred and fifty years ago that cells can be grown outside the body. That, however, was a mere theoretical concept. It took another fifty years before experimental verification of the concept could be obtained. The white blood cells, the leucocytes, were first grown this way in tissue culture. In case of higher plants it was not until the beginning of this century that the first successful tissue culture could be set up.

FURTHER progress in case of plants has, however, been relatively more rapid, especially over the last twenty years. Starting with culture of a mere shoot tip the whole plant has been grown in the laboratory. In many cases the plantlets have subsequently been transplanted to the soil and then nurtured to full development.

To start with any part of the plant, shoot tip, stem, leaf or inflorescence is excised from the plant. It is then placed in a suitable nutrient medium. The task of the scientists is to devise the most appropriate culture medium so that the nutritional needs of the cells being cultured are fully met and they respond with a vigorous and sustained growth. Though various media formulations are now available that prepared by Toshio Murashige of the University of California



is preferred the world over.

The excised part of the plant is, more often that not, likely to harbour certain bacteria or fungal cells. These micro-organisms can also feed on the nutrient-rich culture medium and grow merrily. Not only would the culture thus get contaminated but the microbes may even deny the plant cells their due share of the nutrients thus totally stiffling their growth. This is averted by taking two precautionary measures.

Firstly, before use the medium is thoroughly sterilised to get rid of any infectious agents that may be lurking. Secondly, certain antibiotics are added to the medium to prevent the growth of microbes.

The medium can be liquid or solid. For the latter a nutritious carbohydrate, agar, is added. When grown in this medium many plant tissue cells start dividing and increase their numbers to form a mass of cells that have not yet specialised. Such a clump of undifferentiated cells is known as a callus.

The callus (A) is an irregularly shaped dense mass made up of similar cells. The parts that usually distinguish a plant are not yet discernible. At this stage usually a dose of different types of plant hormones like auxins or cytokinin is given. Under their influence the same cells that formed the callus start differentiating and root and/or shoot formation takes place (B). Further growth and development can be achieved either in a culture flask or in a pot containing soil (C). At a later stage the plantlets thus obtained can be transplanted in the field for full development to maturity.

ONE of the main uses of plant tissue culture is for micropropagation of many commercially useful trees which take a long time to grow under the field conditions. Micropropagation can help speed up the process considerably.

To initiate micropropagation normally a shoot tip is used. A piece larger than 5-6 cm in length is used and implanted in a solid medium. When it gets properly established it leads to the emergence and growth of new shoots. Eventually a clump is formed. Each of these can be further sub-cultured by transforming to fresh medium where it can give rise to a clump. Thus within a very short time, 3-4 sub-cultures of thousands of shoots, each capable of forming a plantlet on its own, can be obtained. Under natural conditions the process can take several years.

The shoots can be cultured with the addition of special hormones to encourage formation of roots. At this stage further multiplication of plantlets with roots and shoots can be resorted to. Alternatively each plantlet can be transplanted to soil for full normal development.

Such micropropagation has successfully been achieved for a number of economically important plants. It would be no exaggeration to say that a singie shoot tip subjected to proper and adequate culturing can yield as many as a million plants in a year. No wonder horticulturists as well as forest departments have looked up to plant tissue culture with considerable hope.

Some plants like orchids are extremely fastidious. It is difficult to grow them. Others like bamboo have a very long generation time. Tissue culture provides a means of growing such plants in large number since not only can the propagation be speeded up but the growing environment also can be more delicately controlled.

TISSUE culture has also enabled a large number of experiments to be carried out which otherwise would not have been possible. For example, if toxicity of certain chemicals to human beings has to be assessed one would have to be satisfied with epidemiological data since human experimentation would not be possible, desirable or ethical. Yet information that can be gleaned from epidemiological data is always limited leaving a number of questions unresolved. Tissue culture proves to be a boon in such cases because cells in culture can be treated experimentally with these harmful chemicals. Effects of cancer producing chemicals, viruses, radiation or disease-bearing micro-organisms have been studied using this technique.

It has even come in handy for studying the effects of certain beneficial or natural substances like hormones, vitamins, therapeutic drugs and the like.

For modern biotechnological processes aimed at bringing about genetic enrichment the technique of tissue culture proves to be a valuable ally. Fusion of cells can be carried out more easily in cell cultures thereby generating somatic hybrid plants. If the cells are first treated with certain hydrolytic enzymes to peel off the cell wall, the remaining portion, called the protoplast, can very easily be fused with another protoplast. Hybrids such as those between two different plants each with a desirable genetic trait which do not materialise under normal crossing procedures can be obtained using cell cultures. Even inter-species hybrids have now been brought about. Since the culturing techniques provide clones, that is, colonies of totally identical cells, the desired genetic make-up can be preserved for ever.

Barely two decades ago the technique was just a curiosity or at best yet another sophisticated tool in the hands of an enterprising research scientist. Today it has become the staple of many a commercial entrepreneur. □

Bambusa arundinacea. They allowed the seeds to germinate in the dark by feeding them with a slightly acidic nutrient medium supplemented with sucrose and agar. It took a week for the seeds to germinate at which stage they were exposed to a moderate intensity of light at a cool temperature. The changed conditions induced a growth spurt and the plantlets grew to a height of 5-6 cm.

Satisfied with the progress so far, the scientists cut out 3-4 cm long portions which included the growing tips. These were transferred to fresh liquid mixture of nutrients that again contained some sucrose. The cultured plantlets were, however, exposed to light this time right from the beginning ensuring all the while that the temperature did not rise beyond 28^0 Celcius. The plants responded vigorously to such a royal treatment producing a clump of shoots.

Enthused, Mascarenhas and his colleagues picked each individual shoot and pampered it by feeding it with the same recipe of nutrients enriched further with coconut milk and one or more of a variety of growth promoting chemicals.

A large number of such sub-cultures were set up and the process was repeated. Third time proved lucky. The shoots which were fed with the medium containing coconut milk and cytokinin, a type of plant hormone, suddenly blossomed giving rise to a bunch of normal flowers. Out of a cluster of 15-20 shoots present in a culture vessel about 60% were in bloom. And that went for both the species.

Overjoyed, quite naturally, the scientists did not lose their objectivity. They had to make sure that this was not a flash in the pan. So they went about it systematically ensuring that the phenomenon of precocious flowering is reproducible. Time and again, they were able to make the normally sedate plant shed off its reluctance and respond by flowering. More importantly, the plants also produced seeds. Some of the sub-cultures were transferred mid-way to the soil. These plants too grew vigorously and flowered. Each culture of *Bambusa arundinacea,* whether in the soil or in the test-tube, gave rise to 50 seeds. The responses of the other species were relatively lackadaisical yielding only 5 seeds each.

Mascarenhas and his colleagues realise that this is only the beginning. Though the clusters of the bamboo shoots developed in the laboratory are lovely, dark and perhaps deep they have miles to go before they can afford even to think of sleep. They are getting busy finding out the most favourable concoction of nutrient materials that allows this lazy plant to overcome its natural lethargy and break out of the shackles imposed by the built-in reproductive clock.

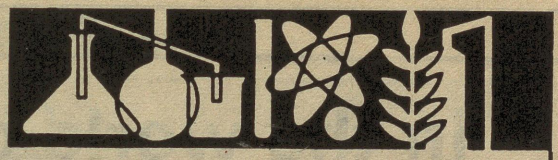
THE world at large, however, is dancing a jig at the news. The report of Mascarenhas and his colleagues on their experimental work, published in the most prestigious science journal *Nature* has been greeted by both the scientific and secular western press with high acclaim. *Nature* itself published an invited editorial comment, an honour normally reserved for only the most significant research reports. The *New York Times* thought it worthy enough of space on the front page. If *New Scientist* carried a laudatory report it was not unexpected. But even *The Economist* let a crease caress its stiff upper lip long enough for a full page article.

Why should everyone get so carried away? As *The Economist* said it with its typical British understatement, "speeding up the bamboo clock opens several possibilities". That indeed it does. And how!

The scientists, true to their character, are modest enough in their expectations. They think that their success would enable them to find out the precise role that plant hormones like cytokinins play in plant growth and development. Also, they now might be able to unravel the mystery of bamboo's gregarious flowering and death.

The world at large is, however, thinking of the economic benefits that could accrue. The least of these is the possiblity of developing more vigorous and disease-resistant strains. With a regular supply of seeds vast areas of wastelands resulting from the natural denudation of bamboo forests consequent upon the gregarious death can now be regenerated. In fact, by maintaining a dynamic balance denudation can be totally avoided. More important though is the possibility that biotechnologists can now wield their magic wand and produce a variety that could be a sturdy engineering material. That is not a mere flight of fancy. For their exist bamboos that reach to great heights. There are others that are rich in silica-content making them very strong. There is even one with a square cross-section. Some are hollow but others solid. All these are useful traits but they do not exist in the same strain or species. Plant breeders have dreamt of bringing them all together. Now they have a way of making that dream come true. □

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH



VISITING ASSOCIATESHIP SCHEME

A. Promotion of extramural research in the various disciplines of science and technology is a major activity of C.S.I.R. In addition to the scientific and industrial research that CSIR carries out in its various research laboratories. To foster interaction between the working scientists of research institutes, industry and universities, CSIR is initiating a ***VISITING ASSOCIATESHIP SCHEME.*** Under this scheme an Associate will be able to use for his research the advanced R & D, computer and infrastructural facilities of a CSIR laboratory/institute of his choice. Besides, the CSIR will provide to the Associate, travelling expenses for two visits per year between the place of his parent institution and the concerned CSIR laboratory, accommodation in guest house at nominal rent and daily allowance at CSIR rates wherever required, for periods not exceeding 60 days in a year. The Associateship will be tenable for 3 years. The time spent in the CSIR laboratory could either be continuous or at convenient intervals.

B. Eligibility, selection criteria and terms :

Associates will be selected by Committee(s) appointed by the Director General of CSIR, on the basis of applications received from Indian Scientists, engineers and technologists working in the different universities, research institutions and in-house R and D establishments in the industry. The candidates should be outstanding in their field as evidenced by contributions to relevant areas of science and technology. Applications must be accompanied by a clearly defined programme of work. Candidates must be sponsored by their employers. The intellectual property, if any generated shall be shared on a mutually agreed basis between CSIR and the sponsor of Associate. The Associate shall be given due credit in patents and commercialization of knowledge generated. He will be able to publish the results of work done giving due credit to his collaborators, after obtaining permission to do so. He shall deliver a lecture each year reviewing the progress made and submit a report on all the work done at the expiry of the associateship.

C. Application format : (1) Applicant's name, designation and address; (2) Date and place of birth and age (3) Academic qualifications (degree onwards with subjects of specialisation, marks obtained and distinctions, if any); (4) Details of Overseas visits; (5) Employment record (Give here details about employer, position held, duration, duties and pay in chronological order); (6) Details of current research work; (7) List of publications (enclose reprints); (8) Proposed programme of work (enclose project proposal); (9) Names of groups in CSIR laboratories with whom attachment is desired (while upto three sets of names can be given, only one will be approved). (10) To which subject area the proposed research work belongs?

(11) Place Date Signature of the Candidate

(12) Statement from the present employer (this should certify sponsorship and continuance of employment, salary and other benefits to the candidate during the tenure of Associateship—applications not sponsored and forwarded by the employer will not be entertained).

D. Selection : Successful applicants will hear direct from the concerned CSIR laboratories.

E. Address : Candidates should send their applications typed on plain paper to ***the Head, Human Resource Development Group, Room No. 109, CSIR Headquarters, Rafi Marg, New Delhi-110001. Applications will be considered Twice every year-those received up to 30th June and 31st December respectively.***

Announcement

INDIAN SCIENCE CONGRESS ASSOCIATION

Awards for 1990

Professor Hira Lal Chakravarty Awards

Applications in prescribed forms are invited from Indian Scientists, below 40 years of age on December 31, 1989, with Ph.D. degree, having significant publications in any branch of Botany—pure or applied. There are two awards; each carries a cash amount of Rs. 4,000/- and a certificate. **Last date of submitting applications is July 15, 1990.**

Pran Vohra Award

Applications in prescribed forms are invited from scientists below 35 years of age on December 31, 1989, with Ph.D. degree in Agricultural Sciences from any University or Institution in India, having made significant research contribution in any branch of Agricultural Sciences. Only research done in India will be considered for the award. The award carries a cash amount of Rs. 4,000/- and a certificate and the awardee will be required to deliver a lecture on the topic of his/her excellence during Annual Session of the Indian Science Congress Association in the Section of Agricultural Sciences. **Last date of submitting applications is July 31, 1990.**

For prescribed application forms and necessary information, please write to the Indian Science Congress Association, 14, Dr. Biresh Guha Street, Calcutta-700 017.

In the world of BASIC-X

V. Ramshesh

IT may be desirable to have a command which could execute a sequence of operations repeatedly. This is particularly important in mathematical computations involving problems in Physics, Statistics, etc. A simple command called FOR—NEXT is available in Basic for such repeated operations.

FOR—NEXT STATEMENT

The FOR—NEXT statement is written as:

```
20 ————————
30 FOR N=1 TO 3
40 ————————
   ————————
70 ————————
80 NEXT N
90 ————————
```

When the program encounters FOR statement in line 30, it knows that a repeated sequence of operations is involved. It then searches for NEXT statement and finding it in line 80 understands that these repeated operations cover lines 40 to 70. So, first, N will be set equal to 1, lines 40 to 70 executed; next N will be set equal to 2 and lines 40 to 70 again executed; and so on till N=3. Lines 30 to 80 constitute a loop, and unless it is completed, execution will not come out of it (unless there is a transfer of control like a GOTO statement in between). An important point is that FOR must be the first statement and NEXT the last statement of the loop.

Program 1 illustrates the use of FOR—NEXT statement in a clear way. In line 10, N is varied from 1 to 2 and the statement in the next line 20 is Print "ONE AT A TIME". Line 30 which says, NEXT N, completes the loop. Accordingly, statement in line 20 gets printed twice.

In the above case, the value of N is defined as a numeral. Even if N is defined in terms of variables (whose values are already given) the FOR—NEXT statement will be obeyed (Program 2). In this program, the value of (A+B)/2 is 6 and that of C/2 is 9 and so line 40 implies that N is varied from 6 to 9. Line 50 is a Print statement. Line 60 which says NEXT N completes the loop. On running the Program, the word GOOD is printed four times.

There can be several FOR—NEXT statements in a program. Further, another FOR—NEXT loop can be executed inside an existing loop. In such a case of two FOR—NEXT statements, the inner loop will be executed first and then the outer one. When several FOR—NEXT statements are placed together, the order of execution will be innermost loop to the next outer one, and so on till the outermost is completed. This feature is called "nesting of loops". The correct way of writing a two loop operation is:

```
   ————————
60 FOR M=1 to 3
70 FOR N=1 to 4
80 ————————
   ————————
120 ———————
130 NEXT N
140 NEXT M
```

Statements in lines 70 and 130 define the inner loop in which N is varied from 1 to 4, while lines 60 and 140 take care of the outer loop in which M is varied from 1 to 3. First, M is set=1, N varied from 1 to 4 and lines 80 to 120 executed. Next M is set=2, N varied from 1 to 4 and lines 80 to 120 again executed. Finally, M is set=3, N varied from 1 to 4 and the sequence repeated. An important point to note in such nested loops is that NEXT statements must come in the order innermost loop first, followed by the next outer one and so on.

Program 3 shows a typical two

INPUT	OUTPUT
5 REM FOR—NEXT	
10 FOR N=1 TO 2	
20 PRINT "ONE AT A TIME"	ONE AT A TIME
30 NEXT N	ONE AT A TIME
40 END	

PROGRAM 1. Use of FOR—NEXT

INPUT	OUTPUT
5 REM FOR—NEXT	
10 A=5	
20 B=7	
30 C=18	
40 FOR N=(A+B)/2 TO C/2	GOOD
50 PRINT "GOOD"	GOOD
60 NEXT N	GOOD
70 END	GOOD

PROGRAM 2. Another case of FOR—NEXT

loop operation. In line 10, X is varied from 1 to 3, and in line 20 Y is varied from 1 to 2. Line 30 is a PRINT statement asking NESTED LOOPS to be printed. The command NEXT Y in Line 40 completes the inner loop, while NEXT X in line 50 completes the outer loop. On running the program, the words NESTED LOOPS get printed six time. Statements NEXT Y and NEXT X are written in the correct sequence. If the order gets reversed, an error message appears (Program 4).

It is possible to slightly modify the FOR—NEXT statement in which the variable may be stepped up or down by regular incremental values. The correct way of writing this is:

FOR N = 1 TO 7 STEP 3 or
FOR N = 11 TO 1 STEP -5

(When no STEP is given, the computer defaults to 1).

In the first case, N will be stepped up from 1 to 7 in steps of 3; it is thus being assigned values 1, 4, and 7. In the second case, N will be stepped down from 11 to 1 in steps of 5; it is being assigned values 11, 6 and 1. Program 5 and Program 6 illustrate stepping up and stepping down operations respectively. In Program 5 the values of P are stepped up from 1 to 34 in steps of 8 and accordingly the values assigned to P become 1, 9, 17, 25 and 33. These values get printed as per line 20. In Program 6, the variable A is stepped down from 5 to 1 in steps of -2 and accordingly the values assigned to A become 5, 3 and 1. As line 20 is a Print statement, the words BLAST OFF get printed thrice.

A simple computation illustrating the use of FOR—NEXT statement is shown in Program 7. The exercise is to find all numbers between 1 to 100, the sum of whose squares is equal to 1700. For solving this, one needs to set two variables A and B, vary both from 1 to 100, and do a repeated operation of $A^2 + B^2$ for all the values of A and B. Call $A^2 + P^2 =$ C and print those values of A and B when C = 1700. Statements in lines 10-60 show how the steps are written. There is a small catch in this Program. As A and B are not distinguished by the computer, each set of

(Continued on page 61)

INPUT	OUTPUT
5 REM STEPPING UP	
10 FOR P=1 TO 34 STEP 8	
20 PRINT P;	1 9 17 25 33
30 NEXT P	
40 END	

PROGRAM 5. Stepping up

INPUT	OUTPUT
5 REM STEPPING DOWN	
10 FOR A=5 TO 1 STEP -2	
20 PRINT "BLAST OFF"	BLAST OFF
30 NEXT A	BLAST OFF
40 END	BLAST OFF

PROGRAM 6. Stepping down

INPUT	OUTPUT	
5 REM EXCERCISE		
10 FOR A=1 TO 100		
20 FOR B=1 TO 100	10	40
30 C=A^2 + B^2	16	38
40 IF C=1700 THEN PRINT A, B	26	32
50 NEXT B	32	26
60 NEXT A	38	16
70 END	40	10

PROGRAM 7. Finding sets of two numbers between 1 and 100, the sum of whose squares = 1700

INPUT	OUTPUT
5 REM FOR—NEXT	
10 FOR X=1 TO 3	NESTED LOOPS
20 FOR Y=1 TO 2	NESTED LOOPS
30 PRINT "NESTED LOOPS"	NESTED LOOPS
40 NEXT Y	NESTED LOOPS
50 NEXT X	NESTED LOOPS
60 END	NESTED LOOPS

PROGRAM 3. Two step FOR—NEXT

INPUT	OUTPUT
5 REM FOR—NEXT	
10 FOR X=1 TO 3	
20 FOR Y=1 TO 3	
30 PRINT "NESTED LOOPS"	
40 NEXT X	
50 NEXT Y	NEXT WITHOUT FOR IN 50

PROGRAM 4. Wrong use of FOR—NEXT

Hasan Jawaid Khan

Bringing Tears To Eyes!

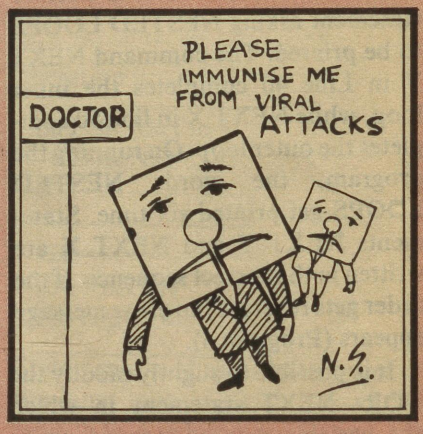
MICROSURGEONS at St Vincent's Hospital in Melbourne, Australia, have successfully brought tears in o the eyes of a 16-year-old boy orn without tear ducts. The condition known as "dry eyes" can be caused by birth defects, infections, burns or diseases such as trachoma. Eyes, if not constantly bathed in tears, develop ulceration, infection and ultimately blindness. The breakthrough by the microsurgeons could help prevent blindness in millions of people all over the world.

The boy was born without lower eyelids and tear glands. Skin grafts were used to build lower eyelids but the regular installation of artificial tears failed to prevent redness, irritation of the eyes and corneal scarring. Previous efforts to divert the secretions of the salivary glands to the eyes resulted in excessive watering, particularly at meal times, because of the transplanted glands' nervous reaction to the sight and smell of food. The problem was overcome by transplanting the salivary gland under the lower jaw with its arteries and veins but without its nerves.

Satellite System For All

THE first satellite image processing microsystem for non-specialists developed in France makes satellite images available to people from all walks of life. Multiscope, the new simple and inexpensive software, produced at the initiative of the French National Centre for Space Research, opens up the possibililty of analysing satellite images to geologists, foresters, cartographers or urbanites, a privilege that was so far reserved for large scientific organizations. The system is very cost-efficient as it reduces the investment cost by more than ten.

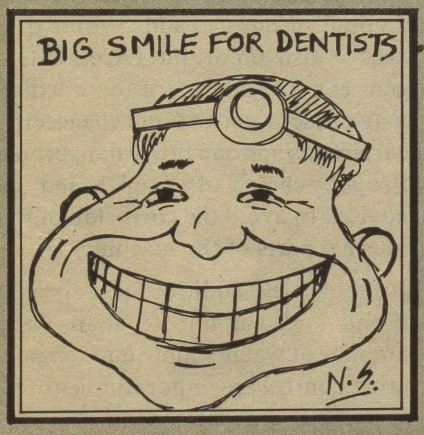
The possibilities offered by computer-aided remote sensing are vast. An agronomist can survey the wheat-fields and supervise the growth of cultivation; a geologist can detect metal and mineral deposits; an hydrologist can check water reserves; an entrepreneur can study the future layout of a highway while concerned authorities can assess the consequences of a natural disaster. The system, which was originally created for processing SPOT images, can be adapted for other satellites also.



Compuvirus Strikes Bangalore

THE computer virus is at it again. 'Marijuana', a lethal 'virus' that corrupts even the hard disc of the computer, has spread its tentacles to computer schools, hardware vendors, construction companies and software export firms in Bangalore. The virus was first spotted in a leading software development house in Bangalore. A computer virus is an abnormal program which when fed into a computer corrupts the information stored inside and eventually can take control of the computer.

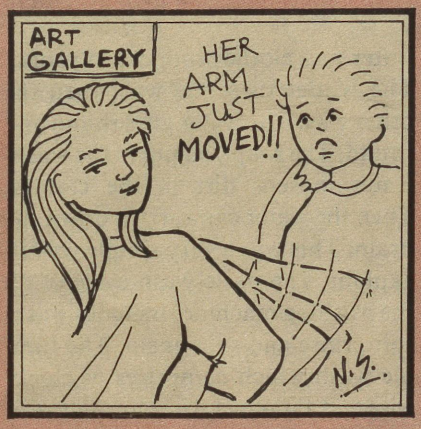
'Marijuana' affects even the hard disk unlike C-Brain, a virus strain that struck computers in January 1988. It corrups the file allocation table, besides the network file servers and workstations. Meanwhile a software firm in Bangalore has developed a vaccine which checks, cur and even immunises floppies from further viral attacks. It can also cure hard disc, but cannot immunise them yet. Till then, computer users Beware of pirated software!



New Safe Dental Filling

WHILE the dentist is filling up a patient's decayed tooth he himself might be exposed to a health risk. During the preparation of amalgam, a silver-grey alloy commonly used to fill a decayed tooth, minute traces of mercury are released which, when inhaled over many years, could cause neurological disorders, insomnia and irritability. Now scientists of the Department of Operative Dentistry at the University of Sidney, Australia, have found that the use of glass-ionomer cement and composite resin to fill teeth could significantly reduce the health risk to dentists.

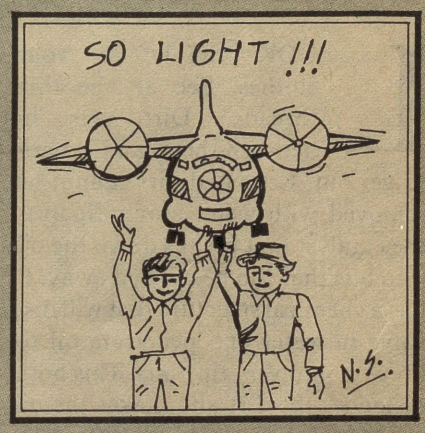
The substance can replace amalgam in small cavities where extensive restorative work is not necessary. The filling materials bear a much closer resemblance to the colour of tooth, unlike amalgam which turns dull grey as the filling ages. By placing the ionomer cement, a compound of complex glass and polyacrylic acid, in the deep layers and the composite resin on the surface, a filling can be produced that leaks less, wears less and is much stronger.



"Live" Sculptures

THE French artist Jean-Marc Philippe plans to add a new dimension to the art of sculpture—rendering life to inanimate sculptures. His first work is the "Circle of Life"—a circular structure of 5 m diameter in summer, which in winter is gradually transformed into a double ring. Another ambitious project is the "Tree of new Alliance". This stylistic metallic tree will be 10 to 15 m high, having a spread of 8 to 9 m. It will change shape with seasons and temperature variations without any mechanical or electrical intervention. Its bronze static trunk supports a big branch made of nickel-titanium alloy; the branch is fully drooping towards the ground at minus 5°C and gradually straightens upwards with thermal heating. The high position is reached at 35°C. Its stamens also react between 20°C and 65°C.

Jean-Marc Philippe is making use of materials, called "Shape Memory Alloys", in his culptures. These alloys remember shapes and restore the same when the temperature is varied. In other words, these materials are capable of deforming and regaining their initial shapes through simple heating. During a special crystalline phase of the alloy, it can be deformed mechanically. The deformation persists as long as a certain threshold temperature is not crossed. On heating beyond this critical temperature, the alloy will regain its original shape. And again at low temperature, the metal regains its deformed state.



Plastic Plane

A German designer has developed a powerful plastic passenger plane that can carry three passengers besides the pilot. Horst Ruschmeyer, an aircraft engineer, built the Ruschmeyer MF-85 using revolutionary new materials and propulsion methods. The new composite plastic material, vinylester resin, is also used instead of metal for the aerodynamically designed wings and fuselage of the plane. The engine produces sound no more than 65 decibels and is also economical in terms of fuel consumption. The range of the MF-85 is 1,500km and its top cruising speed of more than 320 km/h is also outstanding.

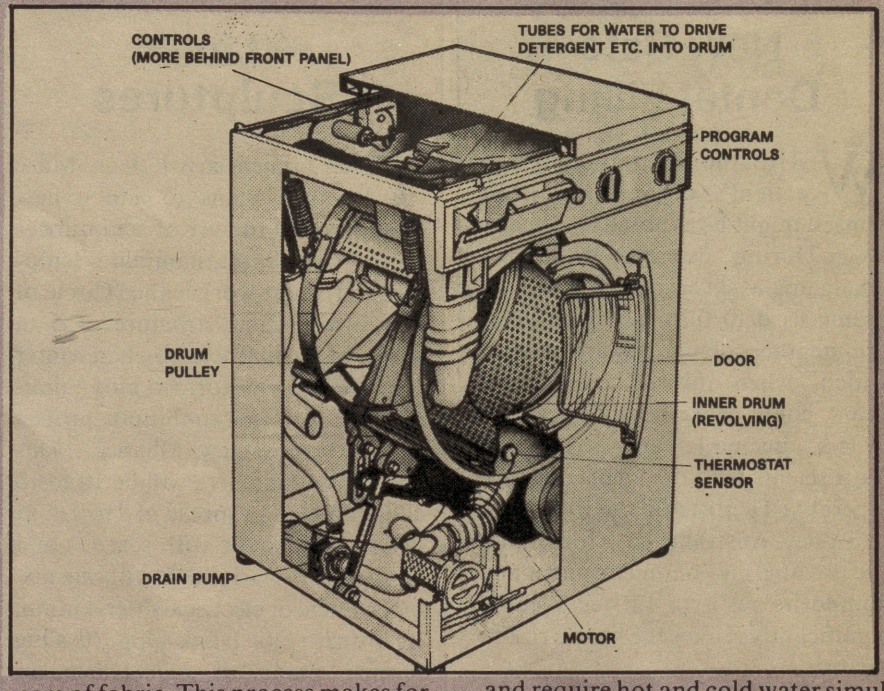
Washing Machines

Parul R. Sheth

LOOK closely at your clothes. See all the tiny threads? Dirt gets in between them and is hard to get out. Oil-based dirt cannot be removed with water alone. Soap is the catalyst that breaks down the oil into bits that can be washed away. It has a chemical structure that will dissolve in water and penetrate oil to break it into very tiny bits. This both dislodges the dirt and makes the oil capable of mixing into the water so it can be flushed away. As everyone is aware, clothing has the added problem of dirt being ground into the weave of the fabric. Thus, washing clothes has from time immemorial taken a lot of hard labour. The dirt must be loosened by striking, rubbing or twisting the fabric so that water can work its way in. The usual way of washing clothes generally consists of treading, flailing and scrubbing. The first step is treading in which water is poured on the clothes and the dirt is loosened by stamping or hitting with a wooden bar, 'dhoka'. In villages where women wash clothes at the river or well, clothes are slapped over a rock to loosen the dirt in them. Scrubbing includes rubbing of clothes on a wash-board to loosen the dirt in a tub of hot, soapy water.

All these are time and energy consuming steps. In cities, the life is so busy that one does not have the time to spare for such things. How much can one depend on maids or extra help? Washing machine is the answer for this problem. For working women and the homemaker, the washing machine is indeed a blessing.

A washing machine can do all that water and clothes round and round. The blades turn one way, then the other way. The water goes round and round. The soap you put in the wash-water loosens dirt in the clothes. Then the water can carry it down the drain. This was a very simple way to explain. The basic wash cycle of all the washing machines includes wash, spin, rinse and spin again. The tumble wash which comprises of clockwise and anti-clockwise churning process is good for removing dirt and the care of fabric. This process makes for better soaking of the fabric in soap solution. The tumble wash, however, is not available in all types of machines. There are machines with unidirectional spinning devices.



SPECIFIC soap powder and detergents are used and the duration of each wash generally depends on the types of fabrics to be washed and machine provides. Wrong brand of soap powders or detergents can damage the washing machine. The amount of powder added prior to a wash is also important. Excess detergent can produce extra foam which may cause water to enter the electrical circuits and can prove dangerous. Proper choice of soap brand is advised to avoid the corrosion of the internal parts of the machine.

Besides the addition of a specific brand and amount of soap, the amount of water supply and temperature control are important features. There are washing machines which do not have internal heating system and require hot and cold water simultaneously. There are others in which you can directly connect the inlet to the cold water supply from the tap and the water acquires the required temperature in the washer. An internal electrical water heater is a must for us as many of us may not have hot water taps. Another thing is the amount of water used up in the machine. We have problems of water

kept in the mind while purchasing a washing machine.

ONCE the washing machine is loaded with clothes and mixed with detergent and water, it takes about 20 minutes to half an hour for each wash. The number of clothes which can be washed each time generally depends on the capacity and size of the washing machine. The maximum weight of washing also varies according to the size of the garments washed and the type of fabric which is being washed. The smallest machine can possibly wash about 10 medium-sized garments while the larger one can wash more.

A variety of washing machines are commercially available. These include manual, semi-automatic, fully-automatic with single-tub, twin-tub, front-loading, top-loading, with or without attached drier, separate drying machine, etc.

The twin-tub or single-tub washing machines are the simplest and inexpensive of all. Each step of washing has to be manually controlled. These washers are available in top-loading version. Ones the clothes have been washed in one tub, they have to be manually shifted to the other for tumble drying. You have to be present at the site to switch off the machine too, after a specific time interval. The semi-automatic ones have certain switch-on and switch-off buttons to be operated manually after the washing is complete. The manual and semi-automatic machines require much less water and the water and detergent requirement can be manipulated. On the other hand, the automatic washing machines are fully computer controlled and one has little or nothing to do once the clothes are loaded in. However, these machines require a continuous supply of water.

The newer washing machines offer a variety of programmes which include bleaching, starching, pre-wash, half-load, etc. The latter is useful when you have few clothes to wash. Pre-washing is very good for extremely dirty clothes. The clothes can be prewashed to remove the dirt. This is followed by a regular wash-cycle. You can select any of these programmes and operate.

ONCE the wash is over, comes the process of drying. The washing machine accompanied with a drier generally has a spin drier. The spin speeds vary with the type of machine. Thick fabrics like that of bed-sheets or trousers or towels require a longer time to dry while synthetic fabric require a short spin. In automatic washing machines, there are electronic sensors which sense the dryness of the clothes and automatically stop the machine. The drawback however lies in the inability of washing machines with attached driers to remove complete dampness from the washed clothes. For this purpose, separate driers are a better bargain.

With so many different types of Indian as well as imported washing machines in the market it is a confusing and a difficult choice for a housewife. Each one of the machines has a few advantages and a few disadvantages to its credit. Nevertheless the fact remains that a washing machine should suit your needs. If you have water problem go in for semi-automatic machines. A separate tumble-drier is ideal for obtaining absolutely dry clothes. The top-loading machine is comfortable to handle than the front-loading one but the advantage of the latter is that you can use the platform space.

Think twice before you install the machine at a place. The floor should be firm and even and should be able to bear the weight of the machine. The washing machine should be kept closer to the water supply after checking the earthing and the necessary electrical connections to avoid an electrical shock. Check the frequency of power supply in imported machines. You can also buy additional filters that remove the water sediments.

Imported machines are expensive and difficult to repair in case something goes wrong. But, these have the latest technologies, computer systems and programmes incorporated within them. Some Indian makes, too, claim to possess a computer designed impeller which ensures even washing of clothes with minimum use of electricity (1 units for 3 hours), water and detergent. The recent makes have the latest technique of 'Pulsater' type of washing specially designed for climatic conditions like India. This system is said to ensure proper fabric care of diverse material — from silks to blankets.

Washing machines are costly and the price may go up according to the size, the number of programmes and the degree of automation. And with the price you pay for a machine you have to take care of it. Keep certain points in mind like putting clothes of one kind in the washer at a time. Do not mix clothes of different fabrics or dark and light colours together. Washing of knitted material is also sometimes risky. Do not keep the drier running for long as it will unnecessarily crease the fabric. Cleaning the machine properly prevents corrosion. After use, leave the machine open for a while to ventilate the insides of the machine. Careful and proper use of a washing machine will wash, rinse and dry your entire family's clothes with no mess, no fuss. Provided you have the money and space, a washing machine can be a real time-saver, especially for busy people.

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(*Continued from p 22*)

to wade through very dense mass in the form of thickly populating stars and huge nebulae. The nebulae, called 'dark nebulae' or 'molecular clouds' depending on the composition, are incomparably thicker and bigger near the galactic plane than in other parts. It would be very natural, therefore, that during such passages of the sun, our earth (which of course is all the time dragged by the sun in whatever it does) would have profoundly different effects on it. In fact, it would be unnatural not to have any effect. It can't be just business as usual.

THE Nemesis theory tries to tie up three observed periodicities of Nature (which are more or less equal, with some allowances given for human error) with a fourth one, but the fourth one is just assumed — ad hoc. As for the other theory, the fourth periodicity (of about the same magnitude) comes naturally — from observations. And there are other demerits also of the Nemesis theory, e.g., the improbable length of time it demands for Nemesis to complete its periodic orbital motion.

But whatever merit or demerit, it should be kept in mind that in both cases — whether with Nemesis waltzing round the sun, or with just the sun dancing alone through giant molecular clouds — the details of the steps have not been worked out still. Extinctions and craters perhaps would not be very difficult; reversal of magnetic poles, on the other hand, would take some explaining. But, then, why the earth has magnetism at all has not been properly explained so far. Some scientists are attacking one aspect of a problem while another aspect—a much older one—still remains unsolved. That is not uncommon in science. The solutions may come along together.

Dr. Sarkar is Curator, Birla Planetarium, Calcutta

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- The form and manner of presentation of the subject should be easily understandable to the undergraduate level.
- The length of the article written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.
- 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.
- While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. **All weights and measures should be given in Metric Units.**
- A short note about the contributor should also accompany the article. The note should contain age, academic accomplishments, important assignments held, field of research and hobbies.
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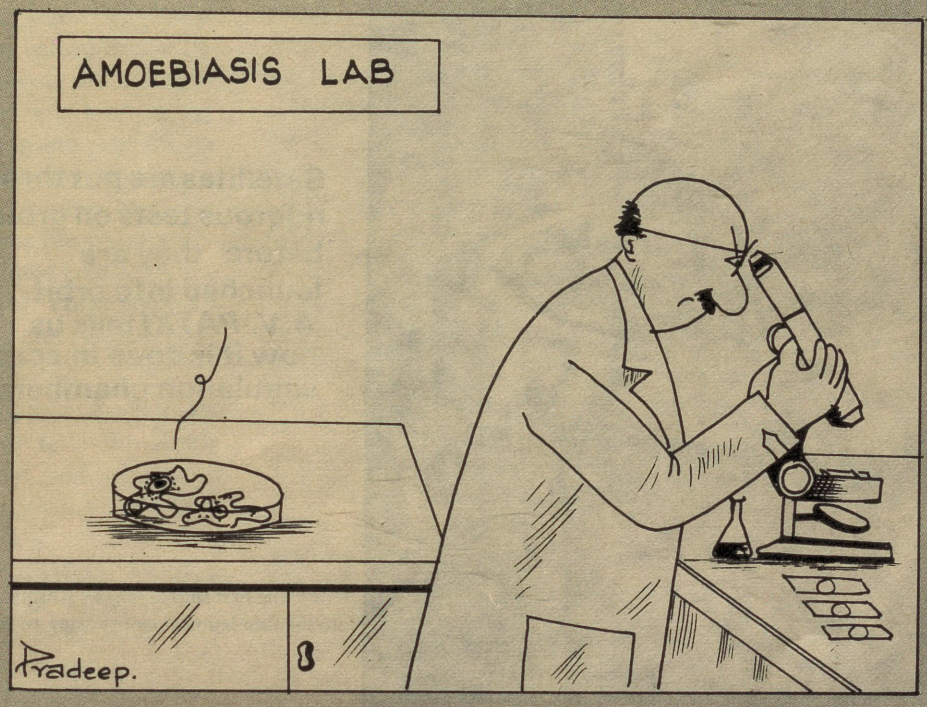
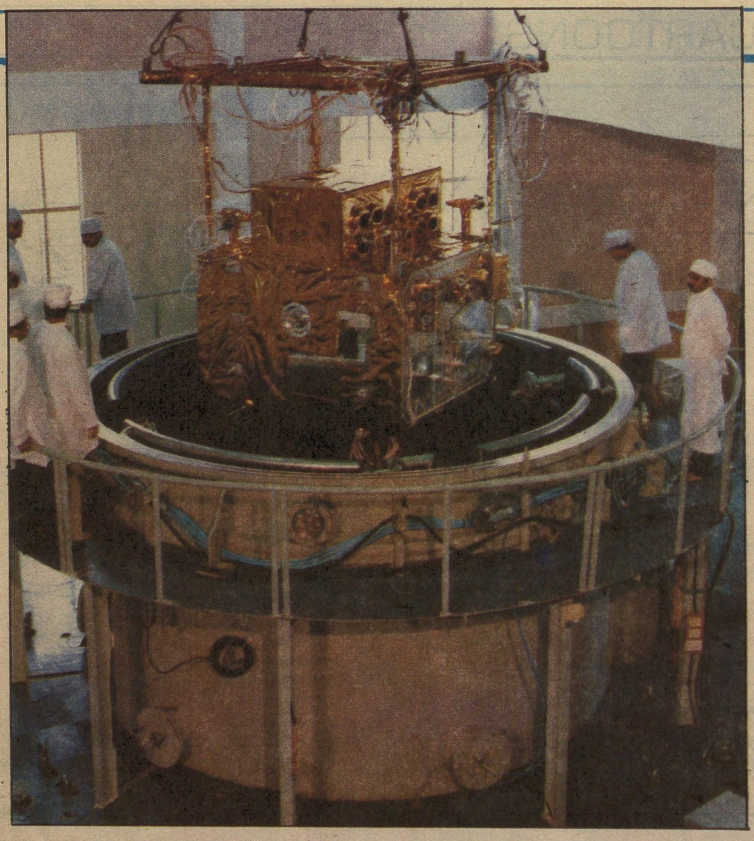


"Yes ! it is true. He has got a big grant, two Research Associates, four Sr. Research Fellows, six Junior Research Fellows and do you know for what ?. Just to find out how we eat R.B.C."

"Take your luggage and be ready Sir. We are reaching Road Research Institute now."



Satellites are put through rigorous tests on ground before they are launched into orbit. *A.V. PATKI* tells us how it is done in space simulation chambers

'IRS': The first Indian remote sensing satellite being lowered into the simulation chamber prior to launch in March 1988

SPACE CHAMBERS– Simulating Space On Ground

THE spread of TV broadcasting through INSAT over past few years has made space technology an essential part of Indian life. Each INSAT spacecraft operates from the geostationary orbit, about 36,000 km from earth. It receives transmitted signals of the order of a picowatt (picowatt = 10^{-12} watt), amplifies the same using its onboard power and re-transmits them back, on a different frequency, though its antennas pointing with an accuracy of the order of 0.1° to a specific point on earth. The spacecraft is kept in position with similar accuracies by its propulsion unit which automatically corrects any drift. The spacecraft is supposed to be operational for seven years continuously. All this means that the onboard systems must be very reliable, and thoroughly tested. In fact this reliability is the hallmark of space technology. In practice this high reliability is achieved by following a series of well established procedures. One of them is to subject the systems to an environment which they are likely to encounter in actual operation. Space chamber is one such special purpose equipment which simulates part of the space conditions on ground for testing purposes.

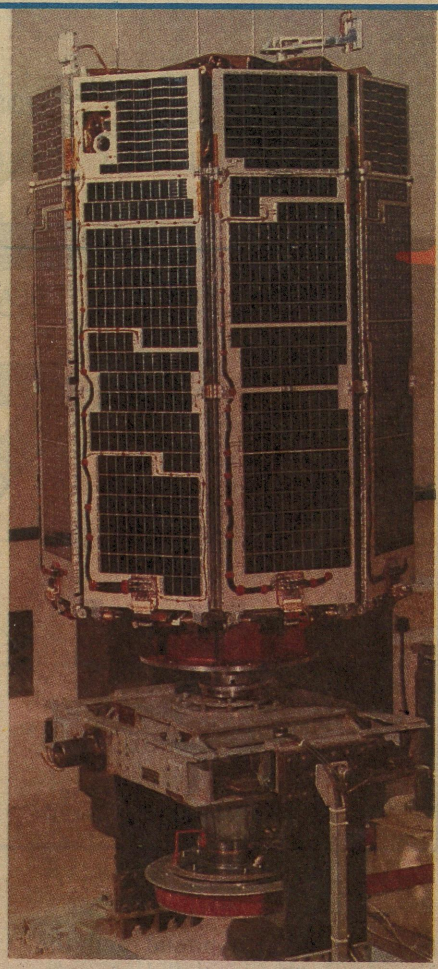
ANY spacecraft consists of several systems, made of different subsystems and modules, normally complex in nature, doing very specific and precise jobs. However, the basic building blocks are the same as in any other engineering system—the components. In an electronic system it means resistors, coils, capacitors, ICs, cables, connectors. In a mechanical system, it means beams, shafts, fasteners, springs, links, bearings and so on. In chemical and material terms, it means metals, alloys, chemicals, adhesives, paints, coatings and so on. The choice of these elements for a particular application demands certain properties which in turn give the system its desired performance at system level. In order to guarantee the spacecraft function within the specifications, it is essential to know the effects of different environments

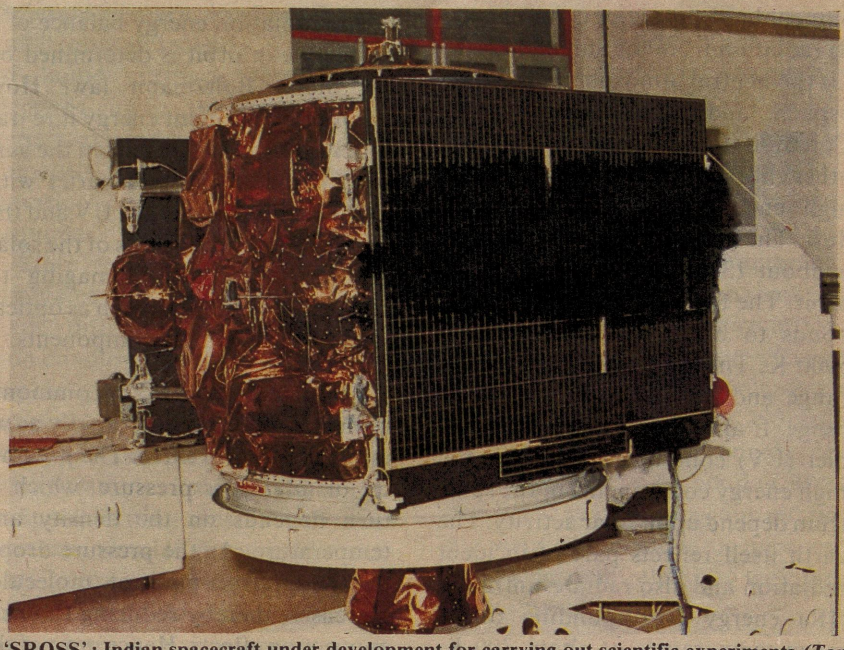
on system performance. As a first step, the component performance is evaluated and strict screening procedures are followed before accepting them. However, this is not enough. Since the systems are built using complex networking and assemblage of these components, the estimation of variation in performance becomes very difficult. Hence the systems are tested under simulated conditions to see the performance. These tests are termed as the thermo-vaccum performance tests.

There is yet another, even more important, type of test. We know that the component performance is greatly dependent on the operating temperature. Most of these components work efficiently only within a very narrow range of temperatures. Beyond this range there is often a degradation in performance and at times total loss of function of the systems. Typically, deployment of an antenna may not take place if the operating temperature drops below -20°exceeds 65°C. A transmitter may stop working if it gets heated above 70°C. A control fuel line (a small pipe) may get blocked if the liquid fuel is allowed to freeze. An earth-pointing antenna will lose its pointing accuracy if the mounting surfaces are unevenly heated. An adhesive joint may lose all its strength beyond a certain temperature. The optical alignment of a sensor and camera may get upset when even a small temperature gradient of 2°C is encountered.

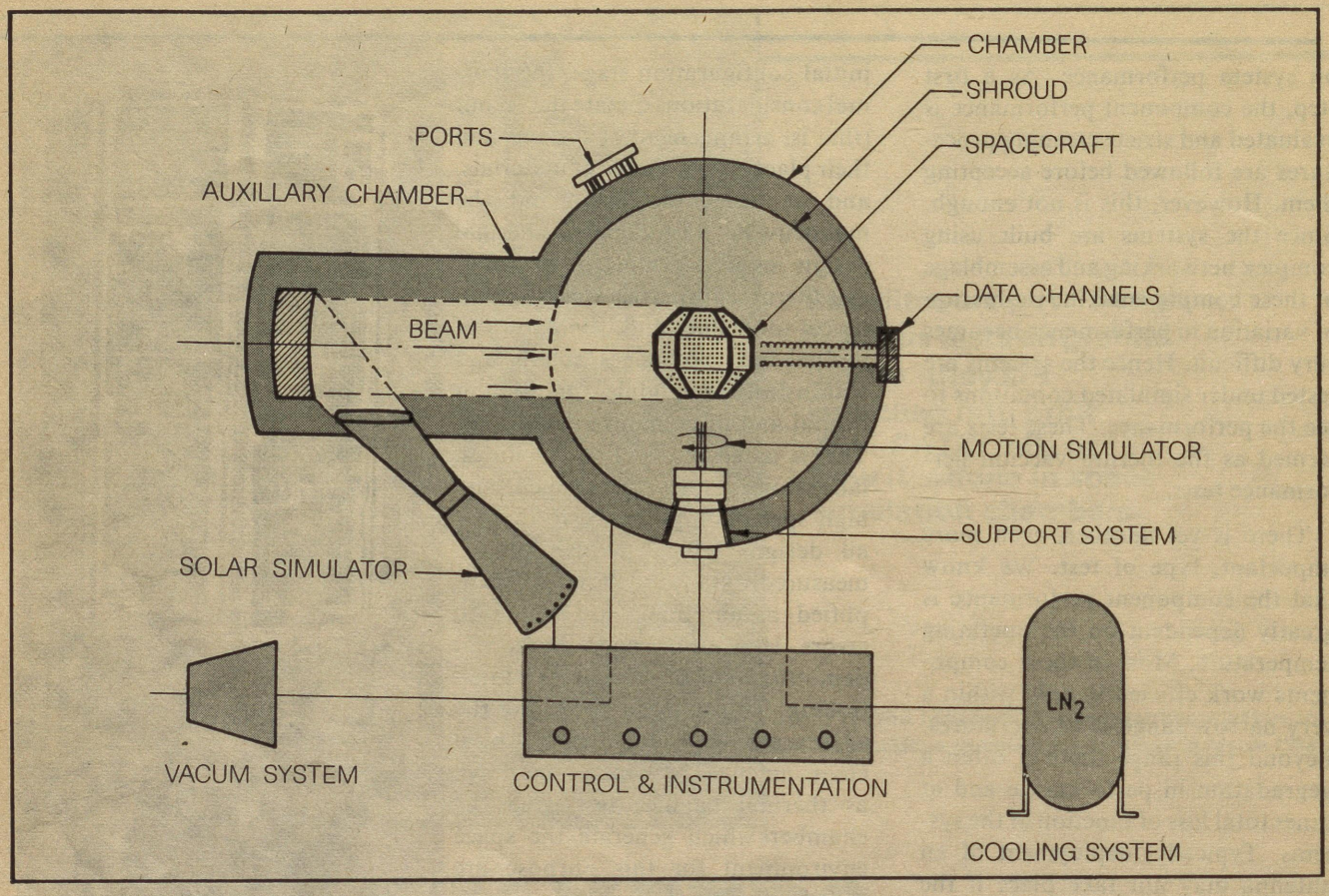
Hence all spacecrafts have to be equipped with special mechanism to control the operating temepratures within a specific range. These thermal control systems use different elements to achieve the goal. They include special insulators, radiators, conductors, selective absorbers and radiators, special-purpose paints, coatings and blankets. Right from initial configuration stage, the thermal considerations dictate the layout (that is, arrangement of systems and their placement), choice of materials, and at times the orbit and the manoeuvers. The detailed thermal design involves evaluation of elaborate thermal properties, detailed analytical modelling and calculation of mutual heat exchanges among and within different modules for different orbital and illumination conditions. This is aided by requisite facilities, laboratories, special equipment and high speed computer. Nevertheless, all designs which involve certain measured data, modelling and simplified assumptions, are prone to errors. Hence they need a practical demonstration of satisfactory functioning. This is done by testing the spacecraft in a simulated orbital environment. These tests are known as thermal balance tests and the chambers which generate the space environment for this purpose are called space chambers.

THE space environment can be broadly divided into two





'SROSS' : Indian spacecraft under development for carrying out scientific experiments *(Top)*
'APPLE' : India's first experimental geostationary satellite launched in 1981 *(Bottom)*



Schematic diagram of space simulation chamber

regions—the earth-bound and the outer space. The earth-bound environment has four major components: (i) radiation from the sun and earth; (ii) the neutral atmosphere; (iii) ionosphere; and (iv) geomagnetic field. Common to both the regions are other entities such as space radiation, high energy particles and cosmic dust. The intensity of sun's radiation is about 1350 watts/sq.m at earth's orbit. The frequency content corresponds to black body radiation of 5900 K. The peak lies in the visible range and bulk of energy is in IR range. It also has significant ultraviolet (UV) component. Further, the high energy components in the spectrum depend upon solar activity. The earth itself reflects part of incident radiation and also radiates infra red (IR) energy corresponding to its mean temperature of about 300 K. Space itself acts like a heat sink, normally referred to as cold space, corresponding to about 3K.

The radiation energy balance of a spacecraft in orbit is determined by the Stefan-Boltzmann law. How much of the incident energy it re-radiates into space depends on the surface characteristics and varies with spectrum frequency. The UV and the high-energy components of the solar spectrum are quite damaging to many exposed surface such as optical coatings and organic components.

The atmosphere, commonly known as air, vanishes rapidly as we move away from earth. The parameter of interest is pressure, which in turn depends on the density and temperature. As the pressure drops, the mean free path of molecules increases, thereby reducing the heat convection effects. Hence most of the heat transfer in an evacuated space is through radiation and conduction. The reduced pressure also causes loss of surface layers of materials having low vapour pressure. This changes the surface finish leading to degradation of optical and thermal properties.

THE different aspects of space environment are simulated on ground on single or combined parameter basis. For the thermal tests the main parameters of interest are vacuum, solar radiation and black space.

The vacuum is simulated to bring down the effect of atmospheric heat transfer. Most spacecraft operate beyond 300 km and upto 36,000 km with a vaccum level of 10^{-6} torr to 10^{-13} torr. However, it is extremely difficult to create these levels on ground on a large scale. Fortunately the heat transfer coefficient due to this effect

becomes extremely small and negligible beyond 10^{-5} torr or so. Hence it is sufficient to simulate this order of vacuum in a test chamber.

The 'black space' effect is simulated by cooling the chamber walls to very low temperature. The walls are designed to absorb all radiation from the spacecraft but not to emit much energy on to the spacecraft being tested. This is done using cryo-cooled shroud or jacket typically maintained around 100K. Under these conditions, the heat exchange between the test spacecraft (at around 300K) and the cooled shroud differs only slightly from the actual condition. This is accepted because further improvement would be too expensive and requires complex engineering operations.

The third important parameter is the solar simulation. This is normally done by xenon arc lamps. They radiate a spectrum similar to solar radiation. Elaborate optical arrangement is needed to generate a collimated beam of a desired diameter. Whereas the total intensity can be achieved with desired accuracy, the spectral variation and large collimation are accepted as engineering limitations. The beam diameter needs to be large enough to illuminate the full test specimen as in actual orbit.

THE space chamber is a kind of pressure vessel which has to sustain high internal evacuation. In order to reduce the pumping load, the joints and sealing have to be very good and the degassing from the wall must be minimum. Hence stainless steel is machined and welded form is used. The overall dimensions are decided by the size of the test object, fixtures, movement and the clearance requirements. With all the provisions for loading, instrumentation, evacuation, circulation and monitoring, the shell geometry and design becomes a highly skilled engineering exercise.

The high vacuum in the space simulator is produced in stages and needs elaborate design and equipment. A roughing system using root blowers can reduce the chamber pressure from ambient (1000m bar) to about 10^{-2} m bar. To reduce the vacuum level further to the range of 10^{-5} m bar range one needs turbomolecular pumps and cryopumps.

Simulation of sunlight is by far the most complex and expensive requirement of a space chamber. Xenon lamps are used as light source. A beam is produced with the help of mirrors and is directed at the test piece. In order to control the spectral and spatial variation of the beam and to achieve stable intensity over time, very good optics, cooling, control and power system is needed. Automatic calibration and corrective feedback is necessary. All these being highly expensive many chambers are built without solar simulation facility and the heat input is simulated by using IR lamps or surface heaters on the spacecraft body.

The shroud is a metallic shield inside the chamber which is cooled by liquid nitrogen circulated through small tubes all around it. The amount of liquid nitrogen flow needed depends upon the internal heat generation and leakage. The operating costs are dictated often by the duration of test and coolant required.

Since the beam direction of the simulated sunlight in the chamber is fixed, different orbit and illumination conditions are created by rotating the spacecraft through a motion simulator. Special fixtures are used to support the spacecraft in different configurations. Special system such as space viewing sensors need more accurate simulation of cold space. This is done using a special cryopanel (covering the field of view of this sensor) which is maintained at much lower temperature of the order of 20K using liquid helium circulation system.

All the systems described above need precise control as tests run round-the-clock and for weeks together. Besides, the test specimens, in the form of live spacecraft, are very costly and delicate. Hence real time computer control with adequate redundancy is essential. Further the spacecraft during test is in working mode and needs active communication. The test data in the form of temperature and health/performance monitoring signals are of enormous magnitude and need special data reduction techniques/facility.

THE ISRO Satellite Centre at Bangalore has been in the spacecraft field since 1972 and has handled about ten spacecraft since then, starting with Aryabhata. Many chambers are available at ISRO, ranging from 0.5m diameter to 4m diameter at different units, without solar simulation. A 1.2m diameter space chamber with solar simulation is operational at ISAC. It generates vacuum of 10^{-5} torr and can be cooled to about 80K. Recently a major project has been undertaken to establish a large chamber of 9m dia with a solar simulation facility. Europe has a space chamber with 7m dia and a solar beam of 3.5m. Another one is under construction with almost double this size. Japan has a similar setup operational for last fifteen years. The Jet Propulsion Laboratory in USA has probably the biggest chamber with 30m height and 6m solar beam. This would easily costs Rs. 200 crores or more today with running cost exceeding Rs. 5 lakh per day. However high the costs may appear, they are justified in view of the increased confidence and reliability they offer to space missions.

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National Chemical Laboratory

P.S. Shankar

Earning the chemical industry's sobriquet "the catalyst's catalyst", NCL has played a key role in this industry's, and so the nation's, progress. Underpinning its technological successes is a traditionally strong fundamental research base

"THE catalyst's catalyst" is how a public sector leading chemical company, Hindustan Organic Chemicals Ltd., described the National Chemical Laboratory (NCL) in Pune in 1975. This was the year when this national laboratory of the Council of Scientific & Industrial Research was celebrating its silver jubilee. Even allowing for the advertising copywriter's hype, this catchphrase has become in recent years something of a truism. Itself specialising, and often excelling, in frontline research in catalysis, NCL has verily catalysed India's chemical industry.

For a developing country like India, the path to industrial progress rests squarely on chemical industry. In the late 40s and early 50s the Indian chemical industry was in its infancy, depending, as it did, upon not only foreign technology but even capital. Today chemical industry is the third or fourth largest manufacturing industry in the country, with an estimated 40 per cent share in the national gross industrial output. And who can deny that NCL has not played a pivotal role in this industry's, and so the nation's, progress?

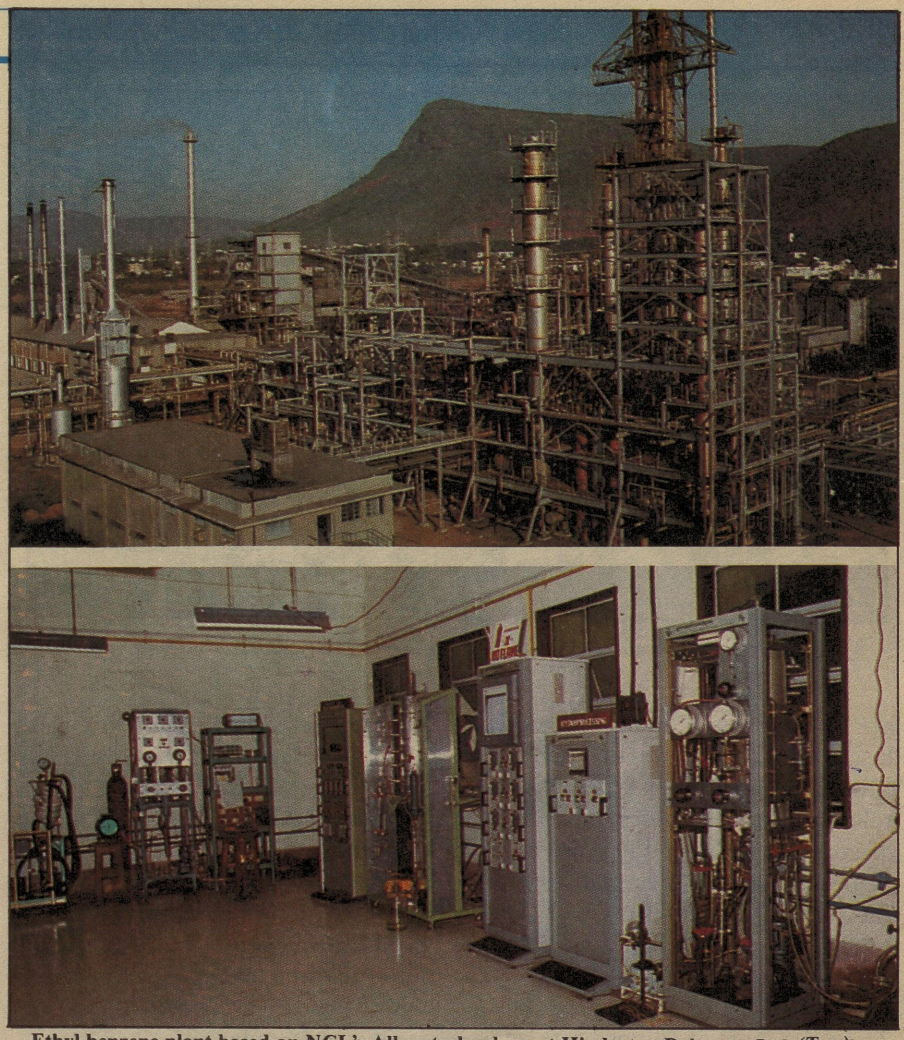
Like its sibilant, the National Physical Laboratory in New Delhi, NCL (inaugurated on 3 January 1950) has a broader objective than the other labs under CSIR. The founding fathers spelt out that NCL ought "to advance knowledge and to apply chemical science for the good of the people"—simplistic in statement but formidable in accomplish-

The National Chemical Laboratory

ment. If in the earlier years, men like Prof. J.W. McBain, Prof. G.I. Finch and Prof. K. Venkataraman, who guided NCL, put it on the scientific map of the world, the men who succeeded, in large measure, in putting it on the industrial map of the country and beyond.

IN the first two or three decades of its existence, NCL very nearly succeeded in making McBain's dream a reality. Dreaming indeed he was when he said on the inaugural day of the lab thus: "I desire to see in India a great and profitable chemical industry, with many firms supplying and utilising basic chemicals of all kinds, and in particular, those directly useful in medicine, public health and agriculture." Dotting its first 25 years were processes for a number of bulk organic chemicals (like propylene oxide, aniline, acetanilide, chloromethanes, chlorobenzene, and phthalates); polymers and elastomers (like thermosetting resins, nitrile rubber, and rubber chemicals); drugs and pharmaceuticals and fine chemicals (such as acriflavine, carbimazole, calcium hypophosphite, clofibrate, sorbide nitrate, sorbitol, mannitol, theophylline, and caffeine); and agrochemicals (like Endosulfan, Dalapon, Simazine, Atrazine, and nicotine sulphate). It had also an in-house unit for producing nearly 300 fine chemicals needed in research and teaching.

Two of the success stories of this era, rather of nostalgic interest, are the projects concerned with opium alkaloids and rayon-grade pulp. While the first project eventually led to the establishment of an opium-processing plant at Neemuch, the second led to wider utilisation of Indian woods. NCL's Achilles heel was, however, the multi-step process for vitamin C. But then no scientific enterprise can succeed without failure.

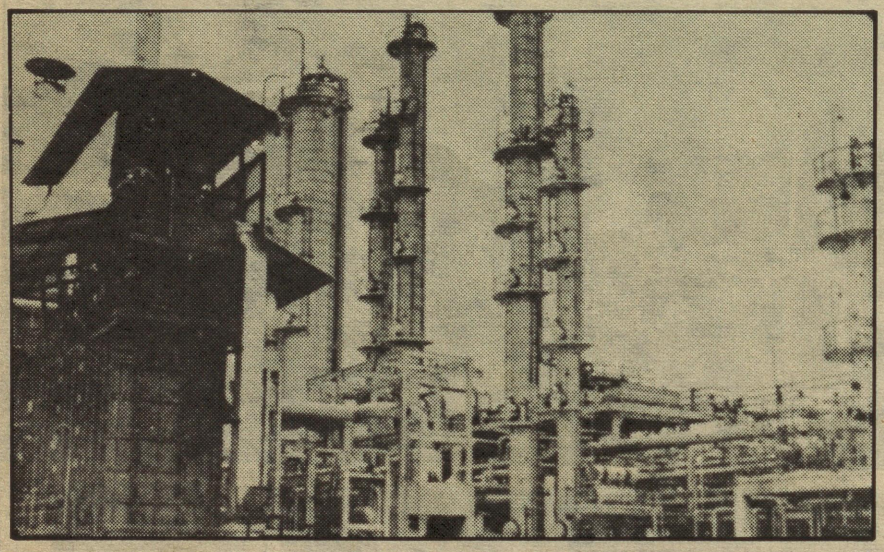


Ethyl benzene plant based on NCL's Alben technology at Hindustan Polymers Ltd *(Top)*' Catalyst Testing Lab *(bottom)*

In the years following its silver jubilee, NCL has gone steps ahead of its catalytic role. It, in fact, has become a very active and potent reagent in the field of chemicals. Its success lies partly in associating the end user right from the time a project is conceived to the time when the technology is delivered to the client. To put it differently, the success in breaking the research-industry barrier is due as much to the innovativeness of research as to the innovative policies of management.

Although NCL is a discipline-oriented research laboratory, its projects deal principally with the problems of food, energy and health and the innovative utilisation of the country's natural resources, and fall broadly into ten research areas. Involved at every stage of research, especially in the transfer of technology, is the division of technical services.

NCL's stronghold in recent years is catalysis and catalysts. Developing novel catalysts for producing bulk chemicals and petrochemicals is the lab's expertise which has won accolades. NCL's success with zeolite catalysts has already become something of a legend. Not long ago, zeolites were the exclusive preserve of giant multinationals like the Mobil Corporation Inc. of the USA. Zeolites are crystalline aluminosilicates which occur in nature but are also synthesised in the lab. These



Xylenes plant at IPCL Vadodra based on NCL's Xylofining technology

are also known as molecular sieves because of their sieve-like activity. More than 40 different types of naturally occurring zeolites have been discovered and over 150 types manmade. NCL has in effect transformed the very name of this class of catalysts. It has given them the now familiar name Encilites, which is actually an acronym for NCL-(zeo) lites. These are non-aluminosilicate zeolites.

NCL has produced a series of Encilites, possess exceptional catalytic activity for a number of industrially important reactions. The uniqueness of Encilites is due to the replacement of AlO_4 tetrahedra by tetrahedra comprising other ions like FeO_4, TiO_4, BO_4 and LaO_4. Encilite-1, developed in collaboration with Associated Cement Companies Ltd. (ACC), is used in the isomerisation of xylenes to a product rich in *ortho*- and *para*-isomers, especially the latter. Petrochemical feedstock containing the three isomers of xylene can be converted into *ortho*- and *para*-isomers, and the other constituent, ethylbenzene, into benzene and ethylene. p-Xylene is the starting material for dimethyl terephthalate and pure terephthalic acid, which are used for producing polyester fibres. *Ortho*-Xylene is used for producing phthalic anhydride, an important intermediate for PVC and plasticisers. The Indian Petrochemicals Corporation Ltd (IPCL) is using Encilite-1 and the technology associated with it (known as xylorefining) in its reactor at Baroda.

Encilite-2 has been used for producing ethylbenzene from ethyl alcohol and benzene. This catalyst and the process are superior to the zeolite catalyst (known as ZSM-5) used the world over and to the process in which ethylene and benzene are used. Use of ethyl alcohol instead of ethylene is claimed to be the first attempt to produce ethylbenzene. The NCL process has also the advantage that with a little modification it can be used with ethylene feedstock as well. Developed in collaboration with Hindustan Polymers, Visakhapatnam, the NCL technology has been successfully tested in the collaborator's plant. Ehtylbenzene is a key intermediate for styrene, which in turn is required in the manufacture of plastics and synthetic fibres.

NCL's Encilite-3 finds use in converting methanol and syngas (mostly methane) to C_2, C_3 and C_4 olefines. Encilite-4 dewaxes petroleum oils. This process, known as Endewaxing, reduces the pour point of oils from 40°C to 6°C, so the oils can be handled with ease even in mid-winter. It is superior to the conventional solvent extraction process. The Madras Refineries Ltd will be carrying out commercial trials on a modified version of Encilite-4 for use with heavier fractions like 'heavy neutral' and 'bright stock'.

In non-zeolite catalysts also, NCL has had a breakthrough. Just two examples should suffice to prove NCL's success. A platinum-alumina reforming catalyst was developed in a record time of just three years. Compare this with 15 years or so it took other centres to develop. A monometallic version of this catalyst has also been developed in collaboration with IPCL and tested successfully at the company. A bimetallic version, a product of joint venture with IPCL and the Indian Institute of Petroleum, is expected to be commercialised at Madras Refineries Ltd shortly.

For dehydrogenation of ethylbenzene to styrene, a promoted iron oxide-based catalyst has been developed. Polychem Ltd, a company in Bombay, has bought the catalyst to use it in its commercial reactor. Another non-zeolite catalyst which NCL has developed in association with Engineers India Ltd (EIL) is named Enceilox to denote the collaborating partners and the oxidation process. It is a supported silver catalyst for oxidising ethylene to ethylene oxide, an important organic intermediate. The catalyst is being manufactured by the United Catalysts India Ltd, Bombay, for trials.

Another series of NCL's catalysts is designated as Encicarb. These cata-

lysts bring about catalysis in the homogeneous phase, that is, the reactants, the catalyst and the products are in the same phase, usually the liquid phase. Bringing about carbonylation, the Encicarb series of catalysts are aimed at utilising carbon monoxide and syngas (mixture of CO and H_2). Encicarb-1 is used for carbonylation of methanol to acetic acid/methyl acetate. Its features are the use of non-noble metal and low pressures, which make the process more economical than the Monsanto technology. Encicarb series can also bring about carbonylation of ethanol to propionic acid, and a host of other conversions, all of industrial importance.

A new catalyst, Enciox-1, for oxidising a mixture of C_4 hydrocarbons to methyl ethyl ketone is under pilot plant trials.

POLYMER research, both in science and engineering, has been one of NCL's strongholds right since its inception. One of NCL's pioneer chemists was in fact described by a former director as a monomer who turned a sizeable polymer. Anecdotes aside, NCL is moving fast into developing new engineering plastics which can replace metals in specific applications as well as polymeric alloys by blending polymers—a far cry from the days of nitrile rubber, which itself was an advanced technology of the seventies. One of the more recent developments is the superabsorbent polymer, named Jalshakti, which can absorb 250–500 times its own weight of water. Produced now commercially by the Indian Organic Chemicals Ltd, Bombay, this polymer has major applications in agriculture, horticulture, wasteland development, forestry, and many other fields. When mixed with soil, sand or any synthetic growing medium, Jalshakti increases both its water retention capacity and aeration. It thus helps improve soil quality. It also helps reduce the frequency of irrigation. Extensive trials in agricultural areas, horticultural land and wastelands using Jalshakti as a seed coating for growing oilseeds, pulses, cereals, fodder crops and vegetables have testified to the success of the product in improving yields. Jalshakti holds thus the promise of adding a new dimension to the green revolution. It has potential for export even to the developed countries.

Two more developments in polymer technology are worthy of mention. One of them is the engineering plastic polyphenylene sulphide (PPS). In collaboration with Shri Ram Fibres (SRF), Madras, NCL has developed a process for producing coating-grade PPS. The pilot plant at SRF at Madras has produced the polymer which has proved its utility in coating applications. Another polymer of much use in aiding the smooth flow of oils in pipelines is the formulation known as DROP, short for drag-reducing oil-soluble polymer. One of the formulations has led to 50% drag reduction as compared to 25–30% brought about by the more conventional additives. Developing light-weight durable polymers which can find use in aids for disabled people, as in the Jaipur foot, is among the projects now under way.

Coaxing Bamboo to Flower

SCIENTISTS of the Plant Tissue Culture Group in NCL have devised a brew (a mixture of different chemicals including coconut milk) and used the tissue culture method to spur young bamboo plants of three species to flower prematurely within a few weeks. Normally these plants flower after 12 to 120 years and only after they are 20 to 30 feet tall.

This discovery will have a major impact in bamboo breeding to fashion novel hybrids that will grow faster, resist diseases and yield a stronger and more versatile wood. With further refinements in the technique one could even get a perennial source of seed. Studies of events leading to flowering under controlled conditions will help in solving the mystery behind the unpredictable flowering behaviour.

These are, however, laboratory findings and much more work is required before its commercial application. □

A new trend in the application of pesticides is the controlled release (CR) pesticide formulations to enhance the pesticide efficiency. CR formulations have many advantages over the traditional pesticide formulations. Because they are much less toxic than the latter, the CR formulations are fraught with lesser handling hazards. NCL has developed CR formulations for carbofuran (broad-spectrum pesticide against rice, cotton, sorghum and jowar pests) and abate (a larvicide). These formulations have been designated by NCL as Encecap series.

PLANT tissue culture (PTC) is a field of study which seems to be incongruous in the scheme of things of a chemical lab. Yet it is here that NCL has carved out a niche for itself by developing techniques of micropropagation of a wide range of plants and trees. A tissue culture technique for growing sugarcane free of the mosaic virus, which attacks the CO-740 variety widely grown in Maharashtra, and a procedure by which a single cane can be multiplied to produce several thousand plants as compared to 4-5 plants by conventional methods have found field applications. Micropropagation techniques for elite forest trees like teak and eucalyptus have stood out as the first successful efforts in the country. A recent success has been the technique for propagating an elite cardamom, which takes only two years as compared to 5-10 years by the conventional ones. PTC techniques under various stages of development cover turmeric, pomegranate, salvadora, bamboo, custard apple, cotton, and many others. One of the current projects sponsored at NCL aims at conserving some rare species that are in danger of becoming extinct.

A currently exciting area of work pursued by NCL, in collaboration with Iowa State University, USA, is using a small molecular weight enzyme, zylanase, for converting the hemicellulose component of plant biomass into dissolving-grade pulp—the paper pulp and rayon pulp. This is however a big drawback in this bioconversion process. Xylanase often contains cellulase, which attacks cellulose itself. Isolating a cellulase-free xylanase is the crucial step in this process. NCL has succeeded in identifying a microbial (actinomycete) strain, *Chainia*, which secretes a cellulase-free xylanase in high levels. With a molecular weight of about 6000 daltons it is one of the smallest enzymes known so far. Very active in degrading xylan, the enzyme leaves the cellulose intact, and thus has the potential of becoming the enzyme of choice application in the paper industry. This discovery has been hailed as the first of its kind in the world. There is also a bonus in using xylanase. The byproduct of xylan degradation is xylose, a pentose sugar, which is a potential source of liquid fuels such as ethanol, as also xylitol, a non-calorie sweetener.

FERMENTATION technology to produce alcoholic beverages is no modern science. It, in fact, is an ancient craft which goes back to the heady wine days of the pagan period. Here also innovations can be introduced, innovations which bring about economies in production. What deserves mention in this context is the continuous production of alcohol from molasses using a flocculant strain of yeast. The catalyst is named Encilium after NCL and its collaborator UM (University of Manchester), which isolated the yeast strain. NCL's role here is the establishment of the engineering parameters for continuous operation of the reactor. The Encilium process is ideally suited for our country as ethanol is produced by fermentation route rather than petrochemical-based route starting with ethylene. Having run a pilot plant of 300 litres capacity for over 100 days, the laboratory has entered into contract with Dharmpur Sugar Mills Ltd, UP, for transfer of the process.

DRUGS and drug intermediates have also been NCL's field of interest. One of the recent developments in this area is the process for vitamin B6. Like the conventional process, the NCL route is based on the Diel-Alder reaction but does not use aniline. It gives an yield of 80% as compared to 60% by the conventional route, minimizes the import of raw materials, and is operable at atmospheric pressure. Developed in collaboration with Lupin Laboratories Ltd, Bombay, the process has been commercialised by the company. This is the first private sector plant and perhaps the first working unit for vitamin B6 in the country. Another recent development is a simple and innovative method for producing nitroethane, an intermediate used in the preparation of ranitidine, touted as the most effective anti-ulcer drug developed so far. A new and elegant two-step process for Ibuprofen, an analgesic and anti-inflammatory drug, is another achievement of considerable significance. The conventional method involves 6 steps, though the starting material is the same, namely isobutylbenzene.

NCL is the National Information Centre for Chemistry and Chemical Technology and the NISSAT Access Centre for International Databases.

One inevitable conclusion that one would come to when one goes through NCL's road to the enviable string of technological successes is that it has built up a strong fundamental research base.

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FASCINATING WORLD OF MATHEMATICAL SCIENCES, Vol.I: The Nature of Mathematics, Vol. II: Applications of Mathematics-I, Vol. III: Applications of Mathematics-II, Vol. IV: Mathematics Education-I *by* J.N. Kapur, *Mathematical Sciences Trust Society,* C-766, New Friends Colony, New Delhi-110065, Pp 264, 272, 256 and 256, Rs. 95.00 each.

MATHEMATICS plays an essential role in modern technological society. Man has now the knowledge both to travel into space and to destroy the earth as a habitable planet. This knowledge has to a considerable extent depended upon mathematics. In a sense, mathematics seems to hold the key to the future destiny of mankind. Yet it is paradoxical that mathematics is unpopular! Its mention is guaranteed to put a stop to social conversation except at a gathering of mathematicians. There also seems to be a well-accepted belief that mathematics is both dull and difficult when compared with other areas of study. So, misunderstandings about the importance and relevance of mathematics are very wide-spread even among the members of the educated class. There is, therefore, an urgent need to remove these misunderstandings and help eradicate what is called 'math-phobia'. Also, the nature of mathematics, its impact on science and technology and on computers; and its penetration into biological, social and management sciences need to be analysed with an open mind. The renowned mathematician Prof. J.N. Kapur has tried to answer and analyse all these questions in his book 'Fascinating World of Mathematical Sciences'. The first four volumes of the book (which runs in eight volumes) constitute the subject matter of the present review. These volumes are an outcome of a series of national and international lectures and seminars given, and articles written, by the author from time to time.

The first volume contains twenty-six chapters on the nature of mathematics. The fascination of mathematics can be felt and appreciated through the various solved and unsolved problems in pure and applied mathematics. This forms the theme of Chapter I. The reader will be fascinated to know that the Fermat's last theorem, which till 1988 remained an unsolved problem, has ultimately been solved. The culture, excitement and relevance of mathematics are dealt within the Chapter 2. The excitement of mathematics is not always self-evident. It needs to be explained and also it requires some training in 'mathematics appreciation'. In Chapter 3, the author has given some insight into the essentials of mathematics appreciation.

Mathematics is not static but dynamic. It is changing not only in quantity but its quality is undergoing a transformation too. It is becoming deeper andmore abstract. In Chapter 4, the author discusses the rate of growth of mathematics and some consequences of the exponential growth. The author gives a nice quotation from the famous book 'New World of Mathematics' by G.A.W. Bochm, published in the U.S.: "Mathematics is for those who love to climb intellectual mountains". Mathematics is, therefore, a highly intellectual discipline. The remaining chapters deal with relationship between pure and applied mathematics, freedom in mathematical creativity, impact of computers on mathematics education and research, criteria for good quality mathematics, generalisation and abstraction in mathematics, future of mathematics and thoughts of great mathematicians and scientists about mathematics. Chapter 20 titled 'Humour and Wit in Mathematics' makes a very interesting and enjoyable reading. Some mathematical jokes find inclusion in this chapter.

Thrill of solving and posing problems can be a great source of intellectual enjoyment. Some interesting and challenging problems and charming number patterns are included in Chapters 23 and 24 respectively. All the chapters are written in a simple language and are stimulating and thought provoking. They take the readers to the wonderland of mathematics and are able to inculcate in them the interest, excitement and fascination for mathematics.

Mathematics has tremendous applications in physical, biological and social sciences and in industry, engineering and technology. However, in spite of these potential applications, even people from the educated class often fail to appreciate the importance and relevance of mathematics. This may be attributed mainly to the fact that applications of mathematics are not as visible as those of other sciences. Therefore, there is a much-felt need to create awareness in students and teachers of mathematics and also in the general public. Volumes II and III dealing with applications of mathematics aim at realising this objective. The concept of mathematical modelling has of late given a new dimension and identity to applied mathematics. Mathematical modelling in simple terms is the application of mathematical competence to models from social or technological situation falling outside the realm of mathematics. In fact, mathematical modelling and mathematical technique are but two sides of the coin of Applied Mathematics. The first nine Chapters of Volume II deal with mathematical modelling. The next seven chapters deal with the attitude of an applied mathematician and general

surveys of mathematical applications in all areas of science and technology with emphasis on some relatively recent applications of mathematics. The fields of these applications include biomathematics, operations research, computer science, space mathematics, management mathematics, etc. The last nine chapters of Volume II are devoted to applications of mathematics in special areas, e.g., decision analysis, marketing, defence, numerical analysis, computer art and graphics, image reconstruction, etc.

Volume III is exclusively devoted to specific applications of mathematics. The first eight chapters are on applications of mathematics in life sciences. Applications to chemotherapy, insect-control strategy, neuro-physiological models, radiotherapy, etc., are described in Chapter 1. Biomathematics concerned with the development of mathematical models in biology and medicine, is a very rich and fertile field. Some problems in biomathematics are discussed in Chapter 3. Chapter 4 relating to the bioarithmetic of human body demonstrates the use of school mathematics to human physiology. The use of elementary mathematics to respiratory and cardiovascular systems leads to interesting conclusions. Chapter 6 deals with some mathematical models in medical sciences. Chapter 7 highlights how the concepts from biology and medicine can be used fruitfully to motivate the learning of mathematics.

Chapter 9 to 15 are devoted to the applications of mathematics in social sciences and economics. Powers and limitations of mathematical modelling in social sciences are discussed in Chapter 9 while Chapter 10 includes applications to optimum economic exploitation of fisheries, forests and mines, optimum taxation policy, marketing, etc. Different ways of mathematizing social sciences are given coverage in Chapter 12 while some basic concepts of mathematical economics are discussed in Chapter 13. The role of mathematics in national economy forms the subject matter of Chapter 14. Chapter 15 relates to the topic 'Mathematics for National Development'.

Chapters 16 to 22 are concerned with the applications of mathematics in management sciences. Operations research and its role in educational planning and administration are discussed in Chapters 16 and 18. Chapter 21 is exclusively devoted to Cybernetics. As defined by the founder of this concept, Norbert Weiner, Cybernetics is "the (comparative) study of control and communication in the animal and the machine". Chapter 22 considers the importance of mathematical modelling and operations research for transportation problems in Indian Railways. Applications of modern algebra, modern abstract mathematics and some unusual applications of matrics find inclusion in Chapters 22 and 25; while the last chapter incorporates some thoughts on applications of mathematics. The combined Volumes II and III give an overall view of the richness and variety of applications of mathematics. In both these volumes, each chapter can be read independently of the other chapters. These applications of mathematics will surely be able to inspire and convince students, teachers and the general public about the role mathematics plays in the modern social and technological world.

Volume IV of the book is concerned with the problems of mathematics education at all levels. This volume is divided into four sections. Section A contains some four hundred thoughts on mathematics education of leading scientists and mathematicians of all ages including the author's own thoughts. These also include forty thoughts expressed by way of debates, discussions, plenary lectures, etc., by leading and distinguished mathematicians, mathematics teachers and mathematics educators who gathered at Adelaide, Australia, for the Fifth International Congress on Mathematics Education (ICME 5) which was held during August 24–30, 1984. The detailed comments on the thoughts of Prof. G. Poyla of Standford University, U.S.A., and Prof. H. Freudenthal of The Netherlands, leading figures in the field of mathematics education, are also included. These thoughts will be able to provide much food for thought for both teachers and students of mathematics. As such, they deserve to be read critically, thoroughly discussed and debated by teachers and all those interested in mathematics education.

Section B contains six chapters on the history of mathematics education in India, steps needed for improving and revitalising mathematics education (including development of school mathematics) and research in India. Some problems in the domain of mathematics education are also pinpointed and their remedies suggested. Section C discusses the New Mathematics movement that spread through the large parts of the world in the sixties and the first half of the seventies. The implications of this movement on mathematics education and its strong and weak points are discussed. The Relevant Mathematics movement and its implications on mathematics education are also spelled critically. The concluding Section D discusses the impact of calculators, computers and informatics on mathematics education. The author pleads for free use of hand-held calculators and computers for improving the teaching and learning of mathematics at all levels.

The language used in all the four

volumes is simple. They have been written in an easy-to-understand manner and also in a lucid style. These volumes will provide much food for thought, excitement and fascination for teachers and students of mathematics and also for the general public. They must find respectable place in the shelves of all school and college libraries. However, there are innumerable printing mistakes in all the volumes. Care should be taken to minimise these mistakes in future editions.

P.K. Mukherjee

HORMONAL REGULATION OF PLANT GROWTH AND DEVELOPMENT Vol. IV Edited by S.S. Purohit, Agra, *Botanical Publishers (India),* IVE/176, J.N. Vyas Nagar, Bikaner 334001 (Rajasthan).

GROWTH hormones collectively regulate many facets of plant growth and development. During the last two decades or so there has been significant increase in our overall understanding of the mode of action of hormones vis-a-vis regulation of various plant developmental processes and, not surprisingly, numerous research papers and excellent reviews on these aspects have been appearing from time to time in widely scattered journals. The book under review is the fourth under the multi volume series launched by the editor five years ago.

The present volume includes altogether 11 review articles, varying both in quality and length of discussion. With the development of sophisticated laboratory techniques like HPLC, GL-MS and immunoassay of various types there has been marked accuracy in extraction, purification and quantification of different hormones, and this topic is the subject of discussion of the first chapter. A very comprehensive review running to as many as 52 pages on regulation of IAA metabolism has been presented in the next article which should find much interest among the researchers working in this area in understanding not only the IAA conjugates in particular but also in acquainting oneself with most of the current literature. The subsequent reviews are mostly on hormonal control of ovule development; yield and modification of oil fatty acids composition in peanuts; rice leaf senescence and secondary plant metabolism in habitual cultures. There is also mention about polyamines and jasmonic acid; the latter being the latest candidate to be added to the list of endogenous plant growth regulators. The last chapter of the book requires little comment except to say that it deals with more speculative area of hormonal regulation mechanism versus plant psychology.

Inclusion of comprehensive reviews on current line of research on the following topics would have been of much interest to Indian students and researchers: the use of monoclonal antibodies to identify the cellular targets of plant growth regulators, application of various immunological techniques to study the mode of action of plant hormones, vis-a-vis gene expression and interaction among different hormones during the plant developmental processes. Although the general plan of this multi-volume series is to provide a unified account of all recent developments in the area of plant hormone research, the editor has neither been successful in overall planning and coordination nor in systematic choice of subjects. No doubt, some of the chapters have been well written. But the main problem here is there are already available a number of recent treaties which have provided more exhaustive information on a wide spectrum of plant hormone research. In summary, the volume will not generate much enthusiasm among the researchers who have already invested in one of the more competitive publications.

P.K. Panda

COMPUTER

(Continued from page 43.)

numbers is repeated twice. This can be avoided by giving an additional conditional statement in line 45 as:

45 IF A=B THEN 60

In such a case as soon as the first set of A and B is printed, line 45 issues a command taking execution to line 60, instead of line 50 (thereby avoiding next B if A=B). Do not panic if on running this Program the screen remains blank intermittently. The computer takes its time to search all the numbers between 1 and 100.

The FOR—NEXT statement serves another useful purpose. It can be used for delaying the operation at any stage of execution. It then becomes a delay loop. This aspect will be taken up later. But the reader may note that a delay loop is written as:

110 FOR D=1 to 500
120 NEXT D

The computer merely counts from 1 to 500 in following lines 110 and 120 thereby delaying further execution.

Dr. Ramshesh is a Scientific Officer at Bhabha Atomic Research Centre, Bombay.

Hand-held PC To Improve Geological Measurements

ACCURATE measurements are important in all branches of science and technology. However, scientists and technologists working in applied areas do not insist on the same levels of rigour and precision in measurements in field sciences such as applied geology as they do in basic sciences such as spectroscopy and crystallography. It is not to say all field measurements are sloppy; only it takes time for newer and better techniques developed in the laboratories to reach the field.

In a recent development a Swedish manufacturer has introduced a hand-held personal computer (Geomac III PC) in the latest version of the Terrameter—an instrument used for measuring the ability of earth and rock to conduct electric current—to improve both the speed and accuracy of measurement. An added advantage is that the PC can evaluate the measurements while the instrument is continuing measurements.

Since electrical resistance of different rocks and minerals differs, such measurements can provide a direct indication of the minerals present in a particular area. One can also use the technique for prospecting ground water.

In the latest model of the Terrameter, the hand-held PC housed in a rugged aluminium housing to protect it from dust and other hazards of using a sensitive instrument in the open fields replaces the conventionally used data logger. The computer operates on the standard MS-DOS system and can display the measured data graphically while measurement continues. The computer is expected to save time in the field by about 20%.

Hand-held computer for geological resistance measuring

As a bonus, the computerised version of the Terrameter can be used for continuous monitoring of ground conductivity—which could help predict landslides and even earthquakes.

Subbiah Arunachalam

A Stem-Nodulating Green Manure Crop

NITROGEN is one of the elements required by plants in large quantity for growth and productivity. Although nitrogen is the most abundant gas in the atmosphere, it cannot be utilized by the plants unless it is fixed as ammonia. Leguminous plants have the ability to fix atmospheric nitrogen with the help of bacteria which live in the root nodules. This relationship between the legume and the bacteria is a classical example of symbiosis. The bacteria get 'shelter' and food (carbon assimilates) from the plant while the latter gets nitrogen in usable form. While the legumes grown for their grain are a source of proteins in human diet, some of the non-edible leguminous plants, by virtue of their high nitrogen content and large phytomass, are a source of nitrogen for the plants. They enrich the soil by enhancing nitrogen content and adding organic matter.

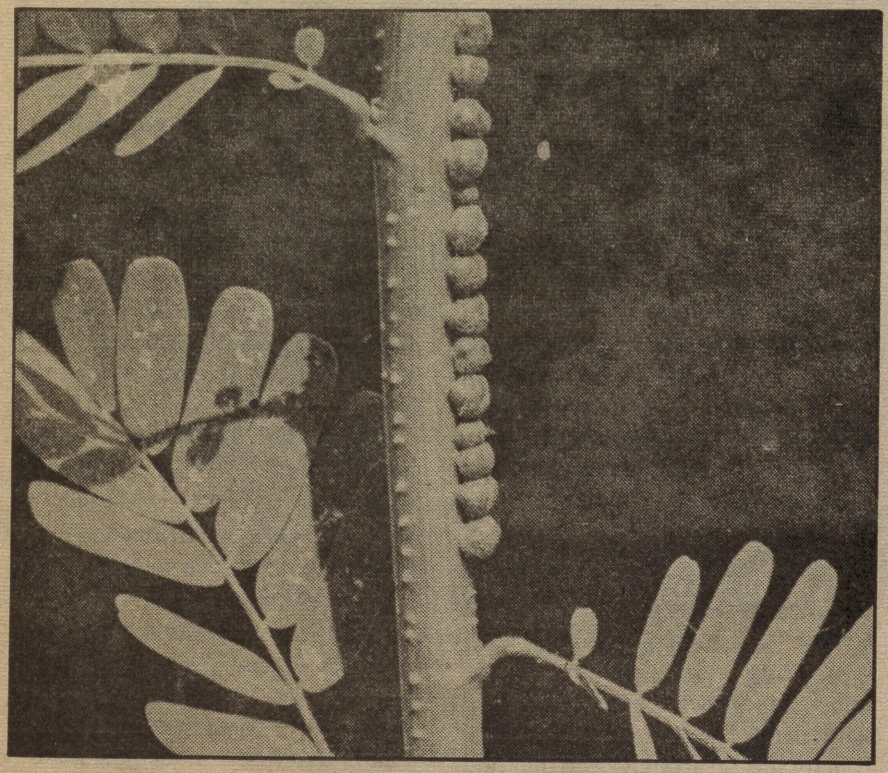
Several *Sesbania* species are used as green manure. *S. aculeata* (dhaincha) is widely grown in India and like the other legumes has root nodules harbouring nitrogen fixing bacteria. Recently a species of *Sesbania* called *S. rostrata*, endemic to west Africa, was found to have nitrogen fixing nodules on the stem in addition to the root nodules. The stem nodulating character of this species has attracted the attention of scientists, and currently there is wide interest to exploit its potential as a green manure crop. Besides *S. rostrata*, two more plants, Neptunia and Aeschynomene also produce stem nodules. Neptunia is a water plant; Aeschynomene grows slowly and does not produce large phytomass to contribute sufficient nitrogen to the soil. *S. rostrata* grows faster, produces large phytomass and has high nitrogen content; hence has the potential as a good green manure crop.

The *S. rostrata* plant resembles the indigenous species, *S. aculeata*, but has larger leaves, flowers, fruits and seeds. The stem is characterised by the presence of tiny projections in three to four rows along the whole length known as mamillae. These are potential sites for root growth under flooded conditions. The bacteria enter through these sites and multiply to produce the characteristic green nodules.

NORMALLY legume species produce root nodules after infection with Rhizobia present in the soil. However, stem nodules are not often formed on *S. rostrata* when grown on a soil for the first time. This shows that the specific stem nodulating bacteria are not always present in the soil. The easiest way to induce stem nodulation is to mix a small quantity of soil on which *S. rostrata* with stem nodules was grown previously. Spraying the stem with a crude extract of stem nodules also induce stem nodulation. The bacterium responsible for the induction of stem nodules has been isolated and cultured. Dr. Bernard Dreyfus, who reported this species for the first time, classified and named this bacterium as *Azorhizobium caulinodans*. Experiments at BARC, Trombay have shown that inoculation with bacterial culture is not necessary when *S. rostrata* is repeatedly grown in the same soil.

The plants are sprayed with the bacterial inoculum 20–30 days after sowing. The nodules start appearing from 7–10 days and attain a size of 3 mm–4 mm in diameter in about 20 days. A 45–50 day-old crop sown in May grows to about 1.7m and may have 400–500 nodules. The plants are harvested at this stage for green manure. When allowed to grow up to 90 days they reach a height of over 5m and produce nodules all along the length of stem and branches. Like root nodules, stem nodules show nitrogen fixing activity. A population of 250,000 plants is expected to fix about 120 kg–150 kg nitrogen per hectare.

In experiments at BARC, rice crop grown using *S. rostrata* as green manure produced as much grain yield as the crop fertilized with urea at the rate of 60 kg N/hectare. In other experiments rice crop grown with *S. rostrata* as green manure and 60 kg N/hectare as chemical fertilizer produced yield equal to that of rice crop fertilized with 120 kg N/hectare' of chemical fertilizer. These experiments indicate that by using *S. rostrata* as a green manure considerable saving on chemical nitrogenous fertilizers can be achieved.



Nitrogen fixing stem nodules and mamillae on the stem of *Sesbania rostrata*

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How Corrosion is 'Cancer' of Metals

WE are all familiar with a brownish, powdery film on iron surfaces which are exposed to air in rainy season. May it be a iron gate, a grill, a nail or a knife—all are rusted. On rubbing this substance one would stin one's fingers. It is rust or, in other words, iron oxide. In chemist's language it is "slow burning". Rusting is the best example of corrosion. In addition to iron aluminium, copper, silver, etc. also rust. Rusting of silver is called 'tarnishing' which is caused by traces of sulphur compounds in atmosphere. Aluminium on contact with atmosphoric oxygen forms a thin layer of aluminium oxide which is more tough and adherent in comparison to iron oxide film.

Let us see why such a film is formed and what harm it does to the metal. All metals are extracted from their ores which is the most stable condition of matter. As such, to regain 'stability' metals resort to corrosion by way of reacting with oxygen, water and other non-metalic substances in the earth's environment. The film so formed on the surface, no doubt a step towards self-destruction of the metal, is a boon in disguise to the latter. This thin layer of oxide cuts off further contact between atmospheric oxygen and the metal and protects the metal as long as it stays intact. This is the nature's own way of protecting metals from the onslaught of environmental agencies.

The actual problem however arises when this film barrier is breached. This may be effected by a number of factors, viz., corrosive environment (sea water), high temperature treatment, mechanical stress, etc. Dissolution of the entire protective film and uniform degradation of the metal is called generalised corrosion. This differs from the localised corrosion of 'pitting' when the protective film is brokendown at defective sites. Pitting can drill holes in thick sheets of metal.

This ordinary looking phenomenon can lead to serious consequences. In the present age of technology, there are a host of areas like automobiles, aircraft, armaments, central heating systems, pipelines, power plants, etc; where corrosion is responsible for enormous financial losses. Besides these, it effects human health and safety and more so the development of future technology. A survey in the United States revealed that the country's economy was affected to a tune of 70 billion dollars each year. Collapse of bridges, aircrafts and steel structures costs valuable human lives. Metals are being used as implants in human body as hipjoints, pacemakers, pins, plates, etc. Their corrosion in the body is a big health problem.

ATTEMPTS have all along been made to prevent corrosion. Coatings of metallic surface with paints, lacquers, waxes, grease etc. provide protection against corrosion. The most effective method has been to add Cr and Ni to ordinary steel. This new steel—stainless steel—is quite resistant to corrosion. Most of our cooking utencils are made of stainless steel and have a longer kitchen life.

Another way of providing protection is to give a ceramic coating to the metal by porcelain enamel, glass or similar fired materials. These coatings, being oxide in nature, do not allow atmospheric oxygen to react with metal. Fixing a thin, chromium film on metal through electroplating is also an effective method.

In early 19th century Sir Humphry Davy, the noted chemist, was assigned a task by the British Government to protect copper bottoms of battleships of British navy. He devised a technique (cathode protection) for attaining this objective. Here zinc is coupled with steel. Zinc, being an active metal, acts as the anode of a "corrosion battery" in the sea water, whereas steel acts as the cathode of the battery. A local current flows causing galvanic corrosion. In this process zinc dissolves but protects steel. Galvanisation is done today on all steel pipes meant for carrying drinking water to protect them from corrosion.

The recent technological advancement has necessitated the development of newer corrosion-resistant, high grade stainless steels and nickel alloys. Thermally resistant formulations (super alloys) are required to resist high temperatures as in nuclear fusion reactors, missiles and rockets. One of such materials developed is metallic glass. It is obtained by extremely rapid cooling of metal from its molten state. This treatment endows the metal with glass-like characteristics, i.e., an internal amorphous arrangement rather than a crystalline structure. A metallic glass has hundredth to one thousandth time slower rate of corrosion compared to a similar alloy. Metallic glasses are available in various forms and shapes, e.g., powders, wires and ribbons.

A coating of amorphous metal on the bulk metal surface can also be provided through laser glazing. Metal surface may be provided with a glassier film resistant to corrosion by an ion beam.

Corrosion eats away the body of a metal as cancer does consume the human body. Material scientists are equally alive to the problem as are their counterparts in medical field.

C.B. Sharma

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