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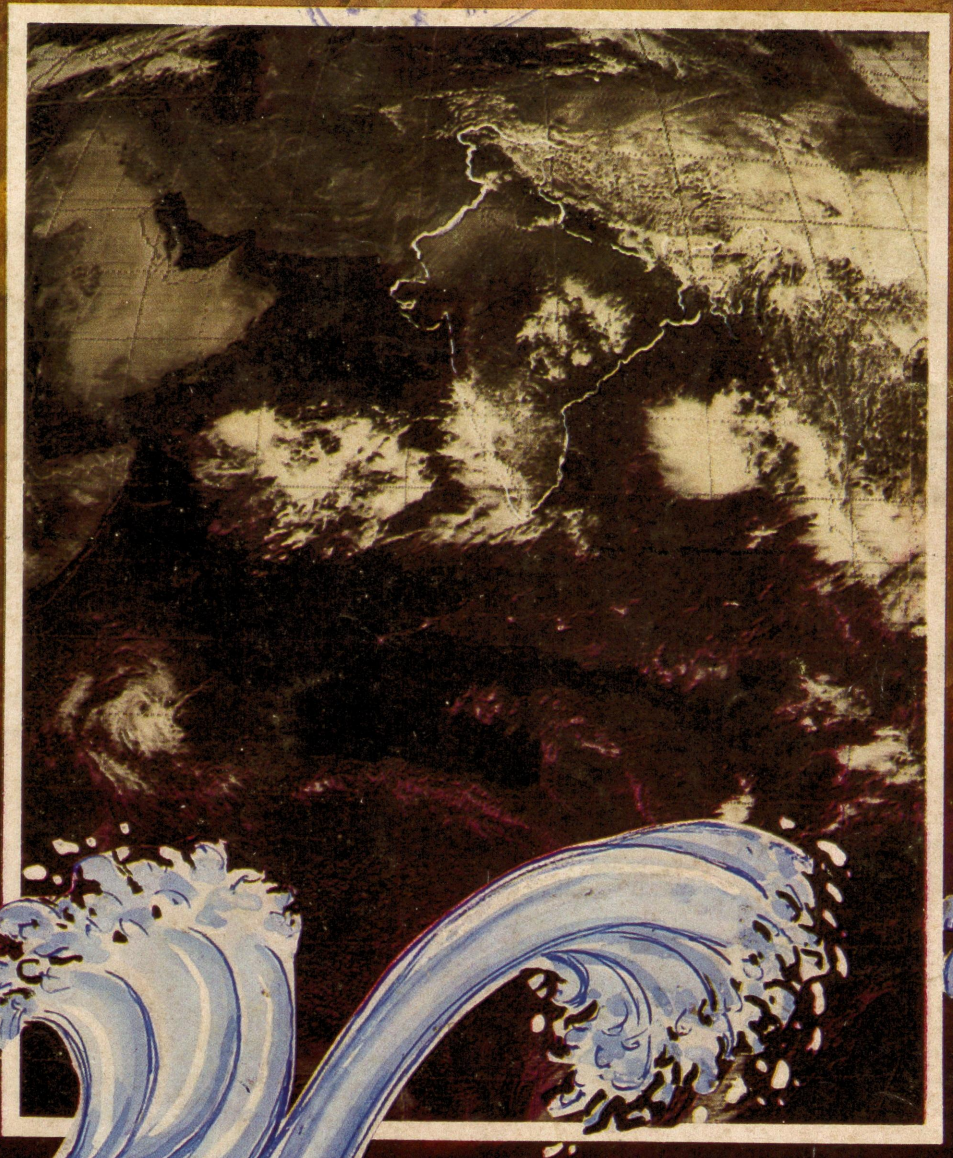

WEATHER FORECASTING

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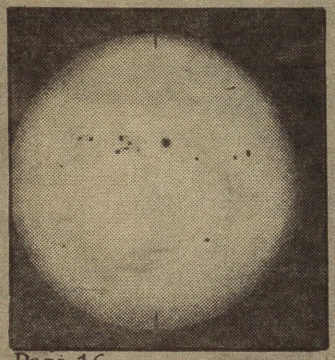

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COUPON
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COVER STORY

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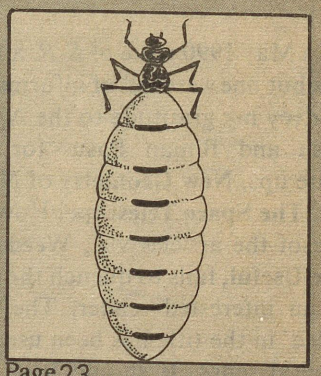

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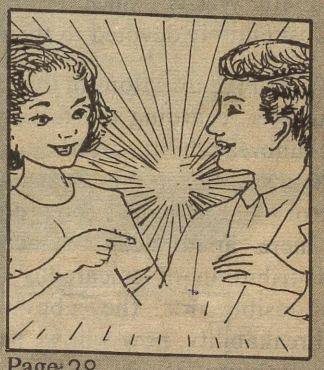

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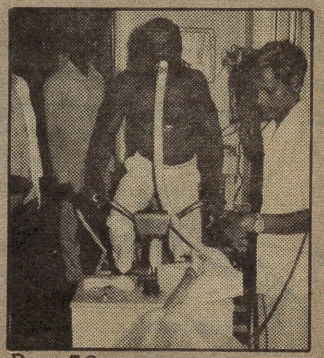

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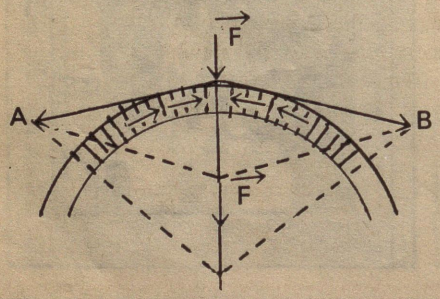
REACTIONS

Unbreakability of Egg Shell

In May 1990 issue of *S.R.* all articles but one were full of information. Convey my gratitude to the Aparna Basu and Biman Basu—for their write ups, **New Geometry of Nature** and **The Space Telescope.** However, one of the articles viz., **Weeds Too Are Useful,** fails to quench the thirst of an interested reader. The word 'weed' in the title has been used in a general sense. It should have been "Aquatic Weeds", since the article is almost entirely devoted to them.

One of the questions in the "Brain Trust" is regarding the reasons for the unbreakability of the eggshell. The answer given therein is unsatisfactory and perhaps wrong too. If it is mere anatomical balance and redistribution of calcareous lattice responsible for the above said unbreakability, how will we explain the stability of an electric bulbs whose inner evacuation causes a tremendous force on it due to the external air-pressure. Actually the stability of glass bulbs, eggshell and also those of classically architectural arches and domes is due to vector resolution of the forces applied thereon. The force F perpendicularly downward acts and gets resolved in the two vector components A and B. The two components press the adjacent particles and these particles, being sandwitched between other particles, offset the resolved components. Thus the force applied on the central top of tomb, arch, bulb or egg shell becomes ineffective to "work"



in physical sense and thus ultimately, these structures conserve their unbreakability. This condition remains operative as long as no force is applied from inside out, otherwise no offsetting would be possible and the spheres would rupture soon.

Sanjai Mishra
Ballia 277 001

The evacuated glass shell of an electric bulb owes its stability to the inherent hardness and rigidity of solid glass. Unlike an egg-shell it has no preferential direction in which an applied force will break it easily. So the analogy is intenable. Structural arches of masonry, however, behave in the same way as an egg-shell—they can withstand load only when applied on the convex side from the top.

B.B.

Perils of Innumeracy

In the article, **Perils of Innumeracy** J.A. Paulos (*S.R.,* April 1990) mentions the interesting episode in which on hearing Prof. Hardy's comment that 1729, the number of the taxi that brought him to the hospital, was a dull number Ramanujam retorts, "No Hardy! It is a very interesting number. It is the smallest number expressible as the sum of two cubes in two different ways". For the benefit of readers the break-up is:

$$1729 = 12^3 + 1^3 = 9^3 + 10^3$$

Reverting to the above dialogue, it seems incongruous that Ramanujam addressed the professor, who happened to be his philosopher, guide and mentor, by his surname. This informal mode of addressing is so alien and contrary to the Indian ethos.

S.K. Gurtu
ISSA
Metcalfe House Complex
Delhi-110 054.

Chitin and Chitosan

The article **Crab Shells a Billion Dollar Industry** (*S.R.*, Feb. 1990) and G.V. Joshi's letter (*Reaction,* March 1990) was very informative. MATSYAFED (Kerala State Co-operative Federation for Fisheries Development Ltd, Trivandrum) and not Kerala State Fisheries Co-operative Federation, as mentioned in the above-mentioned letter by Mr. G.V. Joshi (*S.R.*, March 1990), has set up a pilot plant at Neendakara which has a production capacity of 3 tonnes. Apart from the uses mentioned in the article and the letter, chitin has applications in poultry. Experiments done at CIFT (Central Institute of Fisheries Technology) have proved that chitin incorporated-feed fed chicks gain 10% more weight than normal feed fed chicks. Chitosan can be used for prolonging the ripening period of fruits like mangoes, bananas, etc., thus increasing their shelf life. Another application is in the field of pollution control. Experiments done at CIFT have proved that chitosan reduces the mercury level in water.

Rex Harold
Project Officer
Chitin Chitosan Plant
Matsyafed, Neendakara
Quilon-691582

Pleasant Possession

I was enthrilled to receive the January 1990 issue of *S.R.* The new format of the magazine with colour picture is appreciable and eye catching. All the articles are praiseworthy and **Happy Journey Without Motion Sickness** was written in a novel and interesting manner.. I hope future issues will provide equal pleasure in reading and possession!

Anita Srinivasan
New Delhi-110 060

PREVIEW AUGUST 1990

Cover Story: **Focus on Drugs**

Drugs from Plants

Important drugs that have come from plant source in recent years are discussed

Drug Delivery Systems

New methods are being developed to make drugs more effective and less toxic

Antibiotics

A review of progress in new antibiotics that are safe and more reliable

Also:

About The Cup That Cheers

***Central Drug Research Institute*—**Once a rendezvous for picknickers—Chattar Manzil Palace, Lucknow today houses an Institute dedicated to drug research

***On Sounds—Grammatically Sound*—**The roots of intelligence and creativity can be traced to the gift of language that human beings are endowed with

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★ SANJIV SHARMA	1st in Pre-Med. Panjabi Univ. 1983
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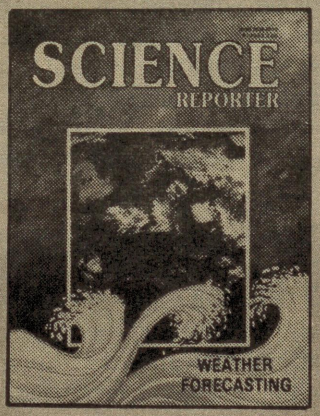

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The Monsoon Game

PREDICTING the future has been a human obsession since the dawn of human civilisation. Early man looked to the sky—stars and planets—for clues to future events such as wars, famines and, of course, weather. The Egyptians, for example, timed the sowing of their crops with the heliacal rising of the star Sirius as it always preceded the flooding of the Nile. Folklore have been composed linking weather with a host of observable phenomena—the colour of the sunset of the morning sky, wind direction, or even the change in the behavioural pattern of animals at times. But these were mostly no more than far-fetched emperical relationships that worked occasionally but failed more often. Weather forecasts based on scientific analysis is a very recent phenomenon, dating only since the last century.

The trouble with forecasting weather lies in the weather itself rather its inherently fickle nature. It depends on too many variables, some of them changing literally by the hour, yet others separated physically by global distances. Even to obtain reliable measurements of these is a Herculean task let alone the processing of the large volume of data required for a reasonably accurate forecast.

Deriving its name from the Arabic word "mausim", meaning "season", the Indian monsoons form one of the most massive weather systems in the world. The monsoon rains constitute the very lifeline of the country's predominantly agricultural economy. Naturally, in India, reliable prediction of the monsoon rain is of utmost importance not only for the farmer but also for the government which, ironically, has to plan for drought or flood relief aid in advance. Not surprisingly, forecasting monsoon has been called the world's most important weather prediction.

Notwithstanding man's boast of not only having understood various natural processes but also having acquired the werewithal to mould them at will, Nature holds many secrets. The basic physics of the monsoon system was described 300 years ago, but meteorologists are yet to piece together the entire mechanism or fully understand its behaviour. The Indian monsoon, it was said, is predictably unpredictable. Perhaps no longer; for now there is a glimmer of hope. To go by the experience of the last two years, monsoon prediction in India seems to have come of age. Using more than a dozen wide-ranging weather parameters and a new mathematical model, Indian meteorologists are now able to, with reasonable accuracy, foretell the performance of the southwest monsoon. This is creditable indeed, given the dubious reputation of weathermen in general. If the present model can stand the test of time and is able to make predictions with consistent accuracy in the coming years it would be yet another notable triumph of man over Nature. This is not to rule out the possibility that future experience would necessitate further refinements as is wont with any mathematical model. But that would not necessarily mean the futility of the new model as is being made out to by some critics. As we said before, the monsoon is a highly complex phenomenon yet so critical to the economic and social wellbeing of our country. If there is a way of predicting it with the degree of accuracy seen during the last two years it would be suicidal to condemn it merely because of certain perceived limitations.

A New Drug For AIDS Under Trial

A new potential drug, Dideoxyinosine (DDI), discovered for the treatment of AIDS, is being clinically tried by the scientists in Britain and France for its efficacy and possible toxicity.

Till now Zidovudive (AZT) is being used for this purpose. Notwithstanding the increase in the survival time of the AIDS patient which is nearly doubled, AZT has side effects. It works very effectively for some months, but after 6 months AIDS virus starts showing reduced susceptibility to the drug. By nearly one and a half month its effectiveness is totally lost. As such it is abandoned by 40% of patients within a year. The side effects include nausea and anemia.

DDI was discovered in 1985 by Sam Border of the National Cancer Institute, Bethesda, Maryland. It works by slowing down the rate at which the virus replicates itself in human cells and spreads through the immune system.

The scientists have chalked out a scheme for trial on selected patients to whom AZT has lost its effect. The patients and even doctors attending on them will not know whether a high or a low dose of medicine or a placebo is being given to the patient. The period assigned for the trial is half of the time usually taken for clinical trials and their acceptance for public use. □

Montreal Nations For Tougher Rules On CFCs

STRONGER measures to protect the ozone layer were agreed in principle in Geneva in second week of March 1990. It now seems likely that many of the world's countries will agree to phase out all chlorofluorocarbons and most halons by the year 2000.

The Montreal Protocol to protect the ozone layer was signed in 1987, and now has some 60 participating countries. It called for the production of five CFCs to be halved by the year 2000, and for the production of halons—brominated compounds used as fire suppressants—to be reduced. Scientists taking part in a meeting in Helsinki last year presented evidence that these cuts would not adequately protect stratospheric ozone, and called for a strengthening of the protocol. Now a meeting in London in June will decide what changes to adopt.

Delegates in Geneva prepared for the London meeting last week by broadly agreeing to ban the production not only of the five CFCs already listed on the protocol, but also of 10 other fully halogenated CFCs, by the year 2000. They also agreed to phase out halons by 2000 or 2005.

Delegates and representatives from industry also agreed to ban carbon tetrachloride by 2000. The solvent was identified for the first time as a major depleter of stratospheric ozone. Conflict remains over another solvent, methyl chloroform, which is used in correction fluid. Delegates from industry proposed cutting the production of methyl chloroform by 25 per cent, but representatives in Geneva said that countries could save this amount simply by controlling leaks and wastage.

The biggest question left for the meeting in June is whether developing and newly industrialising countries, whose use of CFCs and other ozone-depleting substances is expected to grow more than that of all other countries in the coming decade, will now sign the protocol. This depends in turn on whether rich countries are prepared to help them to buy alternative technology. Major producing nations such as India, Taiwan and South Korea have not yet signed.

But rich nations still disagree over the help. For example, developing countries want the industrialised nations to pay for the extra costs of buying one patented compound called fluorocarbon 134a, which is ozone-friendly, instead of the banned, but cheaper, CFC22. Industrialised countries want to agree costs case by case.

The delegates broadly agree that Third World countries should not need to use even the annual limit of 0.3 kilograms per head for which they fought last year. The rich nations currently use 1 kilogram of CFCs per head, but last year scientists calculated that an average consumption of 0.3 kilograms per head for the whole world would be potentially devastating to the ozone layer. □

FORECASTING MONSOON RAIN

With the ever increasing demand for weather forecast of various types in different time scale different forecast techniqués are emerging. VASANT GOWARIKER describes a new approach to long range forecasting of monsoon rainfall

FROM times immemorial the fate of mankind has been inseparably linked with the weather. In India, which is predominantly an agricultural country, it is an indisputable fact that human life and happiness are controlled to a large extent by the vagaries of weather. Of all the weather elements, rainfall is the single most important factor that affects plant growth, agricultural production, irrigation schedules and power generation. Summer monsoon, also known as south-west monsoon (June-September) rainfall constitutes about 75% of the annual rainfall over different parts of India. The country's economy is heavily dependent upon the behaviour of the monsoon rainfall. This naturally generates great demand for the rainfall forecast in different time scales. The requirement varies from detailed forecast of daily weather in time scale of a few hours to more general indications of the broad weather pattern of succeeding months, seasons, or even one year.

THE rainfall forecast, like any other weather forecast, can be divided into three broad categories as short, medium and long range depending upon their period of validity. A forecast for the period of validity upto 3 days in known as short-range forecast; 4-10 days medium-range; and forecasts for a period beyond 10 days viz., a month, a season or a year or even more are classified as long-range forecasts.

For a good forecast meteorological observations have to be good. Well distributed observations in close spacing are required from three-dimensional space and time at regular intervals. Observations are required from the land and ocean, day and night, and from the accessible and inaccessible places alike. The communication systems have to be fast and dependable which can work even in adverse weather conditions. Meteorological data arriving after 12 hours of observation cannot be utilised in short-range forecasts. Forecasting techniques have to be adequate. With the improvement in science and technology, there have been vast improvement in all fronts of meteorological observation, communication and computations. Today, in addition to the conventional observations, remote sensing techniques like radar and satellites are used extensively for meteorological observations. Fast computers are used for data exchange and computations. Our understanding about various weather systems have increased considerably. As a result, today's short-range forecasts are becoming more and more dependable.

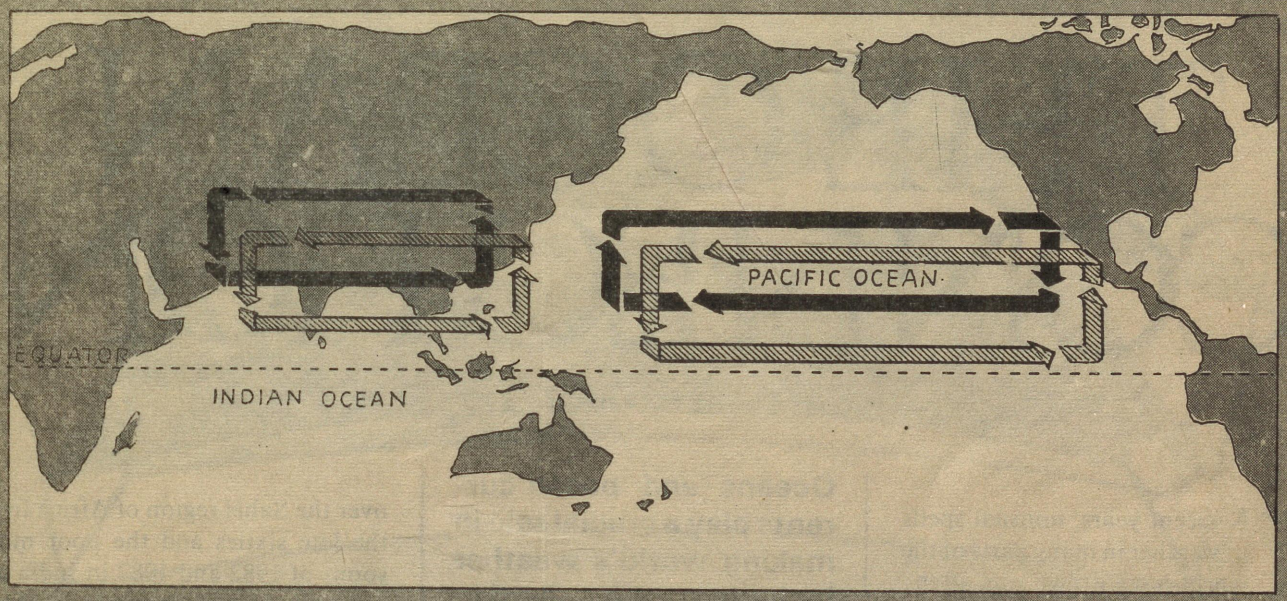
As has been indicated, short-range forecasts have a period of validity from a few hours to three days. The short-range forecasting is usually approached by subjective or objective methods. Broadly, these methods can be divided into three categories viz., (i) synoptic, (ii) statistical; and (iii) numerical. The short-range forecasting by numerical methods is the objective technique. These techniques are used in India to provide day to day monsoon rainfall forecast.

The medium range-forecasts are considerably important for agriculture. During the monsoon season there are variations in the monsoon rainfall on scales of 5-7 days. Forecasts of these variations are particularly important for agricultural operations and water resources management. Various techniques of medium-range forecasting based on statistical methods, a combination of synoptic and statistical methods, and numerical weather prediction (NWP) are available. The most promising are the NWP techniques. The NWP for medium-range forecasting in-volves heavy computations on a global scale and needs a large capacity and fast computer systems (Supercomputer). Keeping in view the importance of medium-range forecasts, Government of India have recently set up a National Centre for Medium-range Weather Forecasting at New Delhi. The centre is equipped with a supercomputer CRAY X/MP 14. Research has begun on development of NWP models specially suited for medium range forecasts. A coordinated scheme for development of agrometeorological services throughout the country is a part of this endeavour.

The normal rainfall values for a month or season provide a first approximation and, in some areas, a very good approximation of the actual rainfall realised. However, in most cases the actual monthly or seasonal rainfall values differ from the

The monsoon rainfall is variable in all time scale. The year-to-year variability is quite large. In terms of percentage departure of rainfall from normal, during 1875 to 1989 the monsoon rainfall has varied from −31% in 1877 to +24% in 1917. Worst failure of summer monsoon rainfall in this century was in 1918 when the country's rainfall was deficient by −5%. In recent times, the monsoon rainfall in 1988 was the fourth best of this century when the summer monsoon rainfall was 16% above normal

Walker Circulation And Southern Oscillation



IN the process of searching for predictors for the long-range forecast of monsoon rainfall, Sir Gilbert Walker made important discovery of Walker Circulation and Southern Oscilation. Both these phenomena are related to monsoon rainfall. The phenomena of sea-saw of surface pressure over the equatorial Pacific and equatorial Indian Ocean is known as Southern Oscillation and was another pioneering discovery by this brilliant scientist. He discovered that when the pressure is high over equatorial south Pacific it is low over the equatorial south Indian Ocean and vice versa. The Southern Oscillation plays a very prominent role in climate fluctuations. The pattern of low and high pressures over the Indian Ocean and Pacific (S.O.) gives rise to a vertical circulation along the equator (Walker circulation) with its rising limb over the low pressure area and descending limbs over the high pressure area. The location of the low pressure and hence the rising limb over Indian Ocean area is considered to be conducive to good monsoon rainfall over India. Its shifting eastward from its normal position, such as in El Nino years, reduces monsoon rainfall in India.

V.G.

normal from year to year. The difference may sometimes be small but at times could be quite considerable. Large deficits in rainfall over the major parts of the country could lead to country-wide drought; on the other hand large excesses could lead to serious floods, resulting in loss of life and property. Long-range forecasting aims at prediction of these departures of rainfall from the normal, generally about a month ahead, or in the beginning of the season.

ALTHOUGH, history reveals that Indian philosophers have been carrying out long range forecast of monsoon rainfall since ages, India enjoys a pioneering position in devising even the objective techniques of such forecasts. H.F. Blanford, Meteorological Reporter to the Government of India was probably the first to make an unoffical forecast in 1881 based on the varying extent and thickness of the Himalayan snow cover in spring. The first offical forecast of the regular series was issued on June 4, 1886 covering the vast areas of Indian sub-continent.

Sir Gilbert Walker, the then Director General of Observatories revolutionised long-range forecasting of monsoon rainfall by introducing the concept of correlation in seasonal forecasting. He carried out very extensive work between 1910 and 1924 on the subject. In 1924, using a very large number of predictor-predictant correlation pairs, Walker developed a linear regression equation for the highly correlated pairs to forecast seasonal rainfall over specified areas of the country.

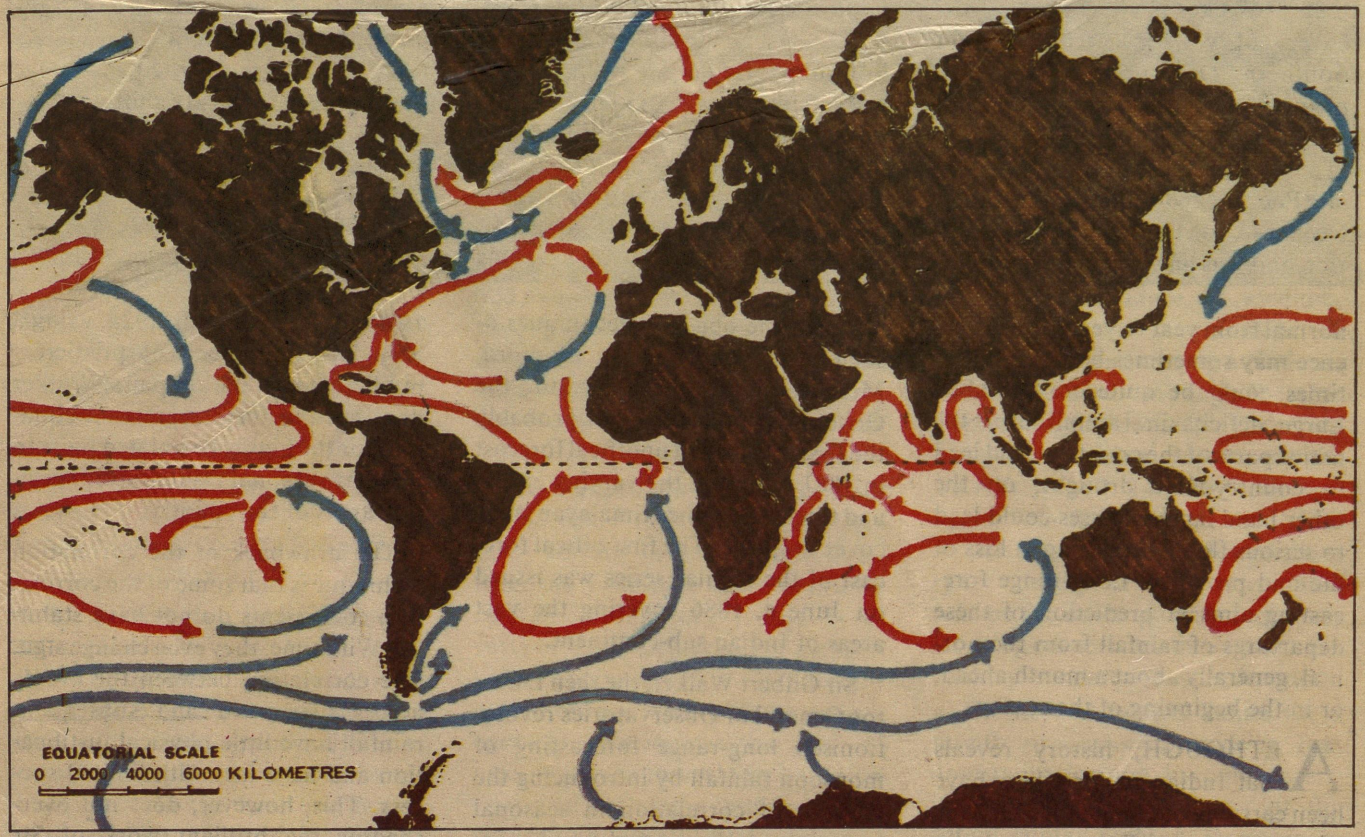
The drawback of the correlation technique is that some of the correlation coefficients do not have stability. With time, they even change sign. The correlation between the events across the world and subsequent rainfall have little physical justification and have met with limited success. This, however, does not overshadow the brilliant work of Sir

(Continued on page 19)

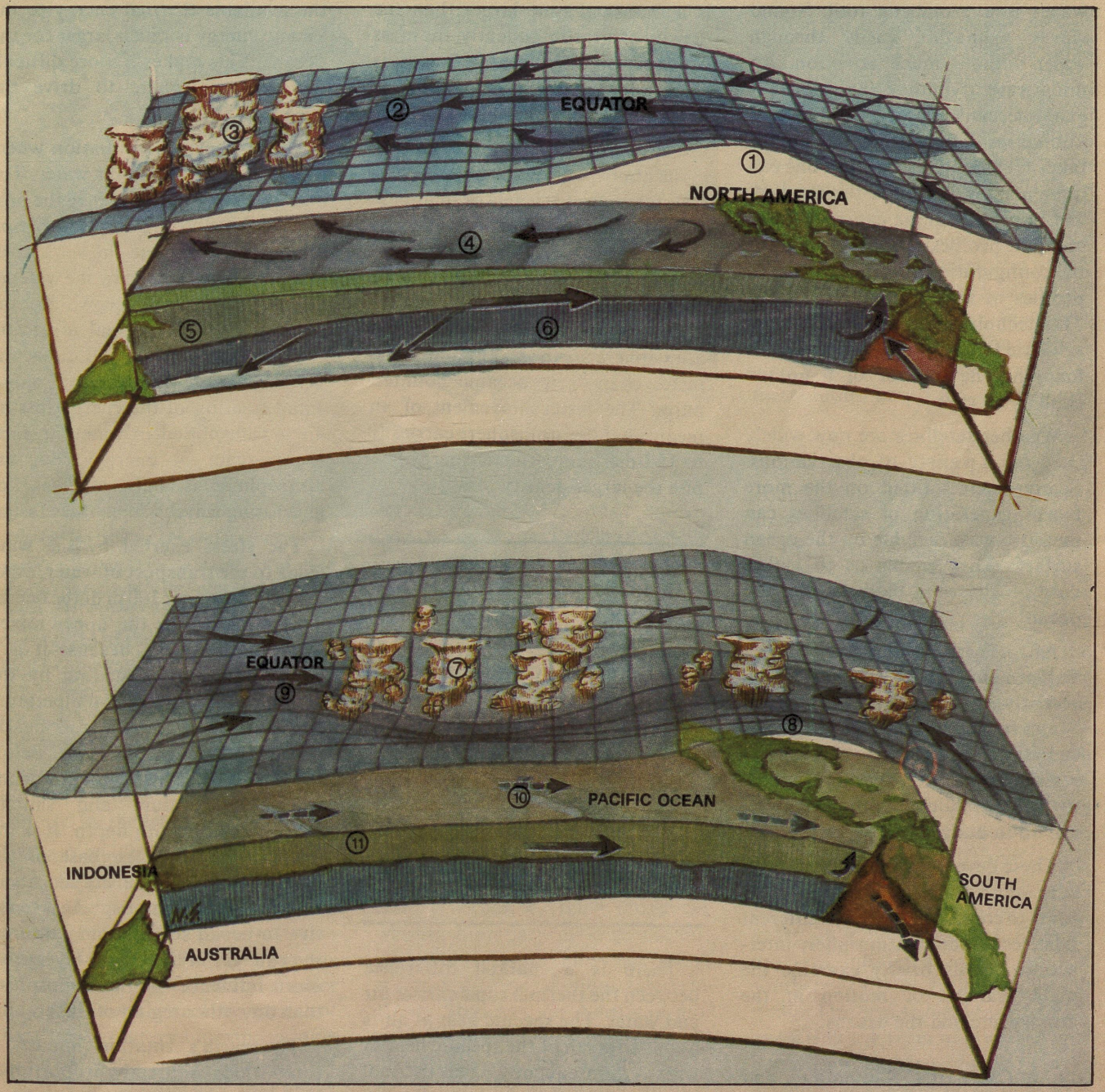
THE OCEAN CONNECTION

Oceans and ocean currents play a crucial role in making world's weather including the Indian monsoons. *P. K. DAS* explains how

IN recent years, unusual spells of weather in many parts of the world have drawn our attention to the influence of the oceans on weather, especially events like the El Nino. Severe droughts over the Sahel region of Africa from the late sixties and the poor monsoons of 1982 and 1987 in India are examples of such aberrations. Many experts have expressed the view that the decade 1980–1990 has witnessed



The ocean currents



The ocean-weather link. In the cold phase of the Pacific Basin, normal weather *(top diagram)* **prevails. A high-pressure system (1) is located over the eastern Pacific, promoting trade winds (2) to blow towards a wet low-pressure system over Indonesia (3) and inducing a westward-setting current (4). Warm water piles up in the western Pacific (5). Cool subsurface water returns in an undercurrent (6) warm-water layer remains shallow off South America. During the warm phase when the pattern breaks down** *(bottom diagram),* **the low-pressure area moves eastward (7) and the high-pressure area weakens (8). Trade winds falter and are replaced by east blowing winds (9) causing the surface current to reverse (10) and warm water surge toward South America in a phenomenon known as a Kelvin wave (11). (Based on** *National Geographic*)

a wider variety of extreme weather events than any other decade in the present century. Why should this happen? Let us try to find out.

THE oceans, which cover almost two thirds of the earth's surface, were poorly understood in the past. But recent improvements in observing techniques hold promise of better understanding of oceanic phenomena and their influence on weather.

Remote sensing with acoustic

waves is a promising tool. Sound waves propagate easily through water without much attention. An underwater dynamite explosion, for example, can be recorded a thousand kilometres away. From the time it takes for the signal to return one can infer many features of the sea bed. The same technique can be used to compute profiles of ocean currents or the configuration of eddies and depth profiles of temperature or salinity. This technique is known as ocean-acoustic tomography. It is similar to mapping the interior of a human skull by X-rays.

Weather satellites are now widely used for a variety of observations. Scatterometers fitted on the more recent generation of satellites can measure wave heights on the ocean surface. They enable us to gather data on the wind blowing over the ocean.

An Earth-Radiation Budget Experiment (ERBE) has been recently launched by the United States to measure the incoming solar radiation as well as the outgoing terrestrial radiation. This would enable us to see how clouds modulate the radiation budget.

These developments will undoubtedly stand us in good stead in the years to come, but to see the different nuances of ocean-atmosphere interactions let us briefly examine the main features of motion in the atmosphere and the oceans.

MOVEMENTS in both air and water are governed by the same laws of fluid motion, but despite this similarity there are interesting differences.

The total mass of air in the atmosphere is nearly the same as the mass of a shallow layer of water, about 10 m deep, spread over the entire earth's surface. The density of water is a thousand time larger than the density of air; consequently, the mass of water in the oceanic basins is about 300 times the mass of air in the atmosphere.

The characteristic speed of motion in the atmosphere is about 10 m/s. In fast-moving jet streams or in intense atmospheric vortices this could rise to about 100 m/s. On the other hand, the typical speed of ocean currents is 0.1 m/s, with an extreme value of about 1.0 m/s. Movements in the atmosphere are thus a hundred times faster than their oceanic counterparts. The faster movement of air means that the atmosphere carries 10 to 15 times more kinetic energy despite the larger density of water.

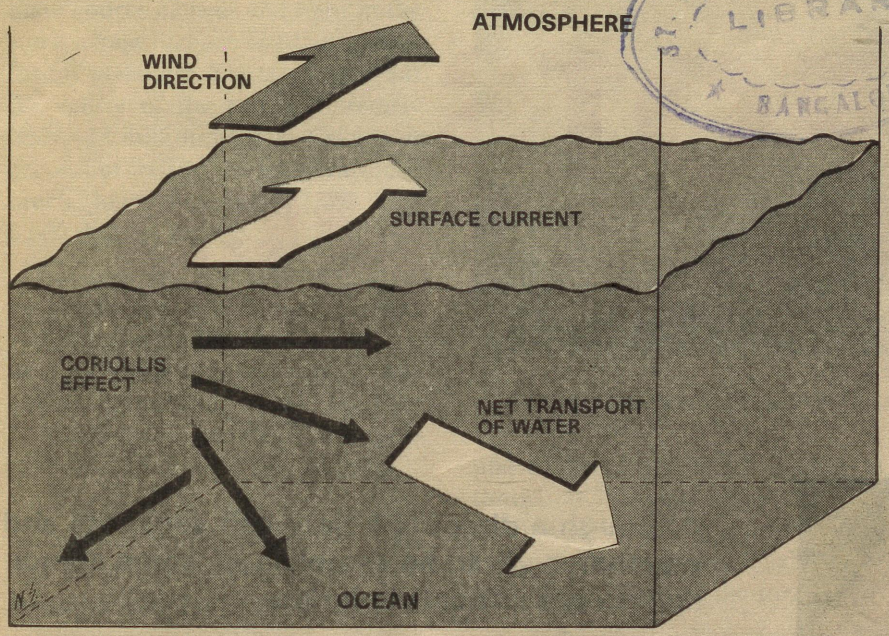
Since the atmosphere is sensitive to ocean surface temperatures, the changes in the mixed layer have more influence on the atmosphere than any other region of the ocean

There is a marked difference between the thermal capacities of air and water. The specific heat of air is about a fourth of the specific heat of water. Consequently, the thermal capacity of water is more than a thousand times greater than the value for air. This accounts for the much slower response of the ocean to solar radiation. Land and sea breezes near coastal regions and, on a larger scale, the monsoonal winds of the world owe their origin to the difference in thermal capacities of air and water. It also implies that the ratio of the available thermal energy to the kinetic energy is much larger for the oceans. This makes it more difficult for the atmosphere to drive the oceans.

Let us consider a situation where the wind is blowing over water. The energy lost by the air will be the product of the retarding force of friction exerted by water and the velocity of air. The energy gained by the water at the air-water interface will be the product of the frictional force and the velocity of water. But, as the velocity of air is much greater, only a small fraction of the energy lost by air is transmitted to water. In fact, the transfer of energy from the atmosphere is only efficient for generating waves which move faster.

The stress exerted by the wind leads to the transport of water, especially in the upper 100 m of the ocean. This is known as the upper mixed layer of the ocean because it is a region of vigorous stirring by the action of the wind. The temperature and salinity of the water is nearly uniform in the mixed layer. Below the mixed layer lies the thermocline where temperature and salinity change rapidly with depth. It is the interface between the base of the mixed layer and the deeper ocean below. Since the atmosphere is sensitive to ocean surface temperatures, the changes in the mixed layer have more influence on the atmosphere than any other region of the ocean.

The earth's rotation imparts a force which is directly proportional to the velocity of a moving parcel of air or water. This acts at right angles to the direction of motion—to the right of the motion in the northern hemisphere, and to the left of the motion in the southern hemisphere. This deflecting force is known as the Coriolis force, after Gustave Coriolis, the scientist who first discovered its existence. If the angular velocity



The Ekman Spiral. The surface current is deflected to the right by the Coriolis effect or the earth's rotation. The net transport of water is perpendicular to the wind direction. For the northern hemisphere the currents are deflected to the right, and in the southern to the left of the wind that produced them

of rotation of the earth is represented by Ω (omega) and the latitude is ϕ (phi), then the Coriolis force is $2\ \Omega \sin \phi \times V$, where V is the velocity of the moving parcel of air or water. The quantity $(2\ \Omega \sin \phi)$ is referred to as the Coriolis parameter and is denoted by the letter 'f'.

The Coriolis parameter (f) represents a frequency because its units are $(sec)^{-1}$. Its magnitude is, approximately, $(day)^{-1}$. We refer to it as a Coriolis frequency. For short periods of time (T) when T is much smaller than 1/f, the earth's rotation does not have time to act on a moving volume of air or water, so the transport of water is in the same direction as the wind stress. But, for motion on the scale of days or months the characteristic time (T) is greater than 1/f; consequently, the transport of water is at right angles to the stress exerted by the wind because it is deflected by the earth's rotation. The combination of the wind and the earth's rotation directs currents. This is known as an Ekman Spiral. It is named after W. Ekman, who gave an expression for the currents generated by surface stresses in 1902. Ekman's spiral can be used to compute the intensity of upwelling near a coast, but this is not so effective near the equator because f is very small in equatorial regions.

The Coriolis parameter (f) vanishes at the equator. Its variation with latitude leads to an intensification of ocean currents along the western boundary of large oceanic gyres or whirls. This interesting result was first demonstrated by Henry Stommel, an American pioneer in physical oceanography. In broad terms we can consider this to be the outcome of a certain amount of spin and its variation with time that a boundary current acquires by the earth's rotation. Many coastal currents of the world, such as the Gulf Stream off the western coast of the Atlantic and the Kuroshio current off Japan are examples of the western intensification of boundary currents. Of special relevance to the Indian monsoon is another coastal current off the east coast of Africa. This is known as the Somali current.

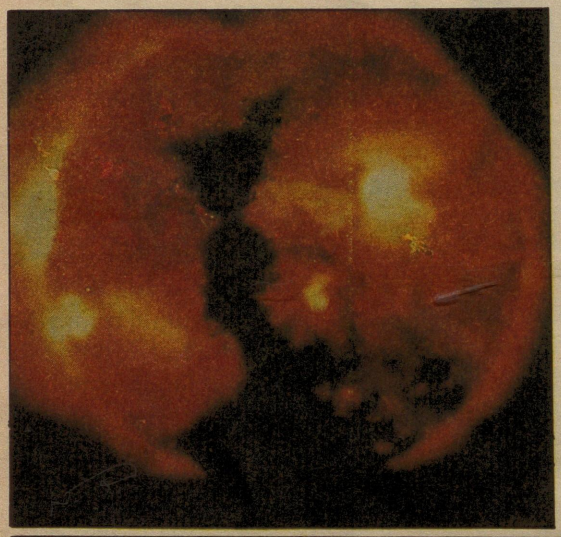
THE Somali current is one of the few coastal currents of the world which reverses its direction in sympathy with the overlying wind. During the northern summer it flows northwards from a location slightly to the south of the equator to about 10°N before turning off-shore towards the Indian coast. In winter, however, it flows southwards in agreement with the winter or northeast monsoon.

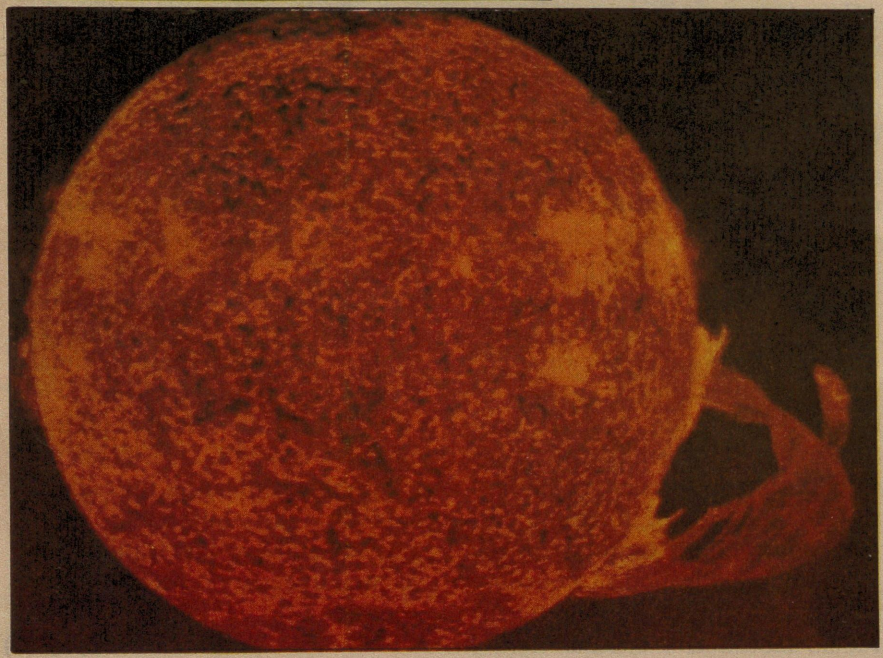
An interesting feature of this current is related to the formation of eddies. Observations indicate that there is (a) a southern gyre embedded in the current between the equator and 4°N, and (b) a northern gyre between 5° and 9°N. The southern gyre begins to form in late April or early May, nearly a month before the monsoon's onset over the southern tip of India. Recent observations suggest that with the progress of the monsoon the southern gyre tends to move northwards and coalesce with the northern gyre, but in some years instead of coalescence the northern gyre just moves away. There is also some evidence to suggest that the southern gyre is more prominent in years of good monsoon, while in years of indifferent monsoons the southern gyre is either absent or weak. The region between the two gyres is in the form of a wedge with low sea surface temperatures. This is a region of intense upwelling. The temperature off the coast of Somalia is often as low as 15°C in June, while the sea surface temperature off Bombay is around 30°C. This gradient of temperature influences the radiation balance of the monsoon air, but the precise nature of this feature is not yet well understood because of lack data.

(Continued on page 46)

SUNSPOTS AND WEATHER

BIMAN BASU





Sunspots as they appear in an x-ray picture from Skylab *(left)*; A Spectacular flare on the surface of the sun photographed from the Skylab *(below)*

Although a direct link between sunspots and weather is yet to be established, some coincidences are difficult to ignore

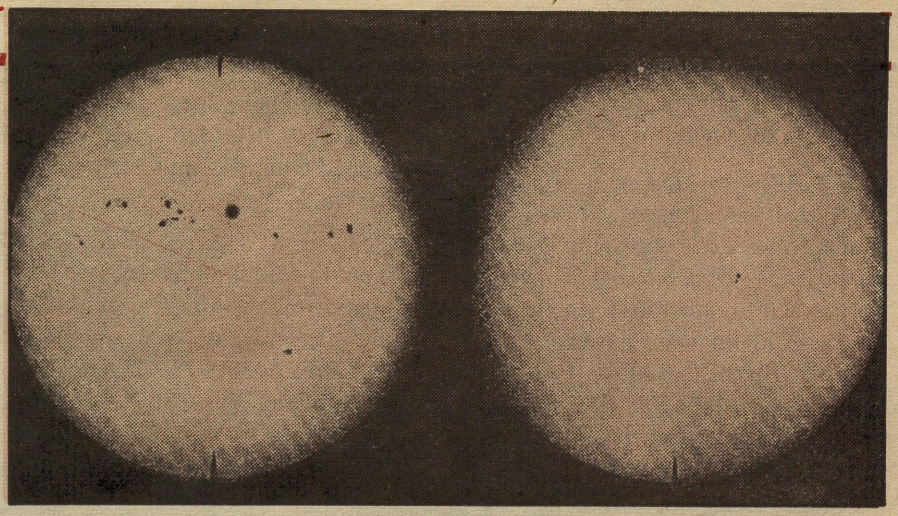
THE weather system of our globe is like a giant machine driven by the heat of the sun. It is the sun which is responsible for most weather phenomena such as pressure systems, jet streams, winds, clouds, rains and snow and of course the monsoons. So, apparently, any change in the sun—its output of heat, for example—should have potential for affecting changes in weather on earth. But till recently, no conclusive scientific evidence was available to prove such a link. Scientists have only now come to learn how very sensitive the earth's weather system is to small changes in the flow of heat and other radiation from the sun. Recent numerical models of the atmosphere indicate that a drop in the solar flux of just 1-2 per cent could bring in a "Little Ice Age" like one that brought extremes of cold to Europe and North America in the 16th and 17th centuries. But how can the sun change?

THE sun is really a star—a rather ordinary one, according to astronomers. It is some 1.4 million

kilometers across—more than 100 times the diameter of the earth. The main source of heat and light in the sun is a huge furnace, fired by nuclear fusion, at its core. The temperature at the centre of the sun is extremely high—14 million degrees Celsius or more; but its surface temperature is much lower—between 5,000 and 6,000 degrees Celsius.

For ages, man had taken the sun to be a constant, non-changing object radiating heat and light steadily. But now we know that it is not so. The sun's brightness and its heat and light output are now known to vary cyclically over periods of several years.

First signs of the sun's variable nature was found almost 400 years ago when Galileo turned his newly invented telescope towards the sun. To his great surprise he saw irregular patterns of dark spots on the sun's bright face that drifted over several days from left to right on the solar disc. Later, these dark spots, called sunspots, were found to appear and disappear periodically becoming more numerous every 11 years or so. Sunspots appear dark because they are cooler than the surrounding areas of the sun's luminous photosphere. According to recent theories, these cool areas are produced by reactions between the electrically charged gases of the sun and solar magnetic fields. That is, a local magnetic field breaks through the surface of the photosphere, producing a spot at that point. A typical sunspot has two distinct parts: a central dark region, called the 'umbra', and a lighter surrounding area, called the 'penumbra'.

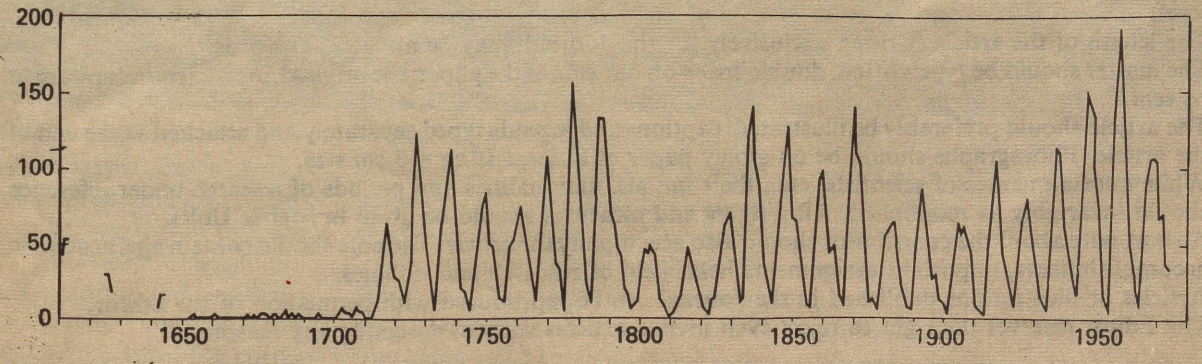


Visible-light photographs of the sun near the time of sunspot maximum *(left)* and near sunspot minimum *(right)*

A sunspot cycle begins with a few small spots far away from the solar equator on both sides of it. With the passage of time, more sunspots of larger size appear; some older spots fade away. The new spots appear closer and closer to the solar equator and to poles, until much of the sun is covered by dark patches. The cycle nears its end when spots in the higher solar latitudes begin to disappear. At last only a few spots are left around the equator. The smaller sunspots are generally around 1500 km across, but the larger ones may often be larger than 50,000 km in diameter.

Although sunspots are a visible manifestation of the level of activity on the sun, they are not the only things happening on the sun at that time. For example, when the sun is most active as it is at present, huge solar flares burst forth releasing high-energy charged particles that disrupt long-distance short wave telecommunication and power transmission on earth.

Another effect of increased solar activity as indicated by sunspot maxima is an overall heating of the earth's atmosphere, as a result of which it expands. One implication of this expansion is that satellites in near-earth orbit often face more 'drag' and as a result lose altitude faster. But it has no effect on geosynchronous communication satel-



Sunspot numbers through ages. Hardly any spots were seen between 1645 and 1715

lites which remain far above the earth's atmosphere.

WHEN the sunspot cycle was at last recognised in 1843, an immediate search was launched for its possible connection with events on earth. Foremost and most interesting of them was, naturally, the weather. By the end of the 19th century, relationships had been 'found' linking sunspot numbers and, among others the monsoons in India and rainfall in Mauritius and Australia. "The riddle of the probable times of occurrence of Indian famines," announced a prominent British astronomer in 1900, "has now been read, and they can be for the future accurately predicted." But such correlations could not stand the test of time.

Still, some of the coincidences could not be easily dismissed. One of the most striking findings from old records of sunspots was the Maunder minimum—a 7-year period from 1645 to 1715 when almost no sunspots were seen. The period also coincided with the coldest years of the so-called "Little Ice Age" which stretched from the mid-15th to the mid-19th century.

Analysis of tree rings for their carbon-14 content also revealed cyclic variations coinciding with the solar cycle. When sunspots were rare, the amount of carbon-14 in the tree rings increased markedly.

Many scientists, however, doubted the veracity of these coincidences, until data from the satellite *Solar Max* brought in fresh evidence. The satellite's on-board radiometer discovered that between 1980 and 1986, i.e., between a solar maximum and a solar minimum, average output from the sun fell by 0.1 per cent, and after levelling off had again started to climb. *Solar Max* data proved beyond doubt that output of solar radiation indeed varied with the solar cycle.

Could so small a cyclic change in solar output have a noticeable effect on weather? At least two researchers now have evidence that it may. The scientists, Karin Labitzke of Berlin Free University and Van Loon of the US National Center for Atmoshperic Research have discovered a distinct link between the solar cycle and stratospheric winds over the tropics. Normally, during a 28-month period, these winds reverse direction, blowing half the time from the east, the other half from the west—a phenomenon meteorologists call quasi-biennial oscillation, or the QBO in short. Depending upon the direction of the QBO flow, it was found by the two researchers, solar maxima and minima seemed linked to changes in air pressure, temperature, the number of storms, and perhaps even the size of the ozone hole over the Antarctic.

At the moment scientists do not have a mechanism to explain the solar cycle QBO link, but the phenomenon has persuaded at least one meteorologist of the National Climate Analysis Centre in USA to incorporate the solar cycle into the computer algorithms for his monthly and 90-day weather forecasts. □

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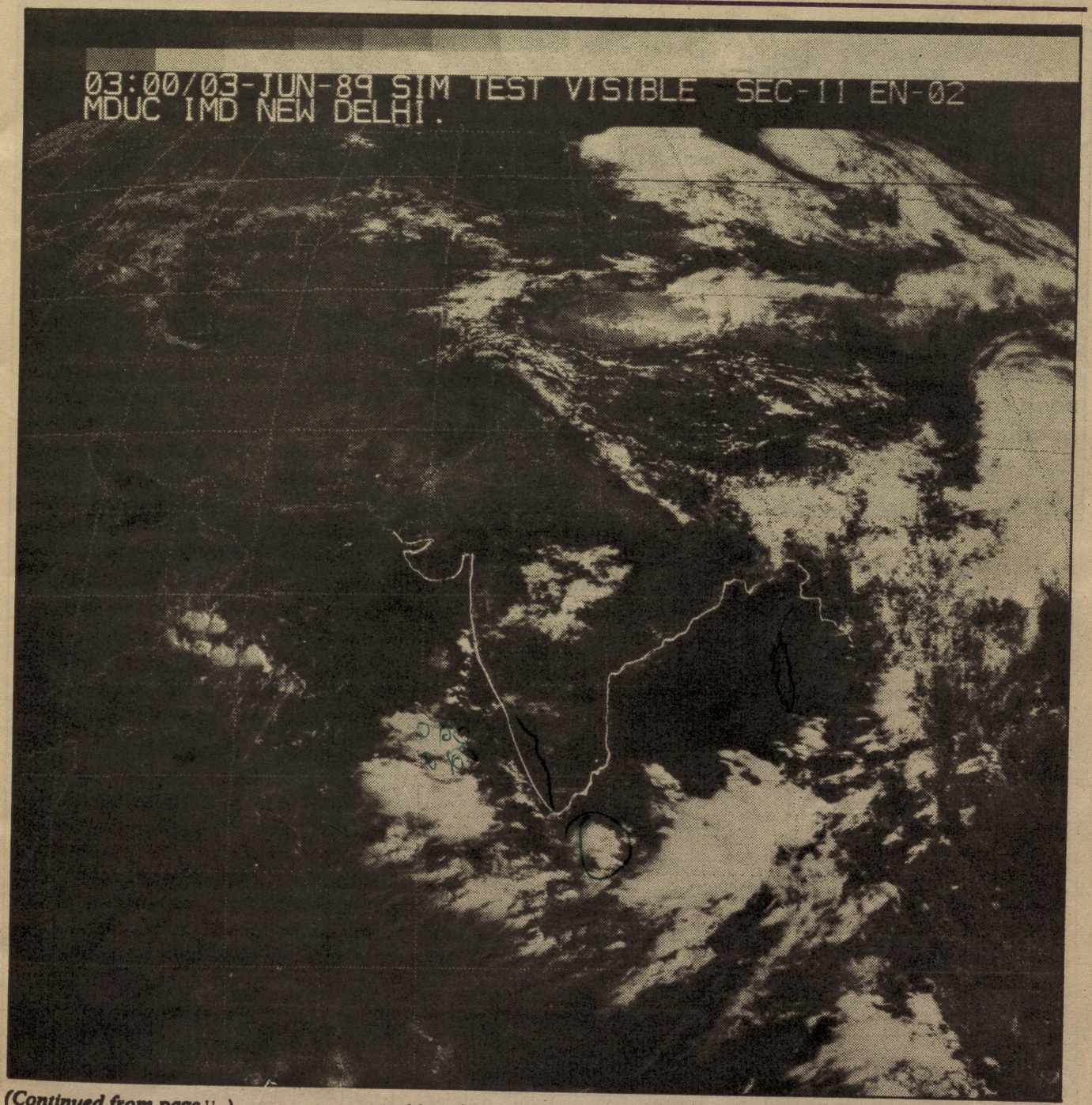


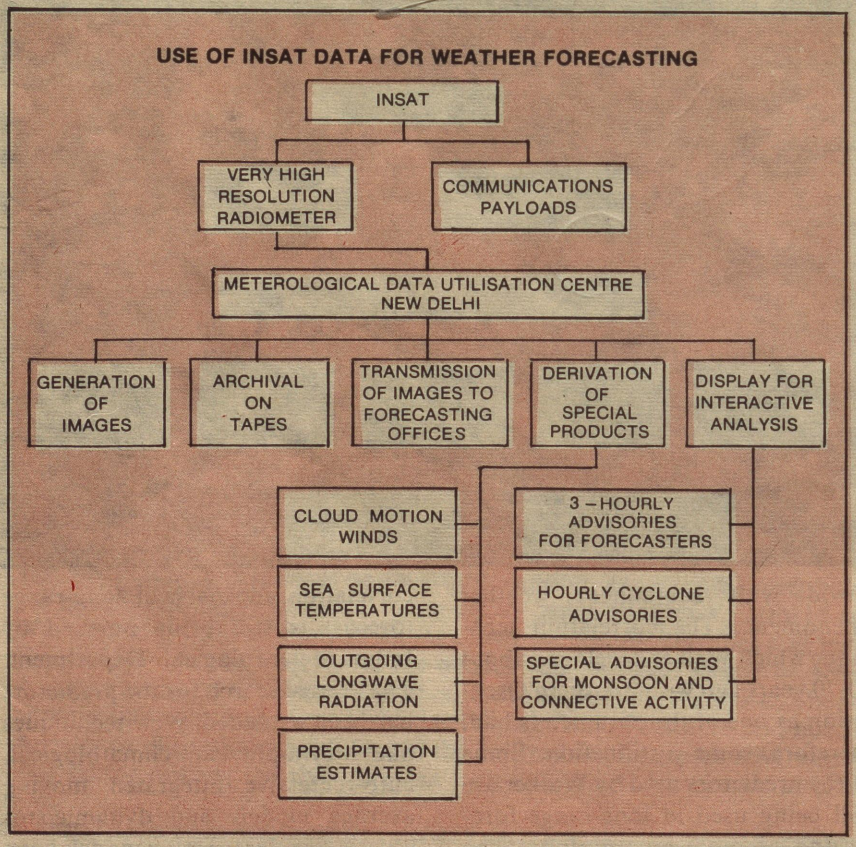
(Continued from page 11)

Gilbert Walker as some of the predictors he used in preparing long-range forecast were, in fact, related with the monsoon circulation through the "Walker Circulation" and Southern Oscillations which had provided some partial justification for correlating some of the events across the world with subsequent weather phenomena. The correlation technique which Walker developed about 60-70 years ago with Southern Oscillation as one of the parameters had, therefore, some justification. Some of the predictors used by Walker are still being used in long-range forecasting of monsoon rainfall. The correlation approach of long-range forecast is still being pursued by India Meteorological Department. The area of search for the predictors has been extended. New techniques like synoptic-cum-climatological, auto-regressive integrated moving average models and dynamic stochastic transfer function models have

IN 1988, a new model with 15 regional and global parameters was utilised to forecast monsoon rainfall as early as in May for the first time. The forecast in 1988 was indicated to be good and towards the positive side of the normal. The forecast was qualitative. The actual summer monsoon rainfall in 1988 was good and towards the positive side of the normal

been developed. In this endeavour some success has been achieved. Results by these new techniques were encouraging on some occasions but failed on others.

AFTER the consecutive droughts of 1986 and 1987 a complete review of long-range forecast methods used in India were made towards the end of 1987 and the need for a new technique was felt. Parameteric and power regression models have been developd by utilising signals from 15 parameters. The parameters are known to be related with Indian summer monsoon rainfall. Some of the parameters are global and others are regional in nature. Some of these parameters may, however, be inter-related. The parameters can broadly be divided into 4 categories, viz. (i) temperature related; (ii) pressure related; (iii) wind pattern related; and (iv) snow cover related. All these parameters along with their relationship with the monsoon rainfall are listed in Table-1.



Physical Linkages

THE various parameters presented in Table-1 are physically linked with monsoon rainfall. It is well known that the monsoon circulation is a thermally driven low-pressure area arising due to the thermal contrast between the vast Asian continent and the Indian Ocean to its south during the summer season. Heating due to elevated land mass such as the Tibetan Plateau and Himalayan massif and latent heat released due to large-scale convection in southeast Asia also contributes to the differential heating. Greater the thermal contrast, better it is for monsoon rainfall. The temperatures are, therefore, considered to be directly linked with the monsoon rainfall included in the parametric model.

The second group of parameters are related to pressure. This is based on consideration that lower the pressure over the monsoonal area better it is for the monsoon rainfall. The Southern Oscillation Index (SOI) which is the difference between the normalised pressure anomally between Tahiti (an island in south central Pacific) and Darwin (Australia) and the Indian Ocean equatorial pressures are, therefore, the measures of intensity of the monsoon low-pressure area. If the SOI is positive, i.e., the low pressure over the Indian Ocean is below normal and high pressure over the Pacific is above normal, it is conducive for good monsoon rainfall. Reverse is true when the SOI is negative. Similarly wind and snow cover parameters are physically related to intensity of the monsoon circulation.

V.G.

Data for the period 1951-87 have been used to examine the relationship of the 15 parameters with the monsoon rainfall. The relationships

Table 1. Analysis of 15 parameters

Year	Monsoon condition	Temperature						Wind			Pressure anomaly (SOI)				Snow-cover		No. of parameters favourable/ Total No. of parameters
		El Nino in current year (—)	*El Nino* in previous year (+)	Northern India (March) (+)	East coast of India (March) (+)	Central India (May) (+)	Northern hemisphere (Jan & Feb) (+)	500 hPa ridge (April) (+)	50 hPa ridge–trough extent (Jan & Feb) (—)	10 hPa (30 km) westerly wind (Jan) (+)	Tahiti–Darwin (Spring) (+)	Darwin (Spring) (—)	South America, Argentina (Apr) (—)	Indian Ocean Equatorial (Jan–May) (—)	Himalayan (Jan–March) (—)	Eurasian (Previous Dec) (—)	
1951	D	F	U	U	U	F	U	U			U	U	U	F	U		3/12
1952	N	F	U	U	U	F	F	U			F	U	U	U	F		5/12
1953	N	U	U	F	F	F	F	F			U	U	U	U	F		6/12
1954	N	F	F	F	F	F	U	F			F	F	U	F	U		9/12
1955	N	F	U	F	F	F	F	F			F	F	F	F	F		11/12
1956	N	F	U	F	U	F	U	F			F	F	F	F	F		9/12
1957	N	U	U	U	U	U	U	F			U	U	U	U	U		1/12
1958	N	F	F	F	F	F	F	F	U	U	U	U	F	U	F		9/14
1959	N	F	U	F	U	F	F	F	F	F	F	F	F	F	U		11/14
1960	N	F	U	U	U	U	F	F	U	U	F	F	F	F	F		8/14
1961	N	F	U	F	F	F	F	U	F	F	U	U	F	F	U		9/14
1962	N	F	U	U	U	U	F	U	F	U	F	U	U	F	F		6/14
1963	N	F	U	U	U	U	F	U	F	F	F	F	F	F	F		9/14
1964	N	F	U	F	F	U	U	F	F	F	F	F	U	F	F		10/14
1965	D	U	U	U	U	U	U	U	U	U	U	U	U	U	U		0/14
1966	D	F	F	U	F	U	F	U	F	F	U	U	F	U	F		8/14
1967	N	F	U	U	U	U	U	F	F	U	F	U	U	F	F	F	7/15
1968	D	F	U	U	U	U	U	U	U	U	F	U	U	F	U	U	3/15
1969	N	F	U	F	F	F	U	F	F	F	U	U	F	U	F	U	9/15
1970	N	F	U	F	F	F	F	F	F	U	U	U	F	U	F	F	10/15
1971	N	F	U	U	U	U	U	F	F	F	F	F	F	F	U	F	9/15
1972	D	U	U	U	U	F	U	U	U	U	U	U	F	F	U	U	3/15
1973	N	F	F	U	F	F	F	F	F	F	U	U	F	U	U	U	9/15
1974	D	F	U	F	F	U	U	U	U	U	F	F	U	F	U	U	6/15
1975	N	F	U	U	F	F	F	F	F	F	F	F	F	F	U	F	12/15
1976	N	U	U	F	F	U	F	F	F	F	F	U	U	F	F	U	9/15
1977	N	F	F	F	F	U	U	U	F	F	U	U	F	U	F	F	9/15
1978	N	F	U	U	U	F	F	U	U	F	F	U	U	U	F	U	6/15
1979	D	F	U	U	U	U	U	U	U	U	U	U	U	U	F	U	2/15
1980	N	F	U	F	F	F	F	U	F	F	U	U	F	U	U	F	9/15
1981	N	F	U	F	F	U	F	F	F	U	U	U	U	U	F	F	8/15
1982	D	U	U	U	F	U	U	U	U	F	U	U	U	U	F	U	3/15
1983	N	F	F	U	F	F	F	U	F	F	U	U	F	U	F	U	9/15
1984	N	F	U	U	U	F	F	U	F	U	U	U	U	U	F	F	6/15
1985	N	F	U	F	F	F	U	U	F	F	U	F	F	F	U	F	10/15
1986	D	F	U	F	F	U	F	U	U	U	U	U	F	U	F	U	6/15
1987	D	U	U	F	U	U	F	F	U	U	U	U	F	U	F	U	5/15
1988	N	F	F	F	F	F	F	U	F	F	F	F	U	F	F	F	13/15

NOTE: + ive and —ve signs indicate direct and inverse relationship of predictors with monsoon; N and D indicate normal and deficient monsoon rainfall; F and U indicate favourable and unfavourable signals from predictors for normal monsoon.

Monsoon Forecast for 1990

(a) 56% of the 16 parameters are favourable for the 1990 monsoon to be "NORMAL" (defined as ± 10% of the long-period average value). Records of the past four decades show that whenever more than 55% parameters were favourable (as they are this year) the overall seasonal rainfall was not only "Normal" but on 85% occasions it was on the positive side of the "Normal". The first statement one would, therefore, make is that the 1990 monsoon would be within the definition of "Normal", validating our February 1990 forecast.

(b) The quantum of monsoon rainfall over the country as a whole for the 4-month monsoon season (June-September, 1990) is likely to be 101% of the long-period average value, the estimated model error being within ± 4%.

(c) Considering the inherent model error, the total rainfall of the 1990 monsoon season would thus be between 97% to 105% of the long-period average rainfall value—which means India is in for a fine monsoon this year.

(d) For a country as vast as India, with the inherent spatial variability of monsoon rainfall, there will almost always be some areas of deficient rain even in the best of monsoon (or some areas of floods even in the worst of monsoons). Based on the analysis of the data of the last 100 years done with a view to getting an insight into the regionwise climatological pattern in the 97%-105% rainfall situation (the limits of this year's forecast figures), we feel that while the possibility of some of the drought-prone areas getting inadequate rains cannot obviously be ruled out, over 80% of the meteorological sub-divisions of India should, in all probabilities, get good rains—space and timewise.

V.G.

are shown in the table. The positive and negative signs shown at the top indicate direct and inverse relations respectively.

The past data for 38 years (1951-88) have been analysed for all the 15 parameters. The favourable and unfavourable signals for normal monsoon rainfall over India as a whole are designated by F and U respectively and are tabulated in Table-1. Year to year behaviour of monsoon rainfall has been indicated by N and D where N indicates normal monsoon rainfall (more than 90% of the normal) and D stands for deficient rainfall (less than 90% of the normal). The normal monsoon rainfall of the country as a whole (including hilly regions), based on long period data 1901-1970, is 88.1 cm.

The parametric model was improved further by adding one more parameter and by fitting curvilinear equation to provide quantitative forecast in 1989. The forecast was that the monsoon rainfall for the country as a whole in 1989 would be about 102% of the normal and the actual rainfall in 1989 was 101.4% of the normal. Thus, in both these years the new techniques provided correct forecast

It was observed that whenever more than 50% parameters showed favourable signals, the monsoon rainfall in India was normal (percentage departure of rainfall ± 10% of its normal), when 70% or more parameters are favourable the monsoon rainfall was not only normal but it was towards the positive side of the normal. In 1988, a large number (86%) of parameters were favourable. Based on this analysis the long-range forecast for monsoon 1988 was estimated toward the positive side of the normal which was actually realised.

This parametric model is purely a qualitative decision-making tool where equal weightage has been given to all the 15 parameters. However, the relationship of monsoon rainfall with individual predictors exhibits a non-linear relationship. To take care of this non-linearity further improvement was made in 1989 by determining a curvilinear relationship by fitting the equation of different degrees. One more parameter, viz., surface pressure anomally of north-eastern hemisphere was also added. The best fit relationship with all the 16 parameters taken together led to the development of a power regression model. The forecasts from this power regression model has been found encouraging both during the sample period (1958-1980) on which the model is developed, as well as during the independent test period (1981-1986). The power regression model has correctly predicted the drought and large excess rainfall during the sample and independent test periods. The monsoon rainfall forecast provided in 1989 by utilising these new techniques with 16 parameters came out to be correct. The model's performance has, however, to be watched for some more time to be sure about their stability in performance.

Dr.Gowariker is Secretary to Govt. of India, Dept. of Science and Technology, New Delhi

He has been instrumental in developing the model of monsoon forecasting described in this article.

The Blind Architects

ALL over the tropical lands, termite hills are found. These termite hills or the nests of termites vary a lot in their size, structure and complexity. Though termites are blind they construct their nests with utmost precision. How they do so is still a mystery.

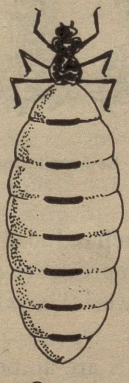
Termites belonging to the genus *Bellicositermes* build giant mounds about 6 meters high and 30 meters wide at base. Millions of termites live in these nests. Other species rarely construct such gigantic nests but live in mounds which barely rise above the ground. Proportionately, smaller nests house only a few hundred termites.

In general, a termatarium (nest of termites) is made up of three types of chambers. In the center, a royal chamber is occupied by a queen and a king. Around the royal chamber, several chambers are used to store food. Apart from these chambers, there are empty spaces around the actual nest which isolate it from the surrounding external walls. These are called 'corridors' and termites do not live in them. The other type of structure is tunnel. Tunnels do not connect any particular chamber.

Members of genus *Apicotermes* are known to build perfect nests. These nests are dug below the ground level and are about the size of an ostrich egg (20cm in length and 15cm in width). They are divided into a series of horizontal compartments supported by pillars. Each compartment is interlinked. A circular gallery connects various chambers with the outside wall of the nest. There are smaller linking paths in the nest to help termites move freely without taking the central route.

THESE blind insects have also solved many commonly occurring problems in their nests. Activity of several millions of insects inside a mound generates heat and exhausts oxygen. To ventilate their nest, termites build narrow, chimney-like ventilators around the margin of the termite hill. These ventilators have a smooth inner wall and are porous and thin, which allows oxygen to diffuse in the nest. During the day, sun warms the walls of ventilators and thereby the air inside them. The hot air draws exhausted air from the deeper parts of the nest. Thus the circulation of air is brought about.

King



Queen

In very hot climatic conditions, termites build tunnels deep into the ground till they find water table. They carry water in their crops (the lower part of the oesophagus which is pear-shaped and sac-like) and wet the walls of living area to cool the nests. Though the percentage of carbon dioxide and humidity inside a termite hill is more than the outside atmosphere, it often has a constant temperature.

There are other interesting ways of building nests. In areas where rainfall is heavy, termites build a mushroom-shaped colony. The flat roofs prevent water from seeping in. Such termite mounds are commonly seen in West Africa. In Australia, termites are popular as "compass" termites. They build their nests in the shape of flat chisel blades which always face north and south direction. This particular shape of the nest exposes it to minimum sun but helps the insects to get the warmth of early morning and evening sunlight.

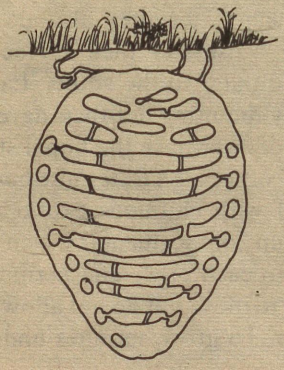
TERMITES are insects closely related to cockroaches. Like cockroaches, termites also do not have a waist and their larvae are almost similar to the adults. Larvae grow by moulting but their development does not have the pupal stage. Like all other insects, termite body is covered with chitinous exoskeleton made up of segments which are joined to each other and permit the termite to move but do not allow it to develop. To grow, termites undergo moulting regularly till they become adults. During moulting and prior to it, termites spend many days without food and lay on their side with folded legs. Exoskeleton cracks in a T-shape from the back of the head to the middle of the abdomen. The new 'skin' takes several days to harden

Soldier

Worker

and stretches itself to accommodate the new dimensions of the termite. Legs and antennae are the last parts to emerge from the old cover. The exoskeleton, which is shed, is eaten by termites. There are about 2,000 species of termites.

A single termite nest consists of a colony of several millions of insects which are the offspring of a single pair of adults. All termites cannot perform all functions. Several insects are grouped for different tasks and they also look completely different. Similar to ants, bees and wasps, termites are also social beings with three distinct castes; reproductives, for developing and maintaining the number of inhabitants of the colony; workers, for building nests and feeding other termites; and soldiers to defend the colony.



Nest of Apicotermes

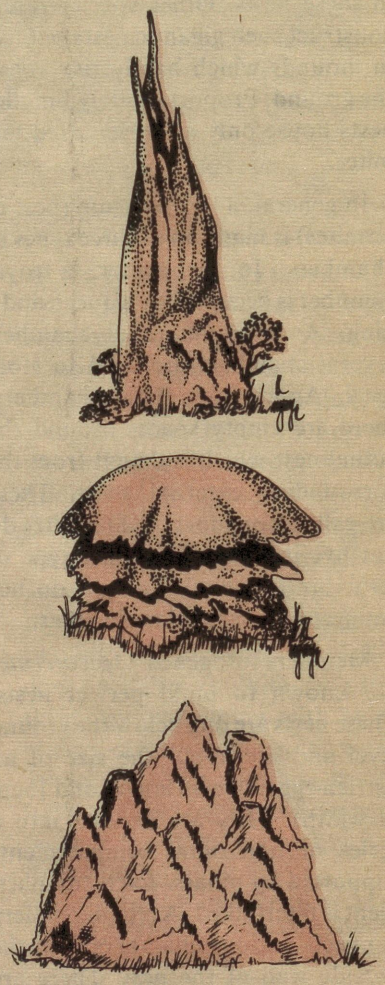
REPRODUCTIVES are winged termites and leave the nest soon after they are born. Immediately after the rainy season begins, these adults fly out of nests and separate into pairs. After they land from their nupital flight, they lose wings. Then they select a site for a nest and copulate. In the course of time, they also lose their antennae and become inactive but for reproduction. Unlike ants and bees, termites continue to fertilise many times in their life-time. Male termite remains constant in size but the female grows to almost 12cm long and 2.5cm wide. Female *Bellicositermes natalensis* grows from 2.5cm to about 25cm in length. The growth is due to the abdominal swelling as a result of overdeveloped ovaries. Females usually produce about 10,000 to 30,000 eggs every day. Male and female or the King and Queen cannot feed themselves. Workers provide them food and collect eggs from the queen and deposit them in other chambers of the nest.

WORKERS are wingless with soft, white bodies. They construct the nest, look after eggs and larvae, and supply food for the royal couple and soldiers. Their eyes are simple or completely absent, a characteristic of animals dwelling in darkness. Workers are both males and females but sterile; their genital organs are much reduced and are not useful for reproductive purpose. They have powerful jaws for chewing food.

Nest of Bellicositermes

SOLDIERS are amber-coloured termites with strong jaws and sharp teeth but are blind and sterile. Soldier termites have a well developed head, often larger than the rest of the body. There are two types of soldiers. The first type uses its jaws and teeth for defense. The second type, called 'nasutes', has an elongated head like a trunk, with a gland at the tip. This structure is used to squirt a viscous fluid to kill ants, the common enemies of termites. Owing to their large jaws, they cannot feed themselves. They rub their antennae on the heads of workers if they are hungry. These rubbing movements stimulate workers to regurgitate food into the mout of soldiers. Alternatively, a soldier rubs the tip of the abdomen of worker with its front feet. This ejects food from the digestive system of the worker through annus. This exchange of food is called "trophallaxis".

Termites feed mostly on vegetable matter like twigs, leaves and grass, but some of them feed on timber.



Different types of Termite-hills

They bore into wooden logs an poles. In the nests of termites belonging to sub-family Macrotermitinae, ball-like objects upto the size of a human head are seen. These balls are dark in colour and spongy in texture with fungus growth. These balls are made of chewed wood pulp and are food to the termites. In warm, humid atmosphere of nest, fungi grow easily on the balls. Fungi are useful as an important source of vitamins for termite growth. In addition, the balls also help in maintaining the temperature at about 30°C by absorbing and releasing moisture. Only workers can feed and digest the food. Dead wood and grass is digested by certain protozoa in the hind-gut of these insects. These protozoa break down the cellulose into easily assimilable elements. Soldiers, king and queen lack these microorganisms.

ANOTHER interesting aspect of termites is their effective mode of communication. This is brought about by chemical substances, called "pheromones", produced by queens and soldiers. Stability of a termite community is also maintained by these pheromones. All the members of the colony continually exchange food and saliva with one another. They also gather pheromones from the queen and circulate them throughout the colony. Young larvae are potentially of both sexes. But pheromones of queen with which they are fed make them sterile and wingless. Soldiers' pheromones reach the queen through workers. When soldier population falls, so do the pheromone quantity. The queen senses it and releases such pheromones which produce soldiers. Sometimes, the queen changes the nature of pheromones to encourage the sexual maturity of larvae. In the event of death of king or queen, other individuals attain sexual maturity rapidly while retaining their external juvenile characters. This phenomenon, known as "neotony", is also seen in higher animals. The sexually mature larvae develop wings and fly out of the nest to establish a new colony.

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The Interesting Prime 379

PRIME 379 has some curious properties on Primes. 379 and many other primes can be generated from its digits and from many prime numbers. It can be formed in some ordered fashion.

1. We can make following numbers with the digits of 379.

3, 7, 9, 37, 73, 39, 93, 79, 97, 379, 397, 739, 793, 937, 973.

of these fifteen numbers, ten are Prime. Non-Primes are 9=3.3; 39=3.13; 93=3.31; 793=13.61; 973=7.139

2. Square of digits of 379 can produce primes in the following way:

(A) $3^2+7^2+9^2=9+49+81=139$

(B) $3^2 \cdot 7^2+9^2=9-49+81=41$

3. SN means 1+2+3+.....+(N-1)+N

(A) S3+S7+S9=6+28+45=79

(B) -S3-S7+S9= -6-28+45=11

(C) -S3+S7+S9= -6+28+45=67

(D) S3-S7+S9=6-28+45=23

4. Prime numbers can also be generated in the following way:

(A) 379-3.(7+9)=379-48=331

(B) 379-(3+7.9)=379-66=313

(C) 379+(3.7+9)=379+30=409

(D) 379-(3.7+9)=379-30=349

(E) 379-(3.7-9)=379-12=367

5. (A) 3-7+9=5; (B) -3+7+9=13; (C) 3+7+9=19

6. (A) $3^2+7^1+9^0=9+7+1=17$

(B) $3^0+7^1+9^2=1+7+81=89$

(C) $3^4+7^4+9^4=81+2401+6561=9043$

7. 809 is a prime number. If it is placed after 379 with a zero in between, it becomes a square number.

$.3790809=1947^2$

Unfortunately, 1947 is not a prime but 19 and 47 are.

8. (A) If sum of 1st 2 digits is placed before last digit another prime is produced:

(3+7)* 9 .... =109

(B) If square root of last digit replaces 9, it becomes a prime number:

$37*9^{\frac{1}{2}}$ ..... = 373

9. The product of the last digit with the sum of 1st two digits yields 90, which when deducted from 379 gives a square of a prime

(3+7).9=90; 379-90=289=17^2

10. The sum of squares of 3 primes makes 379:

$379=3^2+3^2+19^2$

11. (A) The sum of 1st 15 consecutive odd prime numbers [1st—3 and last—53] makes 379.

(B) Sum of 1st 23 (Prime) consecutive prime numbers [1st—2 and last—79] produces 937 which contains the same digits of 379.

12. [739+(7+3+9)]/2 = (739+19)/2= 758/2=379

13. (A) 37.9+(37+9)=333+46=379

(B) 3.7.9+3.7.9+3+7-9=189+189+1=379

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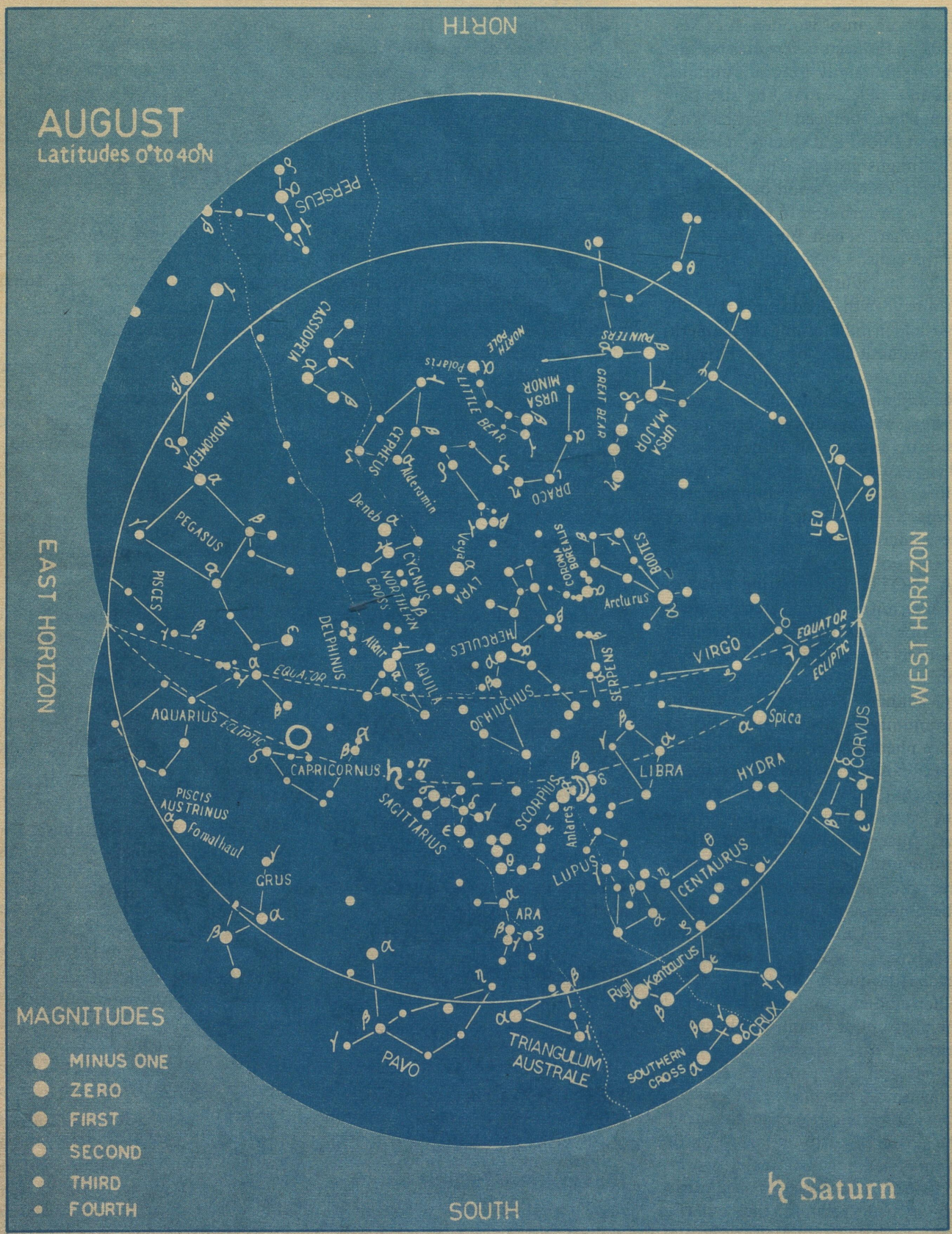

NORTH
AUGUST
Latitudes 0° to 40°N
EAST HORIZON
WEST HORIZON
SOUTH
PERSEUS
CASSIOPEIA
NORTH POLE
Polaris
LITTLE BEAR
URSA MINOR
GREAT BEAR
URSA MAJOR
ANDROMEDA
CEPHEUS
Alderamin
DRACO
Deneb
Vega
LYRA
CYGNUS
NORTHERN CROSS
CORONA BOREALIS
BOOTES
Arcturus
LEO
PEGASUS
PISCES
DELPHINUS
Altair
AQUILA
HERCULES
SERPENS
VIRGO
EQUATOR
ECLIPTIC
Spica
AQUARIUS
OPHIUCHUS
CAPRICORNUS
LIBRA
HYDRA
CORVUS
PISCIS AUSTRINUS
Fomalhaut
SAGITTARIUS
SCORPIUS
Antares
LUPUS
CENTAURUS
GRUS
ARA
Rigil Kentaurus
CRUX
SOUTHERN CROSS
PAVO
TRIANGULUM AUSTRALE
MAGNITUDES
MINUS ONE
ZERO
FIRST
SECOND
THIRD
FOURTH
♄ Saturn

August

THE diagram shows the evening sky as seen from latitudes 0^0 to 40^0N. The inner circle represents the horizon as seen from latitude 22^0 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 Aug. 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 July it is for 10-30 pm and for 16 Sept. 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 15^0 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 Position for August 1990

Date	*1ST.*		*10TH*		*20TH*	
Planets	*R.A.*	*Decln*	*R.A.*	*Decln*	*R.A.*	*Decln*
Mercury	10h 22m	10.3N	11h 00m	4.8m	11h 26m	0.1N
Venus	7h 02m	22.5N	7h 49m	21.3N	8h 40m	19.0N
Mars	2h 43m	13.7N	3h 05m	15.3N	3h 28m	16.9N
Jupiter	7h 53m	21.2N	8h 01m	20.8N	8h 10m	20.4N
Saturn	19h 30m	21.8N	19h 27m	21.9S	19h 25m	22.0S

Adopted form figures supplied by Position Astronomy Centre, Calcutta.

The moon

FULL moon occurs on 6th at 07-49 p.m. and the new moon occurs on 20th at 06-09 p.m. I.S.T. The moon passes about one and a half degrees south of Saturn in the evening of 4th, seven degrees north of Mars in the morning of 14th, about half a degree north of Jupiter on 18th, half a degree south of Venus on 19th and very close to Mercury on 22nd. The moon is at perigee or nearest to the earth on 15th and is at apogee or farthest from it on 28th. The lunar crescent becomes first visible after the new moon umbra at 09-11 p.m. I.S.T.

The planets

Mercury *(Budha)*, visible in the evening sky, sets about an hour after sunset during the month being in greatest eastern elongation of about 27.4 degrees from the sun on 12th. It becomes retrograde on 25th. At the end of the month it comes too close to the sun to be visible. It is in Leo *(Simha)*. Its visual magnitude varies from 0.0 to +1.3.

Venus *(Sukra)*, visible in the morning sky, rises about one and a half hours before sunrise during the month. It passes about seven degrees south of the star Pollux *(Punarvasu)* on 9th. It moves from Gemini *(Mithuna)* to Cancer *(Karkata)*. Its visual magnitude is about —3.9.

Mars *(Mangala)*, visible in the morning sky, rises about an hour before local midnight during the first of the month and about one and a half hours before it during the second half. It is in quadrature with the sun on 13th. It moves from Aries *(Mesa)* to Taurus *(Vrisha)*. Its visual magnitude is about —0.2.

Jupiter *(Brihaspati)*, visible in the morning sky, rises about one and a half hours before sunrise during the first half of the month and about two hours before it during the second half. It is in Cancer *(Karkata)*. Its visual magnitude is about —1.8.

Saturn *(Sani)*, visible in the evening sky, sets about three and a half hours after local midnight during the first half of the month and about two hours after it during the second half. It is in Sagittarius *(Dhanus)*. Its visual magnitude is about +0.2.

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

BREAKING THE SILENCE

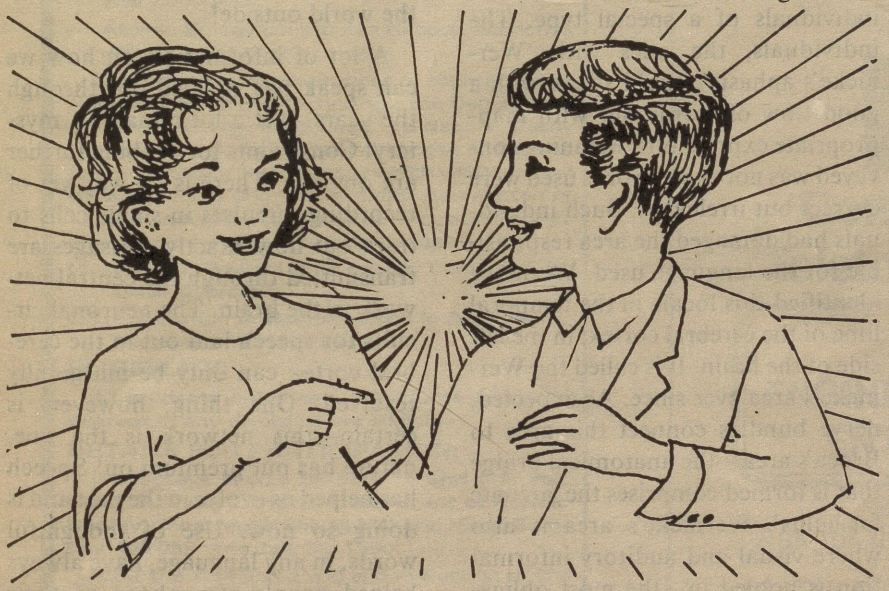
Medha S. Rajadhyaksha

SOME days dawn with a general feeling of well-being making spirits soar for no specific reason. So much so that even travel in an overcrowded public transport does not seem a bad proposition. In fact, it turns out to be an enriching experience! The sheer variety of people, one is thrown in with, is food for observation and contemplation for the next twenty minutes of jostling. And if one chances to be placed near a pair of chatter boxes, the journey is an absolute success! An unusual chance is being stationed near 'silent' chatter boxes, ones who will use their fingers and palms to gesture out to each other. Laughing to themselves, they are a world apart, as the rest watch on inquisitively. Trying to decipher their rapid movements turns out to be quite frustrating. However, their efficient communication skill fails them suddenly when somebody with a special faculty approaches. Their bliss is broken by the spoken words of others. Speech, the mode of communication, used so freely, often with little reverence to what its effect may be, is not for some. And these few we meet sometimes, struggling to reach out, sharply focus how important the faculty of speech is in our social existence. These few who are braving the din of the world in silence are also the ones who have helped us most to find out more about the special capacity of ours to form words and sentences. Breaking their unfortunate silence is a major challenge to the world of science.

Sound that conveys quickly, what is perceived by one to another is an innate requirement of interdependent individuals. Calls varying in pitches, in loudness and in duration are used by a large number in the animal world—for alerting each other against danger, for aggression or for wooing a partner. The use of sound acquires an exclusive quality in human beings. The need to understand each other seems to be far more pressing. For an early evolving man, struggling against the harsh realities, food finding and capturing needed to be strategically planned. Small hunting groups, with individuals playing specified roles were probably formed. Effective communications within these groups was a prerequisite of a successful hunt and ultimate survival. An articulate sequence of sounds was definitely the best mode of expression, while hearing was an ideal way of receiving signals for communication could be established even in the dark. Foundation of the faculty that developed into fully articulate speech was probably laid in those hazy, difficult days. Evidences collected as bony fossils of early hominid skull suggests that our remote ancestors had started speaking. The brain of our ancient cousin Homo habilis, probably, did have a centre for speech. These centres of our brain have given us an edge over other primates. The skill of speech has bloomed with our species—so much so that at times it needs to be given a novel name—'noise pollution'!

THE verbal flow that runs so easily involves complicated neural functions. Thoughts or ideas that are to be conveyed; written words that are to be read out, or a heard word that is to be repeated, all need to be transcribed into sound waves. These sound waves should be such that they enable the listener to recapture the meaning as well as the emotions behind the spoken words. A transfer of perceptions from one person's brain to that of others is expected to take place via this acoustic exercise. Waves of sound of a definite quality can be generated by each of us with the help of our 'sound box'

or larynx. Made up of a combination of nine cartilages that are held together by flexible muscles and ligaments, the larynx can assume configurations of various types during speech. The actual wave of audible sound is produced when the air passing out of our lungs is blocked and released successively by a pair of 'vocal cords'. Depending on the characteristics of the larynx and the vocal cords each one of us can produce a wave of sound of certain fundamental frequency—this determines the basic quality of our voice. Further manipulations of laryngeal muscles provide ups and downs in our tones—expressing our emotions.



As the waves of sound pass out through the vocal tract the various parts of the mouth help articulate it into words with right intonations. Generation of words with correct meaning, right diction and desired overtones requires that all the muscles and ligaments of the vocal apparatus receive precise instructions, well under the control of the speaker. These instructions, as expected, originate in our central processing unit—the brain!

INVOLVED in some aspect of the speech production or another, are a little more than forty different muscles of the vocal tract—all supplied by millions of nerve fibres running down from the brain. Forming the nerves that bring in the messages are the motor neurons—in turn receiving pulses of information from the outermost part of the brain—from the cortex of the cerebrum. Extending across in an arc like fashion, between the two ears, is a special part of the cerebral cortex—the motor part. It is this area that governs, in general, the movements of the muscles in our body. A part of the motor cortex, on either side of the brain, is where impulses that are sent to the speech muscles are evoked. A damage to this location in the brain causes disorders of speech or 'aphasia'—for no signals can be transmitted to the vocal tract muscles. The person with a damage to this part of the motor cortex can comprehend written or spoken words but is unable to form words in response. Aphasia can be due to even more serious yet subtle reasons.

Damage to some other regions of the cerebral cortex could affect comprehensive and articulate speech. A painfully laborious study of brain anatomy of normal and aphasic individuals has, in fact, helped map the other important centres in the brain helping in our verbal outflow!

The middle of the nineteenth century witnessed several original scientists. Though some did not gain eminence, their contributions cannot be undermined, for they paved the path for conclusive discoveries. The early ideas, about where the 'organ of speech' was located, was put forward by the phrenologist F.J. Gall. Frontal lobe of the cerebral cortex was suggested as this site. Marc Dax, a general practitioner in France went a step ahead and proposed that the frontal lobe of the left hemisphere of the cortex was alone involved. These observations passed un-noticed till Paul Broca brought them up by his study. Well known for his progressive scientific ideas a neurosurgeon by profession, Paul Broca had a keen interest in anthropology. In a discouraging environment he laid the foundation of research in anthropology in France. In his lifetime he made a fine collection and a biometric study of numerous brain specimens. Brains of all sorts and sizes, of apes and of men, of old and of young, of normal and of abnormal individuals comprised his remarkable collection.

Scrutinizing and measuring meticulously, Broca recorded several interesting observations—some so important that they linked his name to a part of our brain forever. He identified a well defined area in the frontal lobe of the cortex that was invariably damaged in aphasic individuals, while it was intact in normal ones. Further, a similar damage on the right side did not cause any speech defect. The two hemispheres, though apparently forming identical halves of the brain, seem to have functional preferences. The speech center, identified conclusively by Broca, is a little anterior to the motor centers responsible for movement of muscles for speech and is known

after its discoverer as 'Broca's area'. The Broca's area, which is a center that co-ordinates facial muscle movements and the perceptions of the brain to form strings of words, is indispensable for normal speech!

The close proximity of Broca's area and the motor center for speech suggest a very close link between the two. So intimate is their relation that often a damage caused to the Broca's area leaves the adjacent motor area also impaired. The result is facial paralysis with loss in speech. On the other hand, there are situations where a lesion is restricted to Broca's area alone. The speech disorder that arises, known as 'Broca's aphasia', enables the individuals to use the facial muscles very efficiently for vocal functions other than articulate speech. Singing without a hitch is possible for them, but words can be pronounced slowly and with utmost difficulty. The speaker can convey the meaning by forming telegraphic sentences—with some words missing. Delinked words and grammatically incorrect sentences are marked features of Broca's aphasia. Such failure persists even when it comes down to putting words on paper. Surprisingly, however, the comprehension of language is little affected. Apparently, understanding the language is not really a function of the Broca's area—yet it is the link between what is comprehended and what, in turn, is actually said. The center where all aspects of language are taken care of is a distinct one—though well connected to the Broca's area.

In man, the faculty of speech has evolved to almost the ultimate. Words often convey more than what they actually mean. The use of phrases and idioms add beauty as well as symbolism to speech. The phrases used are relevant if understood; if not, they mean something totally out of context! The appreciation of subtle analogies that we use in our language require a higher neural function. Use of some words that can have far more perceptual implication than what they literally mean requires a different level of cerebral integration. The locus that is involved in adding this flourish of language to our speech is a distinct one. This center, where our knowledge of language and sensory association with words is integrated, was identified by a young German scientist Carl Wernicke. At the age of twenty four, he published his conclusions based on the study of aphasic individuals of a special type. The individuals, the ones with 'Wernicke's aphasia', could speak with a good flow of words but with inappropriate expressions. Meaning conveyed was not exact, words used were correct but irrelevant. Such individuals had damaged the area responsible for the language used. Wernicke identified this locale in the temporal lobe of the cerebral cortex, in the left side of the brain. It is called the Wernicke's area ever since. As expected, nerve bundles connect this area to Broca's area—the anatomical bridge that is formed comprises the 'arcuate faciculus'. Wernicke's area is also where visual and auditory information is pooled in—the most obligatory input when it comes to reading and writing!

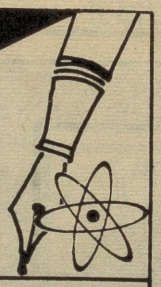
MORE than hundred years ago, Wernicke proposed a model for speech. The fundamental propositions of his scheme still hold good, though a lot has since been added on. The motor area that sends impulses down to the speech muscles does so under the supervision of Wernicke's area, which has turned out to be the 'all knowing' part of this cortical drama for speech production—responsible for correct use of language, grammar, context and the use of abstract words! The net information that arrives at the vocal apparatus puts it into action! Whether the right word is pronounced or not, exactly as instructed by the commanding headquarters, is relayed back through sensory receptors that stud the vocal tract. Pressures felt by the nerve ends in the vocal tract help the brain to judge the movement of articulators like the tongue or the lips. If modulations for diction and overtones need to be made, appropriate messages are pushed back to the articulators. Indeed, a beautiful network of communication built up within helps us communicate with the world outside!

A lot of information on how we can speak has trickled out through the years—yet a lot remains a mystery! Constraints for probing further are obvious. There is no way yet of recording impulses in single cells to trace out how exactly messages are transmitted through the central network in the brain. The neuronal circuits for speech laid out in the cerebral cortex can only be marginally resolved. One thing, however, is certain—this network is the one, nature has put premium on! Speech has helped us evolve in the past and is doing so now. Use of thoughtful words, in any language, have always helped people stay ahead of their times. Civilisation where words are used with respect and with a consciousness of how they affect others, have been progressive ones. The power of words is truly great for they can be stored as books or audio-visuals for communicating with the generations of a distant future. Indeed, this enlightening faculty of speech that is taking us a long way deserves to be used with utmost care!

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

Essay Contest

Nuclear Science and Technology



BACKGROUND:

Today —

- India is one of the few countries which are self-reliant in nuclear technology,
- The country has a strong research and development infrastructure,
- Research laboratories and nuclear installations are spread all over the country,
- India is a leading producer of radioisotopes and radiopharmaceuticals,
- The country's present installed nuclear power generating capacity is of 1465 MWe. It is planned to be increased to 10,000 MWe by the year 2000 A.D.
- Atomic Energy contributes to socio-economic development of the country.

To promote public awareness of applications of Nuclear Science and Technology, the Department of Atomic Energy is conducting a National Essay Contest. The participants shall choose one of the following topics for the essay which will be limited to 5000 words and will be either typewritten or neatly handwritten on foolscap sheets in English or any of the Indian official languages:

(1) **Nuclear Power: Is It Benign Compared to Other Sources?**

(2) **Application of Radioisotopes in Agriculture, Medicine and Industry.**

ELIGIBILITY:

All students studying for graduate or higher degrees in any discipline are eligible.

DETAILS FOR PARTICIPATION:

The essays should be sent to **Shri P.P. Pai, Head, Publicity Division, Department of Atomic Energy, Chhatrapati Shivaji Maharaj Marg, Bombay-400 039 upto July 31, 1990.**

After the first screening and evaluation of the essays, a limited number of participants will be invited to Bombay towards the end of October, 1990 for oral presentation of the essay. First class return railway fare from their place of residence to Bombay and free boarding and lodging in one of the guest houses of the Department will be provided. The award presentation will be made on the Founder's Day, October 30, 1990, in Bombay. (Oct.30, 1990 is the birth day of Dr. Homi J. Bhabha)

PRIZES:

The following prizes will be given for each topic :

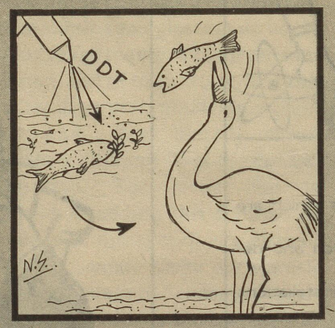
- **First Price : Rs. 5,000/-**
- **Second Price : Rs. 3,000/-**
- **Third Price : Rs. 1,500/-**

The remaining participants who make the oral presentation, will be given **consolation prizes of Rs. 500/- each.**

D.A.V.P 90/151

Q. What is biomagnification?

Ashish Dutta
Sindri (Bihar)

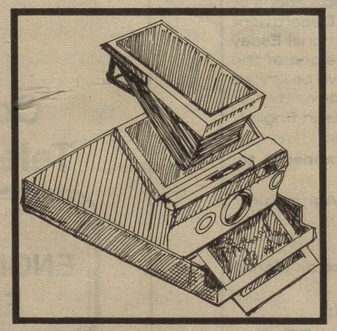


A. The term is used for the process of accumulation and concentration of toxic substances such as DDT and mercury in living organisms through the food chain. For example, when DDT is sprayed in fields or city drains its concentration in water is not very high. But when insects, small crustaceans and vegetation living in the contaminated water are eaten by fish, the pesticide gets accumulated in their body tissue. The level of DDT in the fish may reach several times that of the original level in water. When a fish-eating bird now eats the contaminated fish, the DDT gets further concentrated in its body. If too many contaminated fish are consumed by the bird, its tissue level of DDT may become so high that it dies.

Biman Basu

Q. How does a Polaroid camera produce instant photographs?

Philippa S.
Bhilai (M.P.)



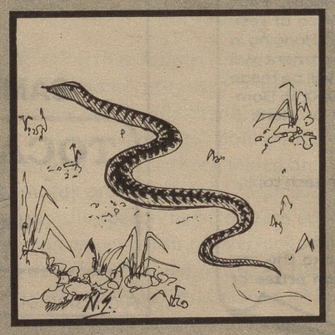
A. The optical system of a Polaroid camera is just like any other photographic camera. But the film pack used in a Polaroid camera is different from ordinary colour films. Colour films exposed in conventional cameras have to be processed in a lab under controlled conditions. For getting colour prints, a negative is first produced from which prints are made which takes time.

The film pack used in a Polaroid camera, on the other hand, carries its own colour printing paper and colour processing chemicals as a paste in small, flat capsules which break to release and spread the chemicals between the film and paper as the two are moved through rollers in the camera after exposure. The processing of the Polaroid film does not require water or additional chemicals and a dry, full-colour print is ready within 60 seconds. The actual chemicals used and the developing process are, however, a trade secret.

B.B.

Q. How do snakes move without legs?

Masood Ahsan
Gulbarga (Karnataka)



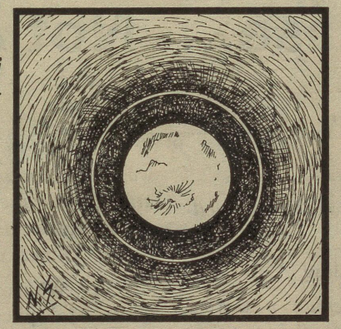
A. Snakes don't have legs, but they have a highly flexible backbone and a belly covered with big, strap-like scales which they use for moving from one place to another. A snake may move by simply bending its flexible body into the familiar S-shaped form along the ground and use the curves to push against obstacles such as clumps of grass, shrubs, stones and so on.

It can also move in a straight line by pushing the free edges of its belly scales, which are powered by strong muscles, against irregularities on the ground. Some species can even climb trees by hooking the belly scales onto the bark.

B.B.

Q. Why is a faint white ring seen around the moon on a cloudy night?

Naveen Sethi
Jaipur

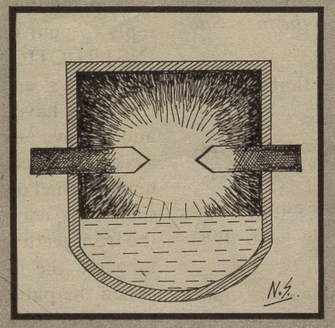


A. This phenomenon, known as a halo, is caused by the refraction of light by tiny ice crystals in some types of high-altitude clouds. Ice crystals, which are usually hexagonal shaped, can also exist either as long needles or flat plates. Since the crystals are randomly oriented in the cloud, they can produce a complex series of internal reflections which, from ground, appear as circles of light. The phenomenon is very similar to the formation of rainbow by internal reflection and diffraction of sunlight by raindrops. But unlike a rainbow which is seen in a direction opposite that of the sun, a halo is always seen in the same direction and surrounding the object producing it (the moon in this case). The radius of the smallest halo is such that it produces an angle of 22° at the observer.

B.B.

Q. How does an electric arc furnace work?

Tripurari Tripathi
Balia



A. An arc discharge occurs whenever a contact is broken in an electric circuit. In an arc furnace, the arc is produced when two graphite or carbon electrodes are brought into contact with each other and are then moved apart a small distance. Just before the carbon rods separate, such a high resistance is developed at their boundary that the tips of the carbon begin to glow. At the same time the air in the gap is ionized and continues to conduct the current to maintain the arc which produces a high temperature, of the order of 4000°C. If an electrically conducting material such as steel is to be melted in an arc furnace, the charge itself can serve as one of the electrodes. An arc furnace requires a heavy current of several hundred amperes, but a voltage of only 50 to 150 volts.

Jagdish Bist

Epilepsy— A Disease.... Not A Curse

Suresh Nadkarni

"What is wrong Uma? You look worried .."

"Worried about my sister—Hema—Doc! They are telling me to take her to an exorcist .."

"Who are 'they'? and why are they telling .."

"They, my neighbours tell me that Hema is possessed by devils. It's a disgrace for the family, according to them. They say, she is mad. Hence they do not talk to her .."

"But Why? What has your sister done?"

"I will have to narrate the incidence, Doc! She was standing in the balcony. Suddenly she started staring upwards and fell down on the ground. She was injured. Blood started flowing from her wounds on the face. She was frothing at mouth .."

"When she got the attack, did you feel that she was trying to bite something?"

"Yes Doc! and after she fell down, her hands and feet started shaking violently".

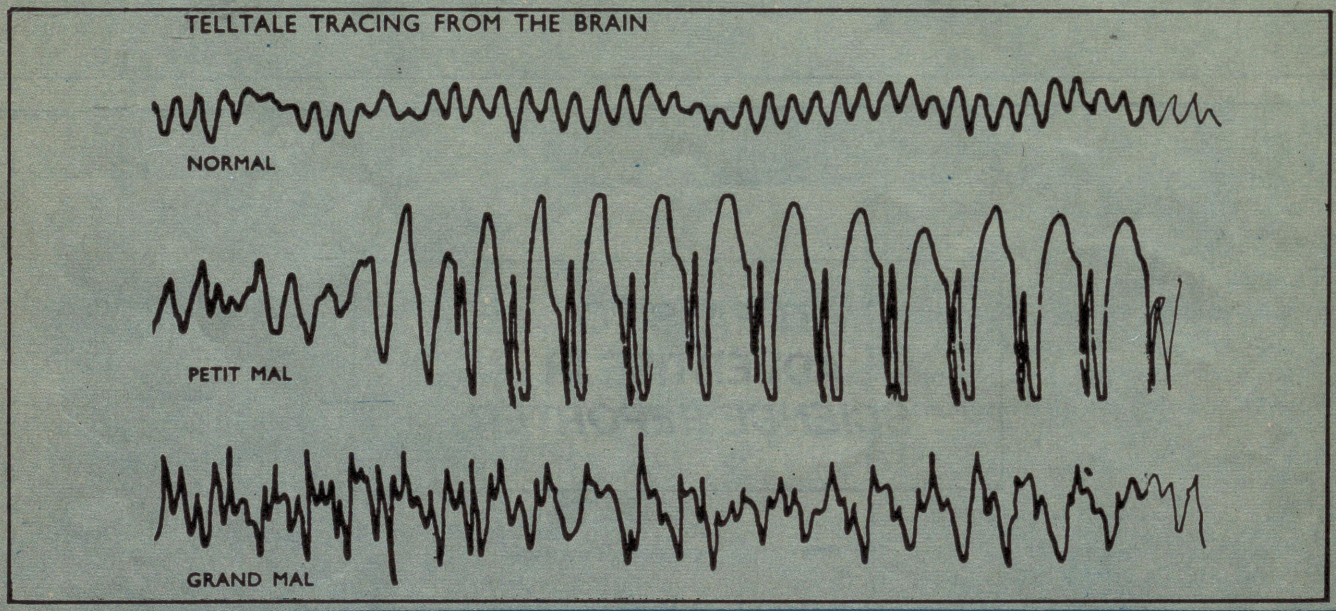
"O.K.! Before this happens they get an aura—some suggesting symptoms, such as ringing in the ears, spots before the eyes or tingling in the fingers .."

"Yes! Yes Doc! She did tell me that she saw some spots. And Doc, more frightening was that, we discovered, she was unconscious throughout this attack—even after the attack. After the convulsions stopped, she was breathing heavily. After about ten minutes she asked 'What happened?" Where am I?"

"Oh .. What you are describing is a typical picture of Grand Mal epilepsy! Forget about those exorcists and all that humgbug .."

"Yes Doc! But before you tell me about the disease, tell me, as to what I should do, if she gets a similar attack in front of me?"

"You have asked an important question Uma. The reply to your question is always given in 'FIRST AID INSTRUCTIONS'. Any way I will tell you—There are some 'Do's' and some 'Don'ts'. In the 'DO-LIST', first thing you have to do is to lower the patient to the floor and remove any hard objects (around) he or she might strike. The second thing you should do is to twist a handkerchief or a roll of paper between back teeth on one side of his/her mouth. It should be large enough to keep the front teeth apart and too big to swallow. This is done to avoid the biting of the tongue during convulsions. When the patient is clenching the teeth during convulsions, DO NOT try to force the mouth open. Wait it to



relax momentarily. DO NOT put your fingers in patient's mouth, lest your finger may be badly bitten off. DO NOT try to force liquids down his/her throat or move the patient during the convulsion. Do have him rest quietly, when the attack is over, until he regains consciousness fully. Do observe all details of seizure to report to the doctor. DO NOT rush the patient to the hospital unless he/she has had a series of seizures".

"Thank you Doc! But she passed urine also during the attack, I am ashamed to say .."

"That is of common occurrence in Grand mal epileptic seizures why should you feel ashamed Uma?"

"Yes Doc! But are there other types of epilepsy?"

"I will tell you! In minor seizures or *petit mal* the loss of consciousness is momentary, lasting only a few seconds. Although there is after twitching about the eyes or mouth,the victim remains seated or standing and appears to have had no more than a lapse of attention or a moment of absent-mindedness. Petit mal occurs most frequently in children. In the third type of seizure, *psychomotor epilepsy,* there is a brief clouding of consciousness with some repeated meaningless movements such as clapping of hands. It is followed by brief periods of forgetfulness".

"But Doc, how long do these seizures last?"

"Not for Long! All three types of seizures last from a few seconds to a minute or two. I must tell you about their frequency also. It may vary from once a year to several times a day".

"What is the cause of epilepsy Doc!"

"Epilepsy, Uma, is a disorder of the nervous system of which the major symptom is convulsive seizures. An epileptic seizure is the result of temporary disturbance of the brain impulses. It might be compared to a burst of static on the radio. It is sometimes called *cerebral dysrhythmia,* meaning a disturbance of the brain's normal rhythm. Apart from the tendency to suffer this temporary disturbance, there is frequently nothing wrong with the brain as far as intelligence and emotions are concerned".

"So epilepsy is a curse!"

"You are trailing many years behind the modern world, Uma, as epilepsy was looked on as a disgrace or even as possession by devils. Unfortunately, people who suffered from it were shunned, regarded as insane or at least "peculiar". Parents would try to hide that their child had epilepsy".

"That would devoid them of diagnosis and treatment!"

"Of course, unfortunately this happened. Consequently people with epilepsy had to endure not only disorder but humiliation and a sense of inferiority that set them apart from others".

"But, how do you diagnose epilepsy Doc?"

"Anyone who has fainting spells, fleeting unconsciousness, convulsions or fits of any sort should have his illness studied by a competent doctor. The symptoms may be due to a disorder other than epilepsy, such as diseases of heart, or arteries, nervous reflex disorders and psychoneuroses. In order to make a diagnosis of epilepsy, a number of tests may be required. An electroencephalogram (EEG) record is helpful; this is made by a machine which records the brain waves, showing the electrical activity of the brain. X-ray of the skull and brain scan (CAT SCAN) may be advised by your doctor for the exact diagnosis"

"How is epilepsy caused, Doc?"

"The first type is Acquired epilepsy, also called symptomatic epilepsy. Acquired epilepsy has a physical cause, such as brain tumour, birth injuries to the brain or a wound or blow to the brain. These injuries irritate the brain and set off an abnormal electrical discharge. In a small percentage of cases, this form of epilepsy may be cured by surgery to remove the tumour or repair the injury. In Jacksonian epilepsy, the specific portion of brain controlling certain muscles may be diseased or irritated. The convulsions will start in a specific group of muscles such as in a hand or leg and progress to involve other muscles. This may lead to a grand mal attack. Idiopathic epilepsy is the most common type. Usually it manifests first in childhood. Eighty per cent of victims have their first seizures before the age of 18. This type of epilepsy runs in families. This should be borne in mind when two, from epileptic families are getting married. Of course, as the name suggests, the cause of this epilepsy is unknown".

"How is epilepsy treated, Doc?"

"Several very effective new medicines are available today. They eliminate or greatly reduce the seizures. These anti-convulsants include phenobarbital, phenytoin, carbamazepine, ethosuximide .. and so on. The patient is asked to avoid exertion. He should have regular habits of eating and sleeping, adequate diet. He should avoid alcohol".

"With all these drugs and other supportive measures, do the epileptics recover fully?"

"Yes! Of Course! But many a times there is poor compliance from the patients. It is vitally important for every

patient to see his doctor at regular intervals and to continue taking the medicine *until instructed to stop.* Patients who stop medication, (which is really to be continued for a long period—say five years, at times) without instructions may suffer from recurrence of their attacks, which must be brought under control all over again. After the patient has taken the medicines for last two years and successfully controlled the seizures, if he stops the medicines and gets even one seizure, medically he is back to square one! He has to restart all these medicines and take them for five years."

"I understand, Doc, that the medicine regime is to be strictly followed. But your five year period of treatment frightens me Doc."

"Actually there is nothing to worry about this Uma! If there have been no attack for a sufficient period of time, the doctor gradually cuts down the medication, but patient should not decide about it himself"

"What about Hema's future, Doc? Can she earn independently or will she be dependent for the life time?"

"NO! NO! Uma!! Don't you worry that way. Individuals with epilepsy can now hold responsible positions and lead practically normal lives, with few restrictions beyond having to take medicine and consult doctor. An essential restriction is that they must not drive a car or ride a scooter. Even swimming is not desirable. Psychiatric help may be valuable to some cases. To supply information on all aspects of epilepsy, 'Epilepsy Associations' are established in Western countries. It's a high time that we should also have such useful organisations!"

"Thank you! Anything else, you would like to tell me Doc?"

"Yes! People should not be frightened of this disease. Their attitude towards the epileptic should be changed. Fits can be triggered off by trivial reasons such as fluorescent lights or watching television. If they exist, epileptics should avoid them. Young people entering a career should avoid working on heights and near unprotected machinery or fire. If a child is epileptic, make sure his teacher understands how to react and what to do!"

"Thank you Doc! I am emboldened by your talk and now I have understood as to what to do in Hema's case!"

Dr. Nadkarni is a practicing physician. Flat 38-39, 5th Floor, Municipal Building, Jobanputra Compound, Nana Chowk, Bombay–400 007

Louis Pasteur's Heritage

MAXIME SCHWARTZ

THE name of Louis Pasteur is known throughout the world. In France each town has its "rue Pasteur", "avenue Pasteur", "Boulevard Pasteur" or "Place Pasteur", and this is also true in many towns in other countries. Such fame is well deserved. The world was not the same before and after Pasteur. His work has revolutionized chemistry, agriculture, industry, medicine and hygiene.

The diversity of the fields in which Pasteur practised his talents is astounding. However, a remarkable continuity underlies this diversity. Each of his discoveries is but one link in a continuous chain from the study of crystals of tartaric acid to rabies vaccine. Molecular asymmetry, fermentation, spontaneous generation, studies on wine, disease of silkworms, studies on beer, infectious diseases, vaccination, all of these subjects were approached in a logical way.

Pasteur's work in crystallography marked his entry into science, and he emerged at once as a master in experimentation. The study of organic crystals led him to the notion that molecules of living cells are asymmetric, that molecular asymmetry is a mark of life.

Pasteur in his lab

THE finding of optically active substances in fermentation media was a first clue, for him, that fermentation was caused by microorganisms and not, as most scientists then assumed, by a set of spontaneous chemical reactions. He further proceeded to show that each type of fermentation was caused by a specific microbe and then, quite logically, he wondered about the origin of these microbes. Did they appear spontaneously in the fermentation media, or did they come from the environment? With a remarkable experimental skill Pasteur demonstrated the invalidity of all experiments purported to prove the existence of spontaneous generation. For one studying the process of fermentation, the study of the diseases of wine and beer was the logical next step. These diseases, as Pasteur showed, were due to the presence of the wrong kind of microbe during or after the fermentation process.

Soon Pasteur was struck by the apparent similarities between fermentation and infectious diseases. Could it not be that infectious diseases, like fermentation, might all be caused by microorganisms, each disease being linked to a specific microbe? The disease of silkworms, then the source of great concern to the silk industry in France, provided him with a first model to test this idea. From there he proceeded to the

Dr. Schwartz is Director of Institut Pasteur, Paris

study of anthrax, chicken cholera, and rabies... but I will come back in a few moments to that part of the story.

Aside from its continuity, the work of Pasteur is characterized by a constant interplay between the quest for the basic laws which govern Nature and the search for solutions to practical problems posed by industry, agriculture or medicine. To Pasteur there was no distinction between a "pure" science and an "applied" science.

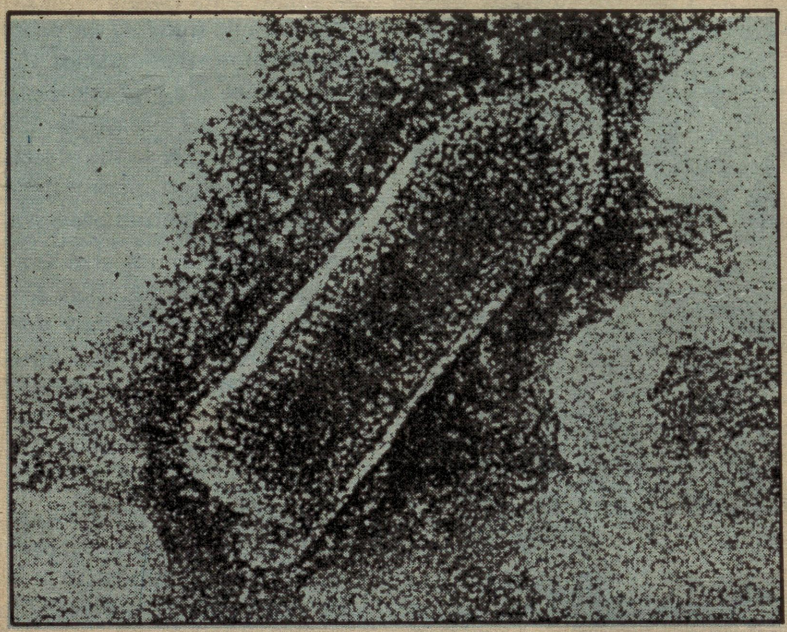
SCIENCE and the applications of science are linked together as is the fruit to the tree which bears it. What's more, Pasteur does not specify which is the tree, and which is the fruit. Indeed, and Pasteur's career is here to show it, the applications are the product of science, but, conversely, important basic concepts originate from the study of applied problems.

When the young Pasteur sorted manually the two types of tartaric acid crystals he had no applications in mind. His interest in the process of fermentation, a logical continuation of his work on crystallography, was also largely a consequence of his attempts to solve problems encountered in a local industry at Lille, where he had just been appointed a professor.

The work on fermentation, while it did lead to considerable progress in the industries of vinegar, wine and beer, also led him to refute the theory of spontaneous generation, a very important basic concept, at the time.

Another example is the work on silkworms. While he solved a major problem for the silk industry, Pasteur, at the same time, established some of the basic rules concerning the origin of infectious diseases. Was that research applied, or basic?

The continuity underlying a rich variety of discoveries, and a constant interplay between science and its applications, are two main characteristics of Pasteur's work. They also characterize the history of the Institute founded by him a hundred years ago.

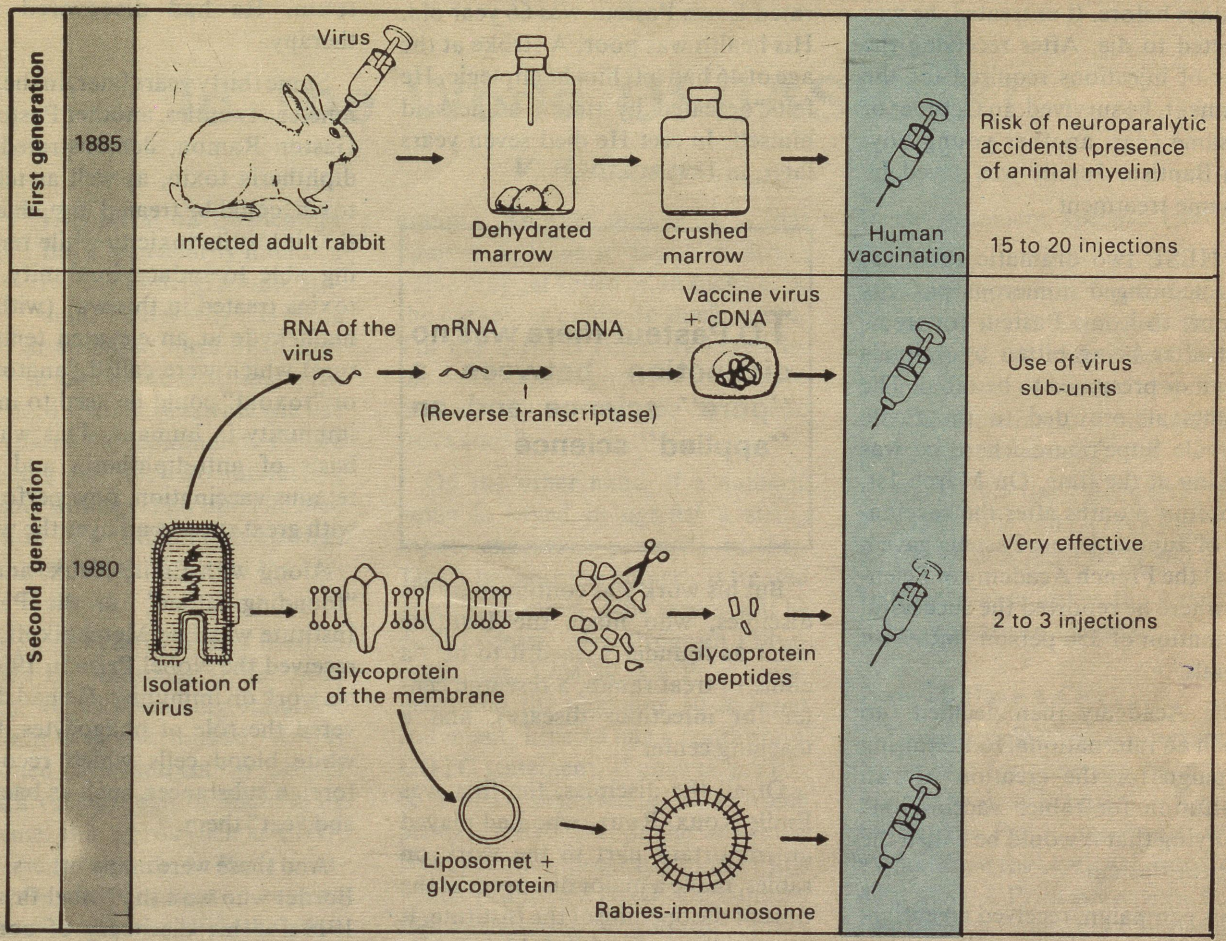


The bullet-shaped rabies virus

But let us go back to the events which led to the foundation of this Institute.

As I recalled earlier, after his work on fermentation Louis Pasteur started to approach the problems of animal diseases. He soon became convinced that transmissible diseases, like fermentation, were due to specific microorganisms.

IN the late eighteen seventies he was working on chicken cholera when he made, partly by chance, a crucial discovery, which was the key to the making of vaccines. He had then isolated the bacterium responsible for this animal disease (the bacterium is now called Pasteurella) and was able to cultivate it in liquid media. Whenever some of the culture was inoculated into a chicken, the chicken would become sick and die rapidly. Once, during the summer of 1879, a collaborator of Louis Pasteur, Charles Edouard Chamberland, preferred to go fishing in the Seine river during the weekend, rather than going to the laboratory to transfer the culture to fresh medium as he was supposed to do. The next week this culture was inoculated into a chicken. The chicken became sick, but did not die. Very surpised by this finding, Louis Pasteur was then told what had happened with the culture. He decided that the same chicken should be reinoculated with another culture, properly grown this time. He was in for another surprise: the chicken still refused to die. This, as it later turned out, was a great discovery or, rather, a double discovery. If the chicken did not die the first time, it was because improper culture conditions had led to an "attenuation" of the microorganisms. The bacterium was still alive, but had lost its virulence. If the chicken did not die the second time, it was because the inoculation of the attenuated microbe had induced an immunity to the virulent microbe.



Human anti-rabies vaccine. Pasteur in 1885 prepared his vaccine from infected brain of rabbit which exposed patients to neuroparalytic accidents. The development of new techniques in molecular biology and biotechnology in the 1980s have made possible preparation of a safe vaccine with only a fraction of the antigen responsible for protection against the disease

Very soon thereafter Louis Pasteur carried out a very similar experiment in the case of anthrax, an animal disease of great economical importance at the time. He could attenuate the anthrax bacillus, and use this attenuated microorganism to vaccinate animals against the virulent microbe. This was elegantly demonstrated in the famous experiment of Pouilly le Fort, in 1881, when 25 vaccinated sheep survived the injection of the virulent anthrax bacillus, whereas the 25 non-vaccinated sheep died.

These successes with animal diseases convinced Louis Pasteur to work on rabies, a disease affecting both animals and man. Technically, the problem was far more difficult than the ones he had approached before. Unlike the microbes responsible for the disease of silkworms, chicken cholera or anthrax, the microbe responsible for rabies had never been "seen" by anyone, and could not be cultivated in any kind of medium. The reason, as we know now, is that the microbe involved is not a bacterium, but a virus, which can only be seen using an electron microscope (invented in the nineteen thirties), and which only multiplies within living cells. In spite of these difficulties, Louis Pasteur and his collaborators were able to grow the microbe, by inoculating it into the brain of rabbits. The virus multiplied within the nervous system of the animal, and could be recovered from their spinal cord. Attenuation of the virus was obtained by drying these spinal cords for several days at 23°C, in a dry and sterile atmosphere. When injected into dogs, fragments of the spinal cords protected them against an infection with rabies virus, even if the infection occurred slightly before the inoculation.

Louis Pasteur had been experimenting with dogs for a little over a year when he decided to apply the treatment to man. This was on July 6th, 1885, when injections of spinal cord were given to Joseph Meister, a 9-year old Alsatian boy who had been gravely bitten by a rabid dog

two days before. If untreated, he was expected to die. After receiving the series of injections required for the treatment, he survived. In October of the same year, another young boy, Jean-Baptiste Jupille was saved by the same treatment.

THESE two dramatic successes encouraged numerous patients to come to Louis Pasteur for treatment after being bitten by animals known or presumed to be rabid. The patients all crowded to the Ecole Normale Supe'rieure where he was working at the time. On March 1st, 1886, four months after the vaccination of Jupille, Louis Pasteur gave a talk at the French Academy of Sciences, where he reported the successful vaccination of 350 persons bitten by animals.

The Academy then decided to launch an international fund–raising campaign for the creation of an "institution for rabies vaccination" specifying that it would be called the "Institut Pasteur"

This campaign, received an enthusiastic response. Thousands of people, from poor workmen to the Emperor of Brazil, the Tsar of Russia and the Sultan of Turkey... and the French government gave according to their means. By the end of 1887, the equivalent of 56 million francs in today's currency (approximately 8 millions $ US) were obtained. By then a piece of land had been acquired in what was then the outskirts of Paris. In June 1887 the construction started and a decree, signed by Jules Gre'vy, President of the French Republic, acknowledged the existence of the Pasteur Institute as a private, state–approved foundation.

On November 14th, 1888, the Pasteur Institute was inaugurated, in the presence of the new President, Sadi Carnot.

When the Institute was inaugurated Louis Pasteur was 66 year old. His health was poor. A stroke at the age of 46 had left him hemiplegic. He felt "defeated by time", as he said himself. In fact He died seven years later, in 1895.

TO Pasteur there was no distinction between a "pure" science and an "applied" science

But his work was continued by his disciples, who made the Institute what its founder wished it to be: "a clinic to treat rabies, a research center for infectious diseases, and a teaching center".

Of all the disciples, the first was Emile Roux. Roux, who had played an important part in the work on rabies, made a major discovery at the time of the opening of the Institute. It was the discovery of diphtheria toxin. Diphtheria, a horrible disease, caused a vast number of deaths in children. Roux and his collaborator, Alexandre Yersin, were struck by the fact that the diphtheria bacillus could act at a distance. Growing in the throat, it could induce a paralysis of the respiratory muscles. Therefore, they looked for a diffusable poison. And they found one, diphtheria toxin, present in culture filtrates. In Germany, Von Behring, a disciple of Robert Koch, discovered that animals injected with low doses of the toxin became immune to it, and had an "anti- toxin" substance in their serum. Roux reasoned that these antitoxins could be used for prophylaxis. Indeed he found that children suffering from diphtheria could be rescued by an injection of serum from horses immunized against the toxin. He had discovered serotherapy.

Some thirty years later, in the early nineteen twenties, another Pastorian, Gaston Ramon, demonstrated that diphtheria toxin, as well as tetanus toxin, could be treated in such a way that it lost its toxicity while remaining able to induce immunity. The toxins treated in this way (with formaldehyde at an elevated temperature) which were called "anatoxins" or "toxoid" could be used to induce immunity in humans. This was the basis of anti-diphtheria and anti-tetanus vaccination, now performed with great success all over the world.

Along with Emile Roux, another "founding father" of the Pasteur Institute was Elie Metchnikoff, who received the Nobel Prize in 1908 for his work on immunity. He had discovered the role of phagocytes, those white blood cells which recognize foreign substances, such as bacteria, and "eat" them.

And there were many others. Jules Bordet who won the Nobel Prizes in 1919 for his discovery of complement. Calmette and Guerin who discovered BCG, the vaccine against tuberculosis, and first appplied it to man in 1921. In 1936, Jacques and Therese Trefouel, Nitti and Bovet discovered sulfa drugs the first truly effective anti-bacterial drugs.

Several other prominent findings were also made by Pastorians who did not, at the time, work at the Institut Pasteur in Paris, but who worked abroad, often in attempts to solve major health problems in tropical countries.

In 1890, only two years after the inauguration of the Pasteur Institute in Paris, Louis Pasteur and Emile Roux asked one of their collaborators, Albert Calmette, a young army doctor, to set up a laboratory in Saigon, (Viet Nam) to fight rabies and

(Continued on page 50)

In The World Of BASIC-XI

V. Ramshesh

THIS serial on Elementary Basic is primarily intended for the undergraduate student. That is why it is being written in a simple way. Each part deals with one command, and programs used therein illustrate the use of the particular command. Before proceeding further, two interesting programs will be taken up. The idea is to show how different commands can be used which illustrate the versatility of Basic.

First, a few clarifications need to be given on what has so far been covered. While discussing variables, one point was overlooked. It was mentioned that subject to proper syntax a variable can be denoted by any name. But words such as END, REM etc., reserved for Basic commands are not permitted to be used as numeric variables. For the same reasons, commands like INKEY$, LEFT$, are not permitted for defining a string variable (these will be covered later).

The next aspect concerns syntax. By syntax is meant how various commands are written. A computer language is so structured that it understands only the correct syntax. But there is one good aspect about a computer. If wrong syntax is used, the error is pointed out. But, what about INPUT statement? Apart from using correct syntax, the information must be keyed in properly. Take an example where two variables are input in the same line number:

50 INPUT M, N

The correct way of inputting is to key in the two numbers separated by a comma. But you may forget the comma. Another possibility is that against a numeric input, a string value may get keyed in. In such cases, the computer comes to one's rescue. Till the input is correctly keyed in, the computer responds with an error message by asking you to "Redo from start".

On the other hand, if a numeric value is keyed in against a string input, execution proceeds further. This is because the numeric is treated as a string input. This aspect will be dealt in detail later. Program 1 illustrates this. Line 20 is a Print statement and the next line 30 is Input statement. Line 40 has a conditional GOTO statement. If answer is YES, control is transferred to line 70 which prints CORRECT. If the answer is NO execution proceeds to next line which prints WRONG. On running this program, a question mark appears after YES or NO. If instead of typing YES or NO, a numeric is input, execution proceeds to line 50 and WRONG is printed. Such ambiguities can be avoided by making the Input statement specific (see Program 3).

Where more than one syntax is permitted for a command, the user must check his system and use the simpler form. Taking a conditional GOTO statement, some compilers permit three forms as:

100 IF N> 100 THEN GOTO 300
100 IF N> 200 GOTO 300
100 IF N> 200 THEN 300

In such a case either the second or third format can be used.

How To Have A Clock

Using simple steps, a program can be written for constructing a clock. Have a look at Program 2. Lines 10 to 30 are Print statements which explain how the clock will work. Line 40 is a blank Print statement. This is followed by three lines of input data; the time in hours, minutes and seconds are to be keyed in separately as soon as a question mark appears. Remember to press Return knob everytime. The time, in hours, min-

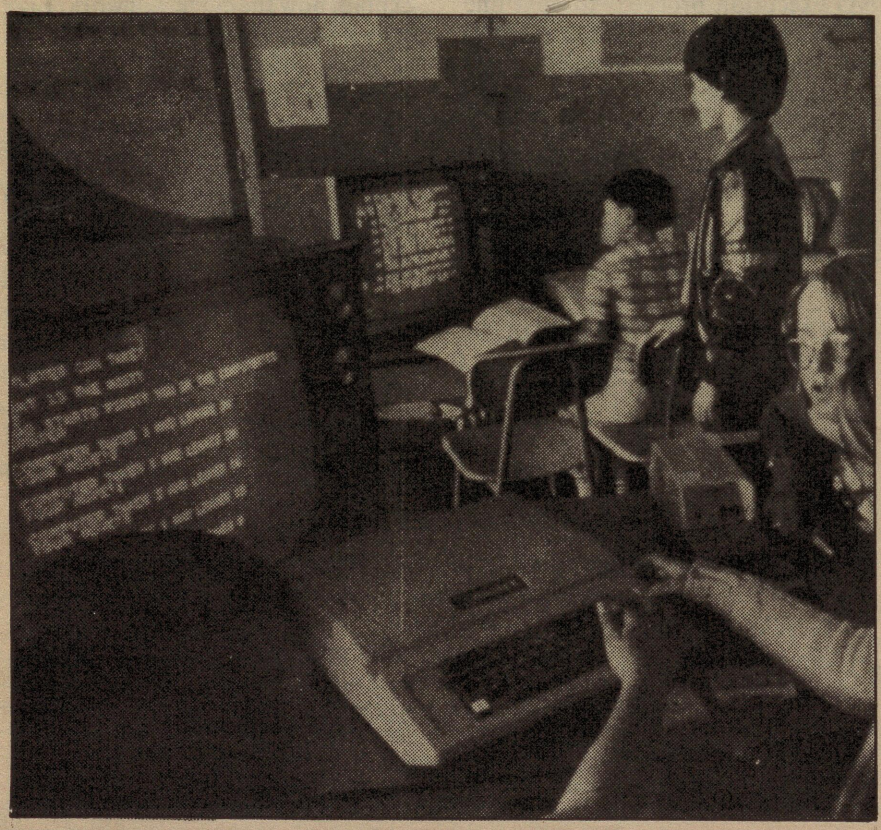
```
10 REM INPUT STATEMENT
20 PRINT "IS SCIENCE REPORTER A MONTHLY?"
30 INPUT "YES OR NO"; M$
40 IF M$="YES" THEN 70
50 PRINT "WRONG"
60 END
70 PRINT "CORRECT"
80 END
RUN
IS SCIENCE REPORTER A MONTHLY?
YES OR NO? YES      (Return knob pressed)
CORRECT
RUN
IS SCIENCE REPORTER A MONTHLY?
YES OR NO? 60    (Return knob pressed)
WRONG
```

Program 1. Right and wrong way of inputting

utes, seconds is stored against three variables H, M and S respectively. The screen is then cleared as per command in line 80. Statement in line 90 prints the time. For the time being forget lines 110 to 130. In line 140, S is incremented by 1 thereby increasing time by 1 second. Line 150 contains a conditional GOTO statement; it says that as long as S> 60, control should go to line 80. As line 80 has CLS command, the screen gets cleared. In effect, the old time is erased and as per next line the new time appears. The moment S becomes 60, execution goes to the next line 160, where S is set = 0 and in the very next line M is incremented by 1. Line 180 contains a conditional GOTO statement and performs the same sequence of operations for incrementing minutes. Till M becomes 60, execution goes back to line 80. When M becomes 60, execution goes to line 190. As per command in this line, M is set = 0. In the next line, H is increased by 1. At this stage control is again transferred to line 80. The clock thus keeps on working.

The purpose of lines 110, 120 and 130 is to take care of the speed of the computer and synchronise it with the time desired (1 sec). Lines 110 and 130 constitute a delay loop in which a variable D is varied from 1 to 120. As explained in REM statement in line 120, the computer does nothing (except counting from 1 to 120) during the operation of this loop. In short, the time taken by your computer to perform this operation should be 1 second (the upper limit of D has to be suitably adjusted). When D reaches 120, execution comes out of the loop going to line 140. As line 80 has a CLS statement, the time will flicker on and off. If the clock is to run continuously, an additional line 205 has to be inserted as:

205 IF H=13 THEN H=1



```
5 REM CLOCK PROGRAM
10 PRINT "INPUT THE TIME"
20 PRINT "AND YOU WILL SEE A
CLOCK"
30 PRINT "IT WILL FLICKER ON
AND OFF"
40 PRINT
50 INPUT "HOURS=  "; H
60 INPUT "MINUTES=  "; M
70 INPUT "SECONDS=  "; S
80 CLS
90 PRINT "TIME IS  "; H, M, S
100 PRINT
110 FOR D=1 to 120
120 REM DO NOTHING
130 NEXT D
140 S=S+1
150 IF S <60 THEN 80
160 S=0
170 M=M+1
180 IF M<60 THEN 80
190 M=0
200 H=H+1
210 GOTO 80
220 END
```

Program 2. Clock simulator

Constructing Quiz Based On YES/NO Answers

Next take up a program that demonstrates how a quiz based on Yes/No answers can be constructed (Program 3). The program illustrates the use of subroutine to evaluate the results in a quiz. The program is easy to follow and for benefit of readers of *Science Reporter*, the quiz pertains to a general idea about *Science Reporter*. In lines 10 and 20, two arbitrary variables R (for Right) and W (for Wrong) are set equal to zero. Lines 30 and 50 are Print statements explaining the game. Blank Print statements in lines 40 and 50 make the printout attractive. Line 70 is an Input statement. The candidate is asked to enter his/her name. This is stored against string variable N$ (this information will be used at the end of Quiz). A CLS statement in line 80 clears the screen as soon as the name is entered. Line 100 prints the first question. The correct answer to this question (NO in this case) is stored

against string variable A$. In line 120, a GOSUB statement is encountered and execution is transferred to subroutine starting at line 1000.

Line 1000 is REM statement. The next line 1010 is a blank Print statement. In line 1020, the person is asked to key in the answer to the question as YES or NO. The answer is stored against a string variable AN$. Line 1030 has a conditional GOTO statement involving this string variable AN$. Irrespective of whether the answer is YES or NO, execution goes to line 1060. This step is introduced just to make sure that the person answers YES or NO. Should the person answer differently (even yes instead of YES), execution goes to line 1040 which prints a statement to that effect. The next line 1050 brings control back to line 1010.

The next few lines evaluate the results. This is done by comparing the candidate's answer with the correct answer (by comparing string variables AN$ and A$). By giving a conditional GOTO command in line 1060, the wrong and right answers are sorted out. If A$ (actual answer) is equal to AN$ (candidate's answer), control goes to line 1100 which prints ABSOLUTELY RIGHT. In the next line, R is incremented by 1. But if AN$ is not equal to A$, execution proceeds in normal sequence to line 1070 and a statement SORRY, WRONG is printed. In the next line, the variable W is incremented by 1. The answers are thus evaluated. There are two Return statements, one in line 1090 and the other in 1120. Hence irrespective of the answer, control comes back to line 130 after evaluation of the result. Line 130 is a blank Print statement. Line 140 prints the next question. This is followed by line 150. This helps to store the correct answer to this question (against the same string variable AN$). At this stage, control is again transferred to subroutine beginning at line 1000. The answer is evaluated in the same way and the score is updated.

This process continues till all the questions are over. Execution finally returns to line 900. This is a blank Print statement. The next line 910 has a Print statement saying QUIZ IS OVER. After a blank print statement, statement in line 920, prints the result. The last line 930 is a Print statement which prints THANKS FOR TAKING THE QUIZ. As the person's name is already stored against the string variable N$, this Print statement identifies the person taking the quiz. END statement in 940 brings the program to an end. An important point to note is that the correct answers to all questions have to be stored against the same string variable.

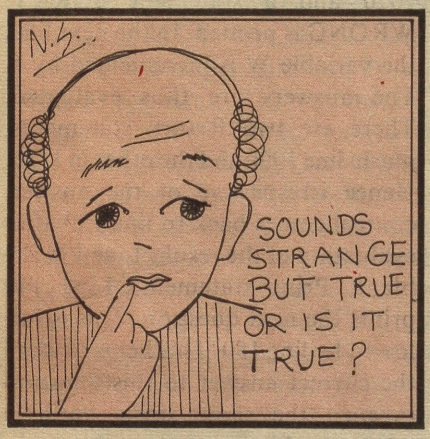
```
5 REM QUIZ PROGRAM
10 R=0
20 W=0
30 PRINT "WELCOME TO A QUIZ ON SCIENCE REPORTER"
40 PRINT
50 PRINT "You have to answer YES OR NO"
60 PRINT
70 INPUT "ENTER YOUR NAME PLEASE,      "; N$
80 CLS
90 PRINT
95 REM QUESTIONS
100 PRINT "Q 1. THE CURRENT VOLUME NUMBER IS 26"
110 A$= "NO"
120 GOSUB 1000
130 PRINT
140 PRINT "Q 2. THE SERIAL ON BASIC STARTED IN SEPT 89"
150 A$="YES"
160 GOSUB 1000
170 PRINT
190 REM ------ ADD MORE QUESTIONS
895 REM ------ BETWEEN LINES 200-890
900 PRINT
910 PRINT "QUIZ IS OVER"
915 PRINT
920 PRINT "YOUR SCORE=    "; R;"---RIGHT AND    "; W;"---WRONG"
930 PRINT "THANKS FOR TAKING THE QUIZ,    "; N$
940 END
1000 REM EVALUATION SUB ROUTINE
1010 PRINT
1020 INPUT "SAY YES or NO    ";AN$
1030 IF AN$="YES" OR AN$="NO" THEN 1060
1040 PRINT "SORRY, YOU HAVE NOT ANSWERED PROPERLY"
1050 GOTO 1010
1060 IF AN$=A$ THEN 1100
1070 PRINT "SORRY, WRONG"
1080 W=W+1
1090 RETURN
1100 PRINT "ABSOLUTELY RIGHT"
1110 R=R+1
1120 RETURN
1130 END
```

Program 3. A quiz based on Science Reporter

Dr. Ramshesh is Scientific Officer, Applied Chemistry Division, Bhabha Atomic Research Centre, Bombay-400 085

Leg Disease Pointer To Heart Attacks

MEASURING vascular disease in people's legs may prove to be a simpler way of detecting those at high risk of heart attacks and strokes.



Leg arteries are mainly affected by atherosclerosis, a clogging-up of the artery which reduces blood flow and causes pain. But the most common disease is varicose veins which, although not life-threatening, causes thousands of operations every year. Varicose veins can develop into the more serious condition of varicose ulcers, which require hospital treatment.

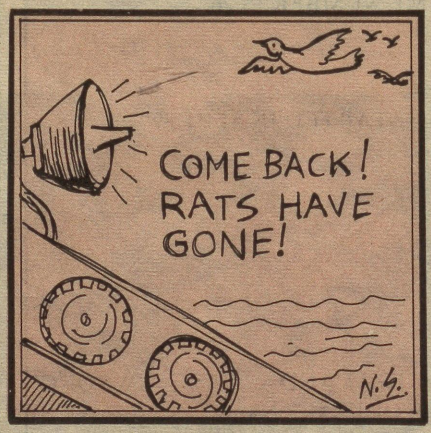
While most people are only treated when such leg diseases are at an advanced stage, a team from Edinburgh University is interested in finding ways of spotting the early symptoms. This is because, compared to vascular diseases of the heart, the legs are far more accessible for examination and treatment, and it is also hoped that measuring disease in the legs may be a simpler way of detecting those at high risk of heart attacks and strokes.

Hasan Jawaid Khan

Calling Sea-Birds

RECORDED calls of Manx Shearwater are to be relayed out of sea at night from Cardigan Island off the coast of Wales (U.K.) in an attempt to attract the threatened sea-bird back to one of its traditional breeding grounds. The Manx Shearwater became extinct from the Cardigan Island when a plague of rats attacked the breeding colony following a shipwreck in 1934. With the rats now eliminated, specially designed solar-powered equipment which plays the calls of the birds has been installed in the hope that the recorded cries of the Shearwater will lure the birds back.

The equipment was recently air-lifted out to the island by a Royal Air



Force Sea King helicopter. Central to the success of the project is a static random access memory recorder. The recorder utilises a 12-volt battery linked to solar panels and will play back the Shearwater calls every night throughout the breeding season. Required to withstand extremes of weather and a harsh salt water environment, the unit is fully encased in a plastic-coated steel box to provide practically maintenance-free operation.

H.J.K

Fighting Pollution With Ultraviolet Rays

TWO researchers at the University of South Wales in Australia are using the potentially harmful effects of sun's ultraviolet (UV) radiation to combat pollution. UV light is employed to destroy compounds such as chlordane and bacteria in sewage ponds. Chlordane is an organochlorine compound, one or more chlorine atoms bonded to an organic radical, and a long-lasting and dangerous industrial chemical pesticide. In the past, such compounds have been shipped to the US for high temperature incineration.

A PhD student from China, Li Xiangzhong, working under Penny FitzGerald's supervision, has found that a mixture of chlordane and hydrogen peroxide exposed to UV radiation breaks down into a harmless mixture of an organic compound and a chlorine ion. Li has found that the breakdown works most efficiently when the concentration of hydrogen peroxide is about 10 times the chlordane concentration. Hydrogen peroxide breaks down into environmentally safe oxygen and water.

H.J.K.

Soapnut for Reclaiming Wastelands

RESEARCHERS at the Department of Chemistry, Regional Institute of Technology, Jamshedpur, (*J. Instn. Chemists* (India), 1988, 60 (Pt VI), 223–224) have reported the oxidizing property of soapnut (*Sapindus* Spp; Family Sapindaceae) in converting coal into chemicals. Its value in the utilization of powdered coal as a fertilizer for increased crop production has been assessed. Experiments conducted by suspending coal in distilled water to which soapnut pericarp was added indicated that coal degradation is completed after 28 days. As a dilute solution of soapnut pericarp is hydrophobic, it can increase the water-retaining capacity of the soil. So, a mixture of coal and soapnut pericarp in small quantities may be applied to the soil for solving the duel problem of soil erosion by checking drainage as well as for upgrading soil fertility with coal degradation products. This procedure may be useful for the reclamation of vast wastelands.

S.P. Mehta

Fire-Resistant Nests

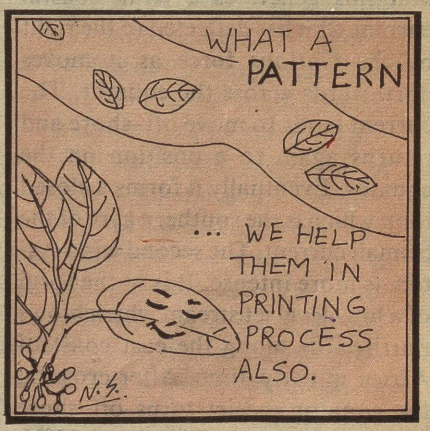
THE nests of birds have fire-resistant properties, claims J.S. Negi of Forest Survey of India, Dehra Dun; (*Indian Forester*, 1989, 115 (1–2), 938). Woven from dry straw, a highly flammable material, bird nests do not catch flame even when they are put on fire. They only get charred and become black retaining their original shape. The nests are woven from straw and glued with saliva of birds. Beehives and silkworm threads are also fire-resistant.

Naturally, the saliva of birds and insects contains some fire-resistant chemicals. An investigation into the nature of these chemicals may lead to the synthesis of a fire-proof material of use in building thatched houses.

S.P.M.

A Novel Thickener From Leaves

RESEARCHERS at the Indian Institute of Chemical Biology, Jadavpur and at Artex Quality Dye-Printers in Textiles, Calcutta have isolated a novel thickener for textile



printing from the leaves of *Litsea polyantha* (Family Lauraceae). (*J. Instn. Chemists* (India); 1989, *n.* Pt III, 77-78). An evergreen tree, *L. polyantha* is common in the forest area of Dehra Dun and occurs from Saharanpur to Oudh eastward. It is also found in the sub-Himalayan tracts of Assam and West Bengal.

The powdered air-dried leaves are treated with chloroform and methyl alcohol to remove the colouring matter and then extracted with sodium hydroxide solution. A brownish gummy substance having a polysaccharide structure is obtained.

This substance has been found to be a good thickener for textile printing of all the three types of fabrics, i.e., cotton, silk and polyester. Moreover, its paste in acetic acid can be preserved for 7–8 days.

S.P.M.

(*Continued from p15*)

There has been considerable research on how the ocean adjusts itself to form two gyres. Clearly, there are two different wind systems that need consideration. One is a weak alongshore wind which blows northwards from Madagascar to the equator from late April. Numerical experiments on a computer suggest that this generates a weak coastal current which is deflected to the right by the Coriolis force as it moves northwards across the equator. The current tends to move off-shore and returns again to a position on the equator. Eventually it forms a closed loop which is the southern gyre of the Somali current. The second wind system is more intense. It is in the form of a low-level jet stream which blows northwards along the east coast of Africa in early June. After crossing the equator the jet turns off-shore towards India after reaching 10°N. This jet was discovered by a British meteorologist, John Findlater, and is called the Findlater jet. It provides the forcing mechanism for the northern gyre.

IF gyre formation is the oceanic response to the wind stress, then two questions arise: Why should the Somali current set in about a month before the onset of the summer monsoon over India? And, is the oceanic response forced by the rotational component of the wind stress?

The first question was the subject of a very interesting paper by Sir James Lighthill, the celebrated British mathematician. Professor Lighthill postulated that the coastal current in late April was forced by an atmospheric disturbance far away from the African coast in the north Indian Ocean. It was earlier thought that the propagation speed of such a remote perturbation would be too slow to have an impact on the east African coast by late April. But Professor Lighthill's work suggests that if we consider the vertical stratification of the current then a perturbation could have the required propagation speed to force a coastal current about a month before the monsoon's onset. The magnitude of the wind stress is important here, and at present it is not yet certain that the wind stress has the required magnitude for forcing a coastal current.

In the tropical atmosphere in equatorial regions the rotational and the divergent parts of the wind stress are of equal magnitude. But, for the dynamics of ocean currents the rotational part of the wind stress has been believed to be the one that predominates. A numerical experiment suggests that if the rotational as well as the divergent parts of the wind stress were considered, then it was possible to simulate the southern gyre of the Somali current.

Of special relevance to the Indian monsoon is another coastal current off the east coast of Africa. This is known as the Somali current

WE have been concerned with the response of the ocean to wind stress over a narrow coastal region, but of greater interest is the response of an entire ocean basin, the Pacific, to atmospheric winds. We need to consider here different kinds of perturbations of both atmospheric and oceanic origin. The impact of the atmosphere on oceanic flow comes from the wind stress. On the other hand, the ocean influences the atmosphere by variations in the flux of latent heat for evaporation. There will be variations in sea surface temperature (SST) due to a rise or fall in the level of the thermocline and by advection due to fluctuations of the wind which, in turn, will influence the latent heat flux.

A long-term climatic fluctuation which is relevant here is known as the Southern Oscillation (SO). It was first discovered by Sir Gilbert Walker, who was the head of the Indian Meteorological Service in the early part of this century. Sir Gilbert found that whenever pressures were low over the north Indian Ocean they were high over the south Pacific and vice versa. As pressures are inversely related to rainfall this suggests that when low pressures prevail over the Indian Ocean in the winter months the chances are that the coming monsoon rains will be good. The Southern Oscillation has a period varying from two to seven years. The intensity of the Southern Oscillation is measured by the difference in sea level pressures of Tahiti (18°S, 149°W), a station in the mid-Pacific, and Darwin (12°S, 130°E) in north Australia, which represents the northern part of the Indian Ocean. A negative value of the Southern Oscillation Index (SOI) implies higher pressures over north Indian Ocean and an indifferent monsoon.

The Southern Oscillation is closely linked to another atmospheric circulation that is named after Sir Gilbert Walker. It is known as the Walker Circulation. To illustrate the Walker circulation, imagine a high positive or a normal value of SOI. This implies a zone of low atmospheric pressures over Australia and the Indonesian archipalego. It is accompanied by large convective clouds and heavy rainfall and rising air motion. This air eventually turns

eastwards and after traversing the Pacific as a high level westerly wind at 200 mbar it begins to sink over South America. The Walker circulation is thus made up of a rising limb over Australia and Indonesia with a descending or subsiding branch over South America.

What does the Walker circulation mean in terms of global winds? It suggests a strong belt of convergence between the trade winds of both hemispheres at a location slightly to the north of the equator. The strong trade winds drive a westward ocean current away from the coasts of Ecuador and Peru towards the western half of the Pacific. The difference in sea level between the eastern and western halves of the Pacific is about 40 cm. To balance the accumulation of water on the western Pacific there is an equatorial counter current and an equatorial undercurrent. The undercurrent flows to the east at a depth of about 100 m. As the balance is almost restored by the time the equatorial undercurrent reaches the South American coast, the depth of the thermocline decreases as we proceed eastwards across the Pacific. This means a rising thermocline as one proceeds from the west to the east.

An important feature of the circulation which we have just described is strong upwelling off the coast of Ecuador and Peru. The upwelling is induced by the strong easterly trade winds that blow the surface waters of the ocean away from the coast. A cold current known as the Humboldt current creates cold sea surface temperatures off Peru. The upwelling is responsible for bringing up rich nutrients for fish from the deeper reaches of the ocean. It adds to cold sea surface temperatures over the eastern half of the Pacific.

The above description refers to a normal or high positive value of the Southern Oscillation Index. Its main features are: (a) a cold coastal current (Humboldt current) and upwelling off the coast of South America, (b) strong trade winds, (c) accumulation of water on the western half of the Pacific which is balanced by the equatorial countercurrent and an undercurrent, (d) a rise in the depth of the thermocline as we proceed from the east to the western half of the Pacific, and (e) an ascending branch of the Walker circulation over Australia and Indonesia with its descending branch over South America.

The impact of the atmosphere on oceanic flow comes from the wind stress. On the other hand, the ocean influences the atmosphere by variations in the flux of latent heat for evaporation

ONCE in every few years a series of dramatic changes occur that disturb the Walker circulation very substantially.

The cold waters off the coasts of Ecuador and Peru are now replaced by a warm ocean current that flows southward along the South American coast during the time of Christmas. This is known as an El Nino. 'El Nino' is the Spanish word for a male child. As this generally appears at the time of Christmas, some refer to it as the 'child Christ'. It disturbs the normal flow of the cold Humboldt current. With the appearance of an El Nino, pressures begin to rise over Australia and Indonesia and the Southern Oscillation Index begins to fall and become negative. This is referred to as the 'warm' phase of the Pacific, while the normal or high SOI represents a 'cold' phase of the Pacific basin.

The close relationship between an El Nino and the Southern Oscillation is revealed by several features. The ascending branch of the Walker cell shifts to the central regions of the Pacific as soon as the SOI becomes negative. The descending branch also moves over to the southeastern parts of the Pacific. As upwelling off the South American coast decreases the sea surface temperatures there rise. This leads to weaker trade winds and less accumulation of water on the western half of the Pacific. The equatorial undercurrent is consequently much weaker. It may even change its direction. The arrival of warm waters off the coast of South America may even trigger a zone of active convection leading to heavy rain and floods off the South American coast. Clearly, the negative phase of the SOI which, as we can see, is linked with an El Nino is fraught with the possibility of many abnormal weather conditions. This low or a negative phase of the SOI in combination with an El Nino is called an ENSO event.

A well marked ENSO episode took place in 1986/87. This was followed by a very poor monsoon over India in 1987. There was a return to the cold or normal phase of the SOI in 1988, which gave us a very good monsoon in 1988. But, it must be stressed that there does not exist a one-to-one correspondence between an ENSO event and monsoon rains. There have been occasions when the monsoon has been good despite an ENSO. Similarly, there have been poor monsoon without an ENSO episode. But, reports from other parts of the world have tended to

confirm the global nature of an ENSO event and its adverse repercussions.

The close relationship an El Nino and the Southern Oscillation is revealed by several features. The ascending branch of the Walker cell shifts to the central regions of the Pacific as soon as the SOI becomes negative. The descending branch also moves over to the southeastern parts of the Pacific

The aberrations that accompany an ENSO sometimes swing over to a stronger than normal cold phase over the Pacific basin. This is a period of heavy rains over Australia and Indonesia accompanied by strong upwelling and cold waters off south America. The tendency for a strong reversal leading to an overshoot is called La Nina, because Nina in Spanish means a 'girl' which has the opposite sex to an El Nino.

An El Nino or a La Nina represents large atmospheric perturbations to which the ocean responds with either cold or warmer than usual sea surface temperatures which, in turn, can lead to extreme events, such as droughts and floods or poor and good monsoons. Scientists are now trying to find out if the arrival of an El Nino or an ENSO even could be anticipated.

One of the powerful methods by which we can study the origin of an El Nino is by constructing a coupled ocean–atmosphere model. Such models are difficult to design because of the difference in the way the atmosphere and ocean respond to each other. The much slower response of the ocean leads to the need for integration over long periods of time before the ocean begins to respond to an atmospheric disturbance.

In view of this difficulty, early models of El Nino (or an ENSO) studied the response of the ocean to a slowing down of the equatorial trades. Recall that the warm phase of the Pacific is preceded by a period of weak easterly trades on both sides of the equator. The models sought to find out the oceanic response to a relaxation of an idealised band of equatorial trades.

As expected, the models showed that shortly after the winds relax, the sea level rises sharply in the eastern half of the Pacific and drops in the western ocean. This is accompanied by large transport of warm water from the western half (Australia and Indonesia) to the eastern half (South America). This was similar to the changes that occur during an El Nino event. More recent models are beginning to experiment with more realistic winds rather than idealised versions of the trade winds.

LONG range prediction of monsoon rainfall has been prepared in India for many decades. It was started by Sir Gilbert Walker when he was the head of the Meteorological Department of India. The prediction is based on a statistical association between monsoon rain and a number of antecedent features which are referred to as predictors. These predictors have been altered as the degree of their association with monsoon rain changed. Over the years new predictors have also been added.

One needs to perform tests to judge the independence of each predictor from the others. A screening procedure is also necessary to find the relative importance of each predictor. This is usually done by finding out how much of the total variance of seasonal rainfall is explained by each predictor.

In view of these difficulties, the present author feels, that we have not yet reached the stage when we can judge, quantitatively, the impact of the ENSO episode on long range prediction of monsoon rain, but this is not to suggest that further attempts should not be made. It appears that ocean surface temperatures play an important role not only for ENSO but also for the dynamics of the monsoon. We need to know more about how ocean surface temperatures are perturbed by not only upwelling or downwelling at the thermocline interface, but also through advection by the zonal and meridional components of velocity.

Considering its global importance, advisory bulletins on ENSO episodes are now prepared every year by the Climate Analysis Centre at Washington in the U.S.A. According to the January bulletin of 1990, the conditions in the Pacific were again moving towards an ENSO event. The main features stated by them were: (a) the last warm phase happened almost four years ago, (b) there has been a considerable build up of warm water in the equatorial zone, and (c) the equatorial easterly winds have weakened and convective activity has increased in the central Pacific. Under these conditions the situation needs careful monitoring.

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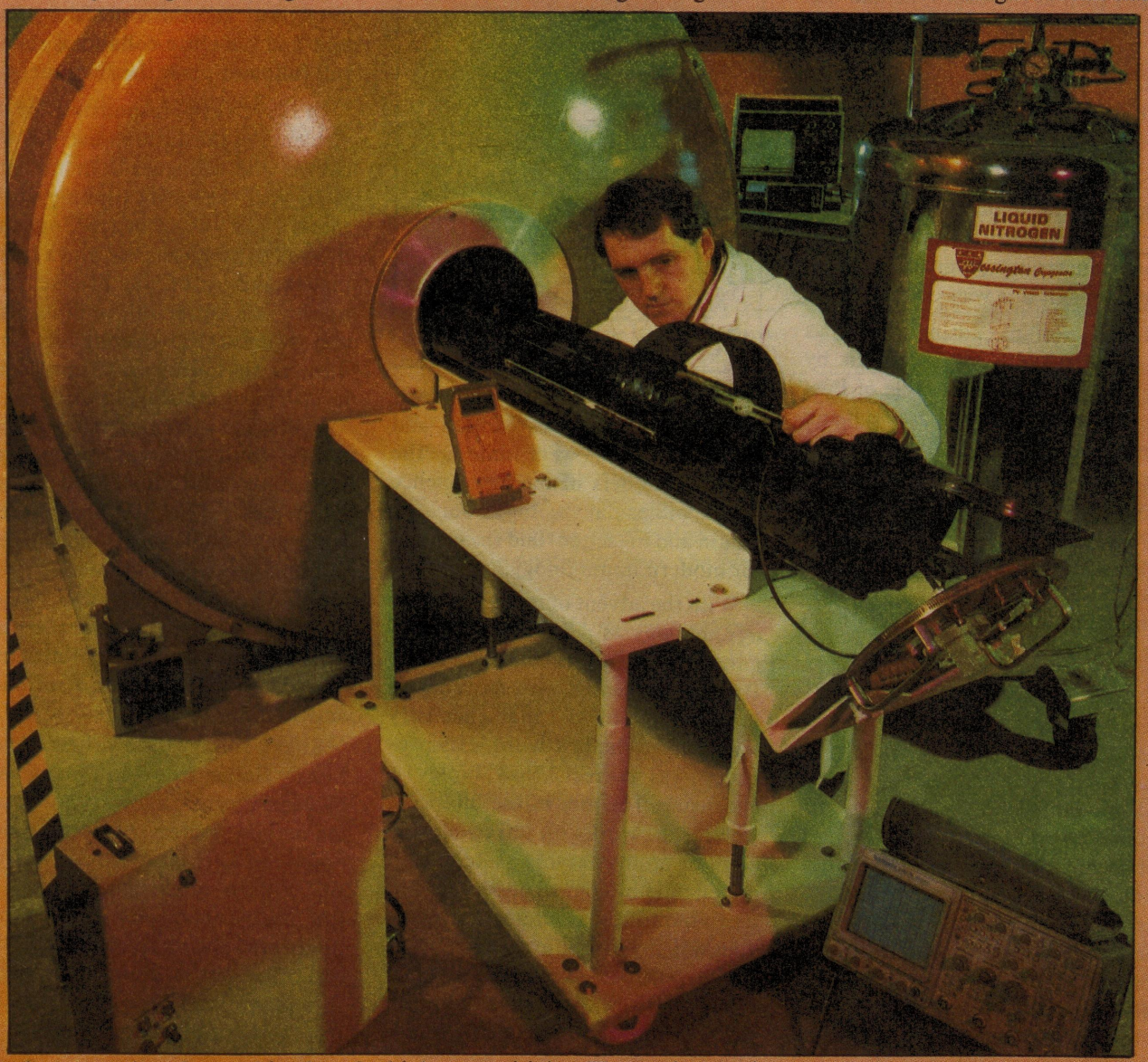
Seeking New Ways To Fight Cancer

BRITISH researchers looking for new types of drugs to help in the treatment of cancer will be able to use this nuclear magnetic resonance (NMR) spectrometer at Britain's Medical Research Council (MRC) Radiobiology Unit in Oxford, England.

Magnetic resonance spectroscopy allows scientists to study non-invasively the biochemical metabolism and physiology of tumours and how these are altered by treatment including radiation and drugs. The system shown here is based round a superconducting magnet. The central bore of the magnet has a diameter of 30 centimeters with an operating field strength of 4.7 Tesla. This is the strongest magnetic field available for a magnet of this size



and ensures that the machine has the highest sensitivity. The equipment is controlled by two computers and is capable of performing most of the modern techniques in NMR. The Radiobiology Unit of MRC will be using NMR spectroscopy to build on its existing research programme developing drugs that increase the effectiveness of cancer treatment—both radiotherapy and by chemotherapy.

(Photo: *Courtesy* **BIS)**

(Continued from page 40)

smallpox, both prevalent in that part of the world. Calmette was very successful and created the Pasteur Institute of Saigon (now Ho-Chi-Minh-Ville).

In addition, because of the problems caused locally by dangerous snakes such as the cobra, he had the idea of using serotherapy to prevent the lethal action of snake venom. Albert Calmette, who was later one of the inventors of BCG, also became the first director of the Pasteur Institute of Lille.

Among the major findings made by Pastorians working abroad are those concerning plague and some were made in this very country.

The bacterium causing plague, as you well know, was identified by Alexandre Yersin, a disciple of Pasteur and collaborator of Emile Roux in the work on diphtheria toxin. The bacterium, now called *Yersinia Pestis* was isolated and characterized by Yersin in Hong-Kong in 1894. Yersin then proceeded to prepare anti-plague serum, and obtained results considered as quasi-miraculous at the time.

In 1986 a very severe epidemic of plague started in Bombay, where it was to take a toll of 32,000 deaths in two years. Yersin came to the rescue, and was followed by Paul-Louis Simond, another Pastorian. Whereas Yersin had identified the bacterium responsible for plague, and had observed a correlation between the infection of rats and that of human beings, he did not investigate the means whereby the bacterium might be transmitted from rat to man.

Simond, during his stay in Bombay, accumulated evidence that this transmission could be mediated by fleas. The critical experiment was performed in June 1897. In a large glass container, Simond introduced a moribund rat, dying of plague, and a healthy rat in a cage, such that the two animals could not touch each other. Once the sick rat died, the fleas left it, passed through the wire netting of the cage, and transmitted the disease to the other rat, which died 6 days later.

After the Second World War Andre Lwoff, Jacques Monod and Francois Jacob were among the founding fathers of the new science called molecular biology. Jacques Oudin and his school laid the ground for modern immunology.

With the advent of molecular biology, biology as a whole has undergone a complete revolution. Louis Pasteur, a chemist who moved into biolgy, used to say that chemistry would have the last word. His prophecy was correct. Now biolgy is chemistry. The aim of the biologist, whether he works on infectious diseases or on the nervous system, is to understand biological phenomena in terms of molecular interactions. One does not any longer use fragments of spinal cord to vaccinate against rabies. The new vaccines of today are made of molecules, or of fragments of molecules.

In this new era, research at the Pasteur Institute has reached a degree of sophistication that the founder, Louis Pasteur, could never have imagined. However, in spite of the dramatic changes in technology, of the immense progress in knowledge, one cannot but be struck by the remarkable continuity in Pastorian research, as indeed was the case for the work of Louis Pasteur himself.

It is certainly true that new areas of research have emerged, such as developmental biology or neurobiology, but questions posed by Pasteur and his close collaborators are still followed up at the Institute.

In 1989, a gene responsible for the virulence of the anthrax bacillus was cloned and sequenced. In the previous year the entire genome of the rabies virus was sequenced, opening the way to new vaccines, and a better understanding of the disease. The machanisms of action of diphtheria and tetanus toxin are still being studied, at the cellular and molecular level. The discovery of antitoxins by Von Behring and Roux was germinal to the foundation of immunolgy. Indeed, the antitoxins, were the first antibodies to be detected. At the Institute a whole department works on immunology and one of the groups, headed by Roberto Poljak, established recently, for the first time, the three dimensional structure of a complex between an antibody and an antigen.

Snake venom toxins, first identified by Calmette are now being used by Jean-Pierre Changeux to dissect the nervous system. Molecular biologists are attempting to convert the BCG into a multivalent vaccine. As for Luc Montagnier, whose group discovered the virus responsible for AIDS, he is in the direct descendence of a man like Alexandre Yersin the discoverer of the plague bacillus.

The Pasteur Institute can be proud of its past, but it must think of the future. For its second century, it will try to keep up with tradition, by performing research of high quality for the benefit of mankind. □

The laboratory and clinical work NIN has done ranks with the finest in Asia. Its *tour de force* lies in providing practical approaches to combating such maladies as protein-calorie malnutrition, vitamin-A deficiency and iron-deficiency anaemia, and in identifying toxic contamination of foods

National Institute Of Nutrition

P.S. Shankar

BERIBERI and the end of first world war are two important landmarks in the annals of the National Institute of Nutrition (NIN) in Hyderabad. Beriberi is a B-vitamin (thiamin) deficiency disease characterised by weak muscles and paralysis. This has plagued the peoples of the Far Eastern countries for centuries, especially the Japanese navy for generations. The disease has also afflicted the people of southern India who eat polished rice.

It was way back in 1918 that Sir Robert McCarrison started his pioneer researches on this disease, which was widely prevalent then. The Pasteur Institute in Coonoor in Nilgiris provided the wherewithal for the study. Sir Robert's research unit, known as the Deficiency Diseases Enquiry unit, became the nucleus of the Nutritional Research Laboratories (NRL). Transplanted to Hyderabad in its fortieth year in 1959, and enlarged in scope and functions in its golden jubilee year in 1969, NRL is now the National Institute of Nutrition. Functioning under the purview of the nation's apex body for medical research, NIN is also the biggest laboratory of ICMR.

NUTRITION is the science of nourishing the body. Put differently, nutrition is the study of food and the relationship between food and health. Health, in turn, is not just a disease-free condition of the human body. It is much more. Health also means physical, mental and social well-being. So it is that NIN addresses the whole gamut of problems encompassing food and nutrition, not in isolation but in relation to other factors which affect health and well-being. And NIN's work has ranked with the finest in Asia. A distinguishing feature of its research is the emphasis it has given to finding solutions which could be put into practice within the socio-economic conditions and the administrative set-up obtaining in the country. The Institute's success owes not a little to the integration of its activities in the lab and in the clinic with the community at large.

NIN's forte is research on protein-energy malnutrition, also known as protein-calorie malnutrition (PCM). PCM exerts its most devastating effects on the young. This is a major public health problem in all developing countries. What the Institute has convincingly shown is that in the development of PCM it is not the dietary protein that is the limiting nutrient but *energy*. As a result, the earlier theory of two separate dietary origins for kwashiorkor and marasmus has been given a short shrift. Marasmus is characterised by shrunken, wizened features and gross physical retardation of the child. Kwashiorkor's trademark is bloated bellies and glassy stares.

As a result of NIN's findings, the approach to controlling and preventing this malady has undergone a drastic change. Not just in India alone, but in other developing countries too. The Institute has also developed a number of common recipes based on cheap and locally available foods of vegetable origin like pulses and legumes. It has also ensured that such foods are culturally acceptable to the people in the different parts of the country. This is because ethnic and religious groups tend to retain the basic food choices.

Protein-calorie malnutrition should, however, not be viewed as a mere nutritional deficiency disorder, cautions NIN. It is a consequence not only of inadequate and improper food intake, but also of poor living conditions, unsatisfactory environment and lack of primary health care. In other words, PCM is primarily a disease of socio-economic inequalities and of maldistribution of food and wealth.

IN a country where malnutrition is seen in its worst and most florid forms, nutrition research must be governed by a sense of urgency and relevance

—C. Gopalan, FRS

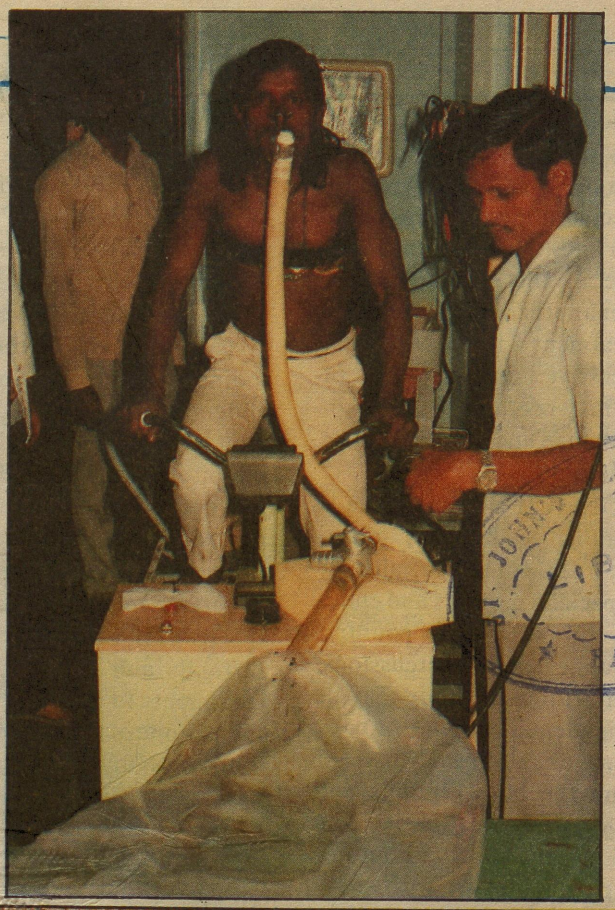
IT is not just a happenstance that a village belle, with a headload of fuelwood, falls into an open well at dusk. What afflicts her is night-blindness, a disease due to the deficiency of vitamin-A. This is rampant among village pre-school children,

MODERN TEMPLES

Main building of NIN *(top)*, **and the Gopalan Block** *(bottom)*

and afflicts nearly half the children in developing countries. Vitamin-A deficiency affects growth and skin condition, and increases the severity of other nutritionally related illnesses. About 20% of the blindness in the country is due to vitamin-A deficiency and could be prevented. Here the NIN has developed a public health method by which blindness can be prevented. The method consists in giving a massive oral dose of vitamin-A (200,000 IU) once in six months to children at risk between the ages of one year and five years. So effective was the treatment that it has now become a part of the national programme for preventing blindness, with over 25 million children being covered.

Here also the Institute sounds a note of caution. This is a temporary



Lab experiment on energy metabolism in progress

Monitoring of height and weight of subjects as part of field study

measure and a partial solution. In the long run, vitamin-A deficiency diseases could be cured only by raising the socio-economic conditions of the population and improving their dietary intake of the vitamin. There could be yet another reason for making this treatment a temporary measure. Excessive consumption of vitamin A may result in toxic symptoms in both man and animal, known as hypervitaminosis A.

IRON-DEFICIENCY anaemia is yet another widespread nutritional disorder found in all age groups, especially mothers and children, in several parts of the country. This has public health repercussions. Insufficient iron in the body may be due to an inadequate intake, or poor absorption, or abnormal loss of blood from the body. Infants and young children who have been fed on cow's milk formulations without sufficient supplementation with iron-containing foods may be victims. In women, the condition may occur as a result of large menstrual losses or the increased requirement for iron during pregnancy. The ideal solution, which is a long-term measure, is diversification and improvement of the diet. This is possible only if the socio-economic conditions of the poorer sections improve. As a short-term solution, NIN has developed a method of fortifying common salt with iron, as a result of which iron absorption improves. More importantly, the method ensures that the benefit goes to all segments of the population. Large-scale community studies in different parts of the country have attested to the efficacy of the fortification method. The Institute has also developed a method of fortifying common salt with both iron and iodine to control two of the most important nutritional disorders of the country, namely, nutritional anaemia and iodine deficiency.

To combat iodine deficiency disorders the Institute has developed iodised safflower oil, which can be used both orally and intramuscularly. Known as Iodosola, this is a substitute for the imported lipiodol based on poppy seed oil. Iodosola is particularly suited for children.

The Institue is also carrying out a systematic study of the content of iodine and goitrogens in foods from endemic and non-endemic areas. Goitrogens are naturally occurring inhibitors of the thyroid gland which prevent the production of thyroid hormones. The study is also expected to throw light on the origin of goitre in certain endemic areas.

IDENTIFYING toxic factors in foods and evolving methods of treatment to reduce or eliminate them is one of the thrust areas. NIN's work on lathyrism caused by eating kesari dal is well recognised. Lathyrism is a crippling disease which paralyses both the legs. This disease has afflicted people in central India who consume kesari dal *(Lathyrus sativus)* as a staple diet. The Institute has not only identified the toxin in this dal but has developed methods to reduce toxin levels. These methods can be used both at home and on a commercial scale.

Edible oils are adulterated by traders with cheap argemone oil, which is toxic. The Institute has identified levels of contamination which do not pose health hazards. It has also developed simple methods to detect adulteration and a technique to decontaminate adulterated oils.

Fluorosis is a malady which results from drinking water containing excess fluorides; too little may also be harmful to the teeth. The Institute's scientists discovered that, after the construction of the Nagarjuna Sagar dam, a disease afflicting the skeleton with crippling deformity, known as knock knees, occurred in parts of Andhra Pradesh. The disease was caused by drinking water from wells containing excess fluorides. The Institute recommended to the state government that drinking water from the Nagarjuna Sagar canal be provided to the afflicted parts, as the canal runs through villages where the problem is endemic.

NIN's research on the deficiency disease pellagra, known also as the disease of the three D's—dermatitis, diarrhoea and dementia—is noteworthy. Pellagra is caused by the deficiency of the B-vitamin niacin and is endemic among populations subsisting on jowar as the staple diet with little of other protective foods such as milk or pulses. The disease, the Institute has shown, is due to an imbalance between two amino acids, leucine and isoleucine, as also pyridoxine deficiency.

ASSESSING the nutritive value of foodgrains grown in the country is also an important area of work. NIN screens all new high-yielding varieties for nutrient quality before they are released to farmers. Working in step with the Indian Council of Agricultural Research, NIN has, in fact, provided the nutritional dimension to the green revolution.

One of the current research problems addressed by NIN is maternal and child health, for the simple reason that maternal and infant mortality rates still continue to be high. The Institute has identified the various risk factors associated with maternal and infant mortality and morbidity. The study has shown a link between maternal age (below 16 and above 29 years) and adverse outcome of pregnancy, as also between low birth weight, intrauterine growth retardation and high infant mortality. This is a finding of practical utility. NIN's researches have also shown that if a pregnant woman takes iron and folic acid tablets during the last 100 days of pregnancy, the mother is healthier and the baby's birth weight increases.

NIN's researches have provided valuable insights into the relation-

ship between malnutrition and susceptibility to infection, nutrition and drug metabolism, nutrition and reproduction, nutrition and growth, and nutrition and work efficiency.

Extensive studies on the growth of infants and children have helped in understanding the growth processes among Indian children and in the formulation of preventive measures to combat undernutrition.

A large number of foods which are less familiar but are used by some segments of the population in interior areas, particularly by tribal people, have been analysed for nutrient content. As a result, it has been possible to determine the extent to which these foods could be used as supplementary foods in meeting the food needs of our population.

In recent years NIN has studied the role of diet and nutritional factors in the cause and control of non-communicable diseases like cataract and diabetes. Fenugreek *(Trigonella foenum-graecum), methi,* seeds added to the diets of diabetic patients, it has been found, reduces to a significant extent both blood sugar and cholesterol levels. Nutrition and cancer is another interesting line of investigation. NIN scientists have found that the effects of carcinogenic agents were more marked in zinc deficiency. Certain foods like green leafy vegetables, onions and spices such as mustard seem to possess potent anti-cancer properties. Turmeric, even at very low levels in the diet, exhibited a significant anti-mutagenic effect.

NIN's systematic analysis of Indian foods has provided valuable information which now enables us to recommend appropriate low-cost diets to meet the nutritional requirements of the different segments of our population

FOOD irradiation, like fluoridation of water, is one of the scientific controversies which surface now and then. NIN's study in the 70s on irradiated wheat sparked off such a controversy. It revealed that freshly irradiated wheat *chapatis* induce high levels of polyploidy in malnourished children. In animals, the effects, in addition to polyploidy, were damage to sperm, increased incidence of miscarriages, and a reduced immune response. The Institute therefore recommended that wheat subjected to irradiation must be stored at least for three months before consumption.

"A major need in nutrition seems to be a harmonious and reinforcing blend between basic fundamental work and community application. Of the main centres of the world, NIN stands in the very front rank in this regard," D.B. Jellife, international public health expert on NIN's golden jubilee in 1978

NIN's activities extend to offering training programmes in human nutrition to persons engaged in nutrition work at various levels. The comprehensive nature of the courses has attracted participants from South East Asia, Middle East Africa and Pacific regions, participants being sponsored by WHO or UNICEF. Courses range from certificate level to doctorate level (in biochemistry).

The Institute pays considerable attention to the dissemination of its findings at popular level, through brochures, pamphlets, video films, exhibitions, slide and sound presentation and the like. This activity has gone a long way in smoothening the rocky interface between lab findings and application at community level. While the popular publications have served the need for which they are meant, NIN's profile of scholarly papers, especially in biochemistry, in international journals is pretty high.

NIN also functions as the nodal agency for the National Nutrition Monitoring Bureau, which has more than ten centres in the country. The NNMB database has corroborated the Institute's finding that the primary limiting nutrient in the Indian dietaries, of even the poorest segments of rural India, is energy and not protein. The Bureau can provide information, among others, on the mean intakes of foods and nutrients at the household level as well as at individual level. It is therefore possible to provide quantitative estimates of the proportion of families and individuals in rural India who do not meet their protein and calorie needs.

Also housed in NIN are ICMR's Food and Drug Toxicology Research Centre and the Laboratory Animals Information Service Centre.

What NIN has shown over the years is, in a nutshell, that "changes of diet are more important than changes of dynasty or even religion", as George Orwell said not long ago in *The Road to Wigan Pier.*

For further information readers may address: The Director, National Institute of Nutrition, Jamai Osmania P.O., Hyderabad 500 007

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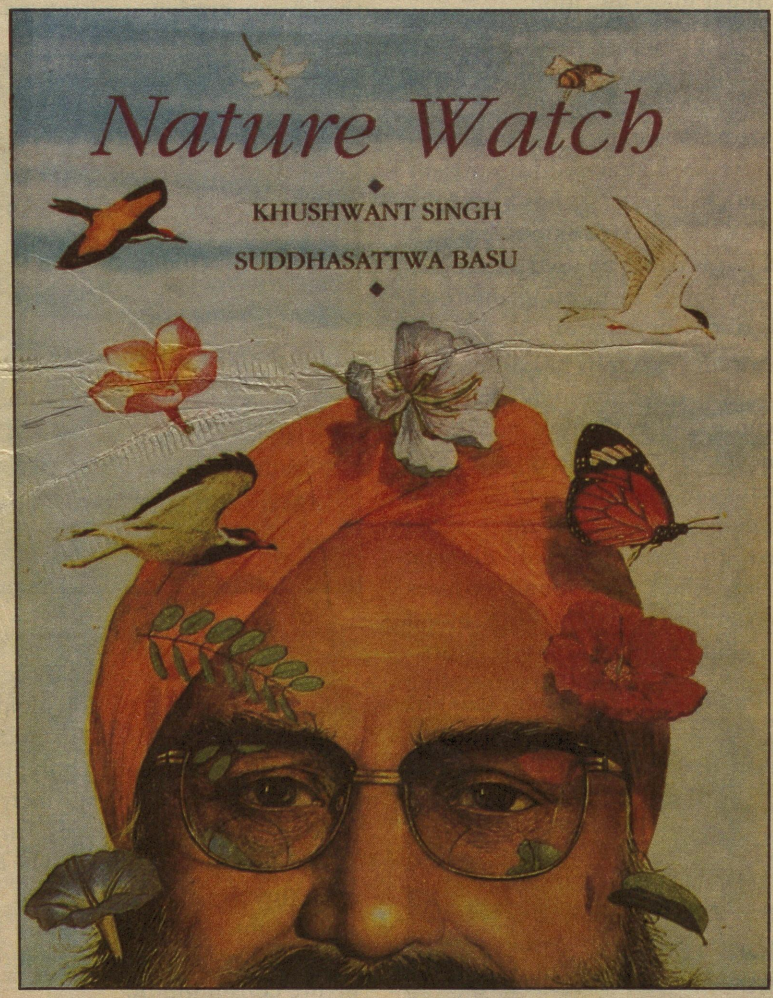
Splendorous Nature

JOURNALIST, editor, novelist, parliamentarian, politician of sorts, humanist, humorist — Khushwant Singh is all this and, what many do not know, a naturalist *nonpareil* too. He belongs to that fast depleting tribe of Nature lovers whose interests are not restricted to animals, birds or plants but embrace the entire world around them. His talks on Nature and environment on the radio and TV have been quite popular. His keen observation of the many splendoured panorama around and his near obsession for recording Nature in the raw reveal him for what he is — a born Naturalist.

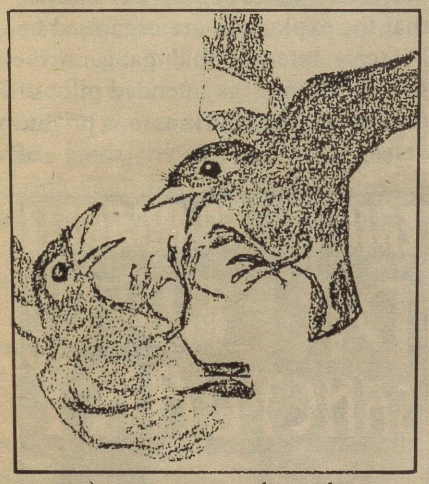
According to Khushwant Singh, it was three-year old Allegra (Leggie) Wint in far-away Oxford, who, with her insatiable love for and uncanny familiarity with the local wild flowers, initiated him to the wonderful world of flowers. On returning home to Delhi Khushwant Singh found that he was almost "on alien territory as far as the fauna and flora were concerned". Acquiring books on trees, birds and insects and seeking out the company of bird watchers and horiticulturists, the budding naturalist took his work seriously. Thus started his lifelong *"affaire de coeur"* with Nature. The fields notes he has been keeping with great regularity has thus bloomed into the present book*.

Although one comes across well-written nature books, say, from Time-Life Series, Readers' Digest, Hamlyn's and others, a sleek *desi* production by a dyed-in-the-wool *desi* author on an out-and-out *desi* subject is something to be proud of. Khushwant Singh laces his book with apt verses from Sanskrit works (translated into English by well known Sanskrit scholars like James Brough, A.W. Ryder and William Radice), Bengali, Urdu, Punjabi and Hindi.



Khushwant Singh unfurls Nature month by month — making the reader aware of the almost palpable changes that take place from month to month and season to season. His descriptions are so accurate that one can almost see the relay race of the flowering trees with the gulmohur "passing Nature's baton to the laburnum", hear the throaty croaking of the frog during the rains and the ecstatic song of the koel. His scientific bent of mind is reflected in the way he describes the firefly. He says: "little is konwn about them (fireflies) besides the fact that they have glands that secrete substances known as luciferin and luciferase which produce light when they come into contact with oxygen". He has this to say

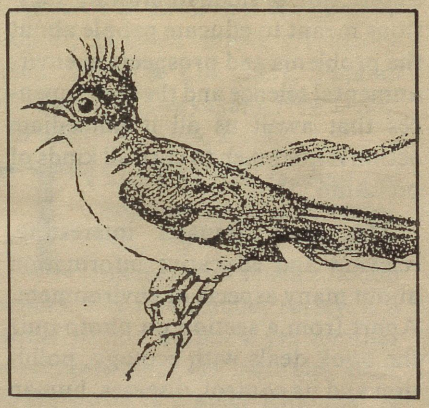
of flower plunderers : 'My *Chandni* and hibiscus shrubs continue to be plundered by the devout who suffer no pangs of conscience from plucking flowers others have planted as long as the loot is offered to their gods". He voices his exasperation at Delhi's stray cattle thus: "One of these days, I will drive one of them into my garage as unclaimed lost property"! At another place he comments: "the custom (tying Raakhi by



women) seems now to have degenerated into a device practised by women to extort favours from their gentlemen friends" — coming from the gallant Khuswant Singh, this sounds rather uncharitable!

Khushwant Singh, takes pains to explain the Latin names of some plants — such as *Bassia latifolia* which is named after Fernando Bassi, Curator of the Botanical Gardens of Bologna, or the twin leaves of *Bauhinia* named after the famous Botanist brothers Jean and Gasper Bauhin, or *Plumeria acutifolia* which is named after the 17th century French botanist Charles Plumier.

Those of us who are trained to be classroom Naturalists hardly have

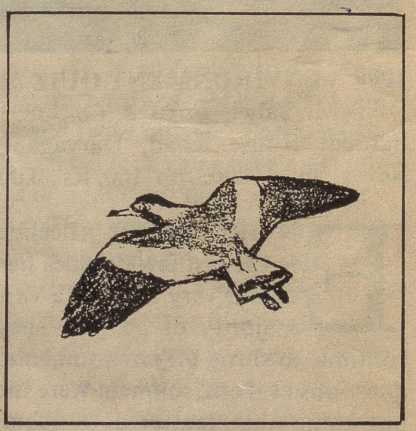


the inclination or the time to observe Nature, much less to study her, in all her pristine glory. Therefore, books like Khushwant Singh's (may their tribe increase, Amen!) are gentle reminders to us to lay aside whatever we are busy with and to look around once in a while and drink deep at Nature's sparkling fountains.

The book is well planned and well produced; Tien Wah Press of Singapore has done a neat job of printing and binding; the overall impact is much above the Indian average. But one wishes Khushwant Singh had used good colour transparencies for the flowering trees instead of reproducing paintings. To cite examples, the pictures of *Bombax malabaricum, Cassia fistula, Neem,* etc., do not do justice to the beauty of these trees when they are in flower or to their grandeur. The close-ups of flowers, though, are good. Pictures of birds and butterflies have come off pretty well.

Some mistakes have crept in inadvertently in the text. For example on page 67, reference is made to *Sophora griffithii* found all along Palam Road. This yellow flowered plant which is found in abundance in Delhi is *Cassia alata* and not *Sophora griffithii*. And oh dear! *Yucca gloriosa* (p. 66) is not of the *cactus* family, but belongs to *Liliaceae*.

Several spelling errors have crept in : Acacia mollison for *Acacia mollissima* (p. 58), Acacia planifron for *Acacia planifrons* (p. 58), Acacia leucopholea for *Acacia leucophloea* (p. 58); Sansivaria for *Sansiveria* (p. 68), Calliotropis for *Calotropis* (p. 68). A little more attention to proof reading would certainly have prevented silly mistakes such as *permanant* (p. 18); *scaly-belled* (p. 20); *fine a sense* of timing (p. 43); *100 mangoes of varieties* (p. 48); *it's-pods* (p. 66); *responsibilies* (p. 75); *recieves* (p. 93); *folliage* (p 93) etc.



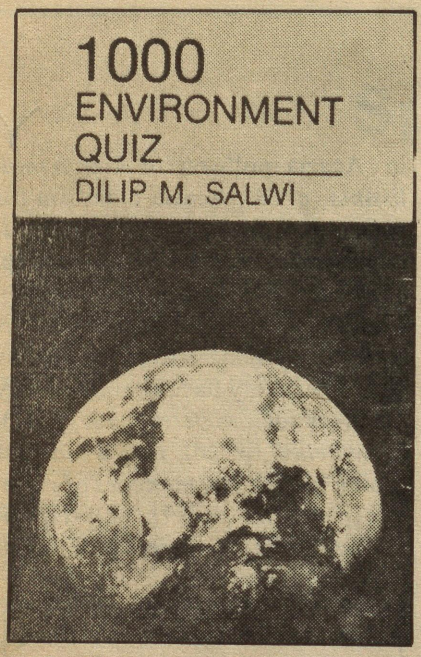
The addition of an Index of Latin names as well as common names would have enhanced the value of the book.

These minor mistakes notwithstanding, *Nature Watch* is a great book written by a great Nature watcher which should find a place on every book collector's shelf.

Lets' have more of it Khushwantji!

Kamala Ramachandran

NATURE WATCH, *Text by* Khushwant Singh: *illustrations by* Suddhasattwa Basu; *Lustre Press Pvt. Ltd.,* New Delhi; 1990; Printed and bound by Tien Wah Press, Singapore. Pp. 96, Price Rs. 250



1000 ENVIRONMENT QUIZ *by* Dilip M. Salwi, *Rupa & Co.*, 3831 Pataudi House Road, Daryaganj, New Delhi–110002, pp. 160, Rs 30.00

ENVIRONMENT decline in the last few decades has meant very little to a vast majority of people. They continue to shrug off environmental questions as if environment were the last thing that mattered to them. Trees continue to be felled, fossil fuel use continues unabated, factories still discharge noxious fumes into atmosphere and harmful effluents into neighbouring waters—all activities with potentially disastrous consequences for the health of environment and of the people at large.

The need to curb this environmental degradation was never so acute as it is today. But sadly, environmental awareness has been slow in reaching the masses, to the people who really matter in any environmental campaign. The book under review is aimed at precisely this issue. But it is a book with no great theories and postulations on ways to combat environmental damage. It is, rather, a collection of small interesting questions meant to educate people about the problems and prospects in environmental science and the consequences that await us all if immediate action is not taken to curb all kinds of pollution.

The book imparts interesting, relevant and educative information about many aspects of environment. Apart from a section on photo quiz the book deals with ecology, pollution and its control, diseases, human settlements, history, disasters, success stories, wildlife, treaties and conventions, literature, awards, and many other aspects of environment and its conservation. Besides, there is a special section on the environment scene in India.

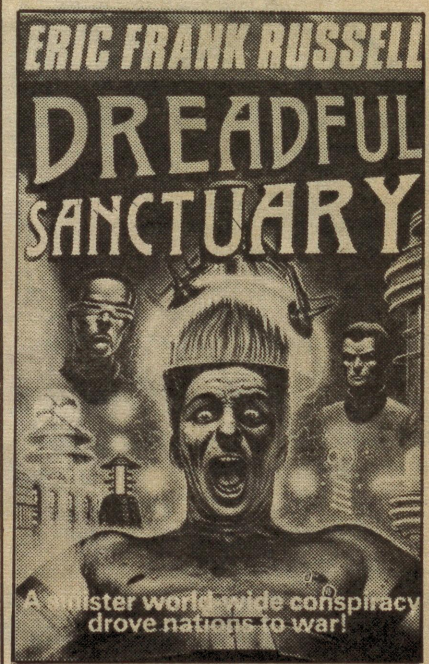
Although the book is primarily meant for children and the questions have been framed taking into account the syllabus of school-goers, the varied aspects of environment that it deals with make it equally enlightening for anyone interested in the subject.

Hasan Jawaid Khan

DREADFUL SANCTUARY *by* Eric Frank Russell, *Mandarin Books,* (Available from: *India Book House Pvt. Ltd.*, 412, Tulsiani Chambers, 212, Backbay Reclamation, Nariman Point, Bombay–400021) $3.50 pp 255, ISBN 0 749300736

WHO are we? What is the secret of our existence? Where do we go from here? The search for the psychic identity, whether of an individual, a society or of the whole human race, is one that has preoccupied much of art, and some of science. Science fiction, too, tries out its hand at the game, and if the results are not what Sartre or Dostovsky intended, so what? It might be a good story anyhow. Eric Frank Russell, one of the grand old men of science fiction of the Golden Fifties, has tackled this issue in his book, *Dreadful Sanctuary*. It was originally published in 1953, and has been republished several times since.

The story concerns mysterious accidents that have been happening to Mars-bound rockets, all of which blow up killing all on board. When the 17th in the series blows up, John Armstrong, an intrepid hero engineer in the usual (old) SF mould, takes things into his hand. He finds out, after a series of great adventures, that the explosions are organised by a secret international gang. Armstrong, Quinn (the intended pilot of the 18th craft) and Hansen, a private detective, track down some of



influential senators, scientists, etc., who are members of this gang, the Norman Club. They learn that according to the Norman Club, the planets are all inhabited by human beings. Mars, being occupied by the whites, is the most advanced (what else?) and they help the Venusian

(Browns) and Mercurian (Blacks) to advance. Only Earth (Yellows) is left out of this great altruistic cosmic club, as it is too backward and violent. The inhabitants of Earth have not been able to evolve to better things. So Mars, Venus and Mercury have taken to dumping their mentally unfit (a disease to which they are prone) on to Earth, as they are too humane to kill them. Hence, Earth is the "Dreadful Sanctuary". The Norman Club, which is in the position of watchdogs, arranges occasional wars and sabotages rockets, so that earthmen do not progress.

The rest of the story is taken up by various efforts to undo the efforts of the Norman Club. Finally, of course, virtue is triumphant, the gang is foiled. Of course, it turns out that the whole farrago of the Martian Race, Cosmic Club and what not is a hoax, the whole thing being organised by a mad, German scientist bent on taking over the world.

Of course, it all sounds too corny for words, but for the deft touch of Russell. The story is quite dated, and it is amusing to read it now. The racism is open and above board. The whites are, of course, the only people who can have original, progressive ideas. The yellow races are all backward, and the mad scientist wanting to take over the world has to be a German (shades of the Second World War). The Russians are not the absolute baddies that they have become in later books. Nuclear power is the panacea for all problems. There are also a few interesting SF gadgets, a "psychotron" which can determine whether a person is sane or not, a "schizofraser" to make anyone tell the truth, and a "coagulator" to induce heart attacks. Well, despite everything, the book is readable, but not as good as Russell's earlier books such as "Sinister Barrier" or the "Jay Score" series.

S. Mohan

GALAXY'S END *by* Richard A. Lupoff, *Grafton Books* (Available from: *Rupa & Co.*, 3831, Pataudi House Road, Daryaganj, New Delhi-110 002—, Pp. 304, £ 1.95.

TELEPATHIC reading and mind-control, time travel, etc., are very popular themes with science fiction writers. The novel under review is a sequel to the author's yet another novel *Sun's End*. The main character of the novel is Daniel Kitajima. A disaster at the L-5 project, which occurred high up in Trojan orbit between Earth and Moon, had wrecked Daniel's body. Prosthetic replacement of his organs restores him to the apperance, and most of

the functions, of a normal man. Daniel's heart becomes a nuclear-powered rotatory pump; his eyes function like photo-optic sensors; his artificial limbs are endowed with super-human strength; only his senses of taste and smell are missing. Nonetheless, Daniel is far from being exactly a human!

The story starts in the year 2091, about 80 years after Danielt met with the accident. Travelling in space with Osvaldo and his two lady companions, Lydia and Tovah, Daniel departs from them at the planet Smirkova, while Osvaldo and the ladies continue their journey towards earth. Some strange things begin to happen to Daniel. He becomes a changed personality due to the microchip carying electronic clone of Osvaldo installed into his brain circuitry. The chip resembles a virus computer program. This changes Daniel's brain functioning and, strangely, he also acquires the ability to travel in time. He goes through bizzare experiences, travelling back in time in the past as well as in the future. But Daniel's mind is monitored with some well calculated design to extract information.

The danger exists before the entire galaxy. It is suffering from some degenerative disease? Or has it been attacked from outside? Can the galaxy and billions of species and millions of intelligent races and civilisations, all forming part of it, be saved? What is the impact of the information extracted from Daniel and what is the role played by him in the ultimate analysis? The readers entangled in the web of all these vexed questions quickly leaf through the pages of the novel curious to get a clue as to what is at the root of the entire mystery. Even after finishing the novel there remains much food for thought for the readers. Belonging to the class of hard SF, the novel will hold their breath till the end.

P.K. Mukherjee

MODERN SCIENCE IN CRISIS—A Third World Response, Jointly Published *by Third World Network and Consumer's Association of Penang* (Available from 87, Cantonment Road—10250 Penang, Malaysia), Price $ 4.30.

IN the technologically administered world of ours, half a billion persons living in the Third World countries suffer

from hunger, one billion are undernourished, more than 35 million children under age five die each year, and nearly 40 per cent of the population cannot meet even their most basic needs. Who all are to be blamed for this? Is the problem intrinsic to the very conception of science, or is it specific to uses towards maximizing profit and dominating the people?

A close inspection reveals that the problems in the contemporary world are inscribed as much in the nature of modern science as in its technological appropriation. The corresponding knowledge forms in the hands of developed nations continue to be means to the exploitation of the already exploited. In the recent times, their application has been directed towards further destruction and wastage of valuable natural and human resources. The advanced research requirements in energy studies, agriculture, health care and telecommunications have forced the Third World increasingly under the control of rich nations, systematically plundering the Third World societies in the name of promoting scientific temper. Various social-engineering experiments like the Green Revolution, the massive expansion of modern medicine system, questionable research objectives related to esoteric fields of nuclear power have all only exhausted scarce natural resources. At the same time, advancements in genetic programming not only render a major portion of human workforce redundant, but tend to question the very nature of employment-structure. The Bhopal gas tragedy, the Chernobyl nuclear disaster, ozone layer depletion, the systematic elimination of earth's forests and natural resources, are some of the major environmental disasters, caused by institutionalized goals of modern science and technology. The militarist imperative imposed on society daily doubles the possibility of complete destruction of the best achievements of the human civilization and the very life on earth. Such politically dictated norms have, therefore, serious cultural consequences for the pleoples movements the world over.

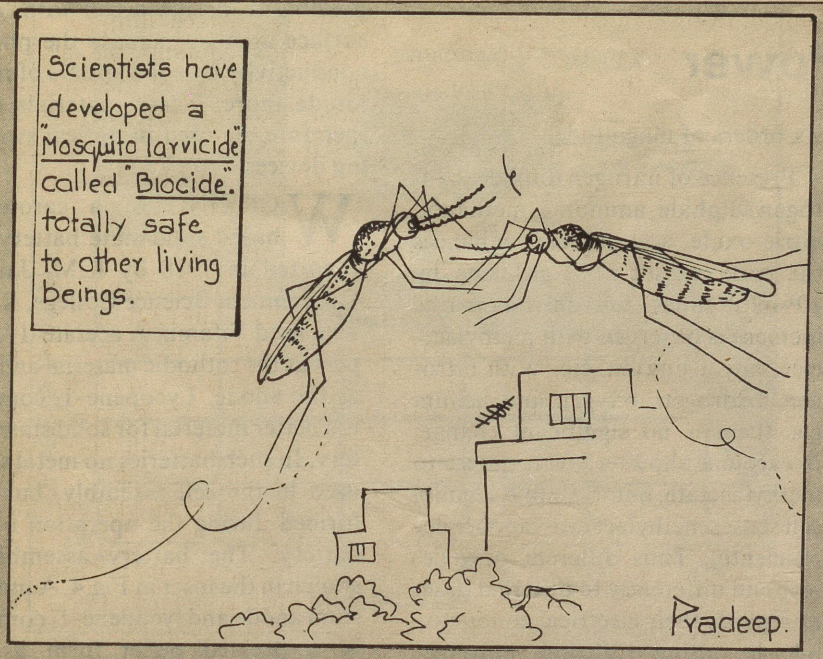
Gender-biased designs, for example, in the area of fashion has reduced women to the status of commodities. The advertising and cinema industry has long exploited the female figure for business operations. Regulation of pregnancy and birth through ultrasound monitoring and amniocentesis are further features of dehumanization of women through medicalizing their problems. The male bias implicit in advocating sex-determination tests with a view to aborting female foetuses is further strengthened by advances in bio--technology today, which has many other serious consequences. The use of genetic research for justifying racial prejudices through IQ test (Eysneck and Jenson) is well known. Racial discrimination promotes a dangerous notion of humanity that sees intrinsic inferiority in the genes of certain racial and social groups. The techniques of recombinant-DNA and possibility of creating and unleashing new and deadly forms of mutated species for biological warfare and their future consequences deserve special attention from the Third World people which are being treated like guinea pigs.

The question arises, how should the Third World countries deal with the conflict between the prevailing pattern and the peoples' basic needs? Whether they should continue to imitate western science or reject it in favour of some suggested indigenous knowledges or critically negate the reigning institutional objectives? The book under review dwells upon the above centrally significant issues of the relationship between science and culture. Divided into 15 Chapters, the book contains the declaration and conclusion of the international conference on 'CRISIS IN MODERN SCIENCE' organised in November 86 by the publishers themselves.

The core idea emphasized in the book is that each technological form generates quite different forms of social interaction, and the choice of technology to be applied solely on grounds of efficiency may well bring unintended consequences. The so-called economic aid and development, not surprisingly, continues to impoverish the Third World population, making it more dependent on developed countries. The document stresses upon the need for evolving an appropriate form of science and technology for the Third World and for complete revamping of the present science policy management in order to initiate a perspective on self-reliant, basic-needs-oriented and ecologically sound science and technology. It exposes current science education and research efforts as mere extentions of the programmes of western masters.

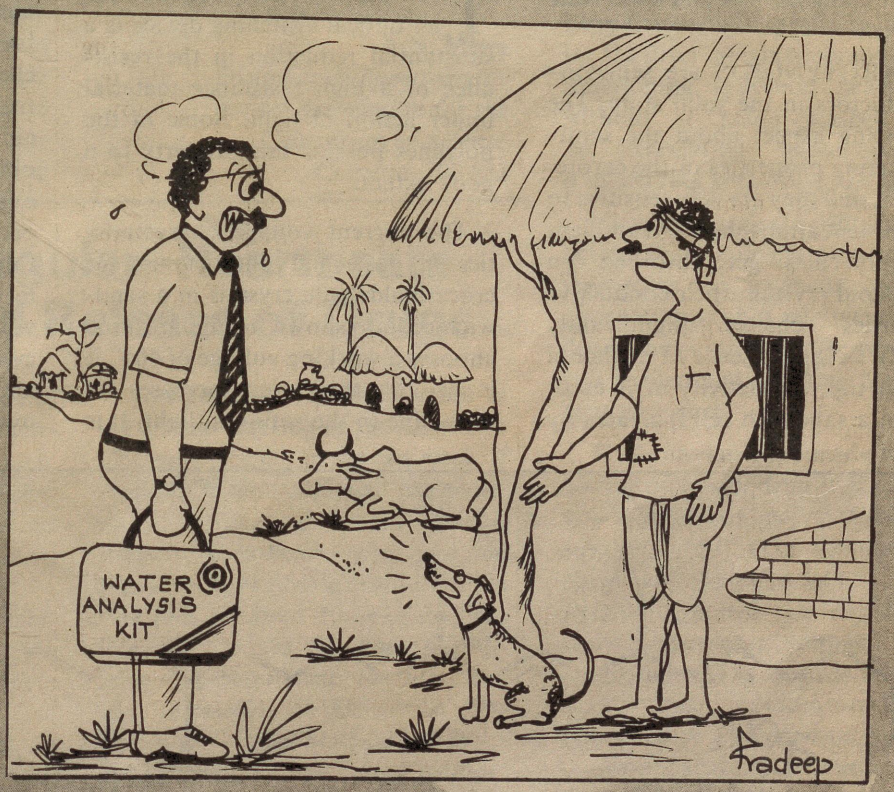
Merits of the book notwithstanding, its horizon remains restricted by convenient categorization of the problems in terms of traditional oppositions: indigenous—western, science-culture development—underdevelopment, etc. Socio-economic structure of the Third World being increasingly integrated into a global nexus under the firm control of multinationals, we should rather endeavour to develop a critical-science perspective, with specific emphasis and expressions for the various peoples of the world who remain together threatened by nuclear holocaust or ecological disaster, apart from being subordinated to a technocratic structure in their human needs.

Vijay Kavshik



Pradeep K. Srivastava

"Do you know any 'maternity home' nearby?
I am extremely scared. I can't lay my eggs anywhere else."



"It is really great that you have developed a portable kit to test the presence of bacteria, pathogens and other harmful things in the water but the problem is that we have no water at all. Sir!"

Carrot Power

THE common yellow pigment of carrots, carotenoids,constitute the second major pigment found in all autotropic plants. Their presence in plant leaves along with chlorophylls indicate their involvement in photosynthesis. Free and protein bound carotenoids are found in rod and cone layers of eye and in the olfactory epithelium of animals and human beings. Carotenoids are conjugated π-electronic chain molecules with alternate single and double bonds (Fig.1). This structure gives these molecules the properties of a semiconductor in the crystalline state. It now seems possible that they can be used in the development of some useful devices such as gas sensors, optical switching devices and solid state batteries.

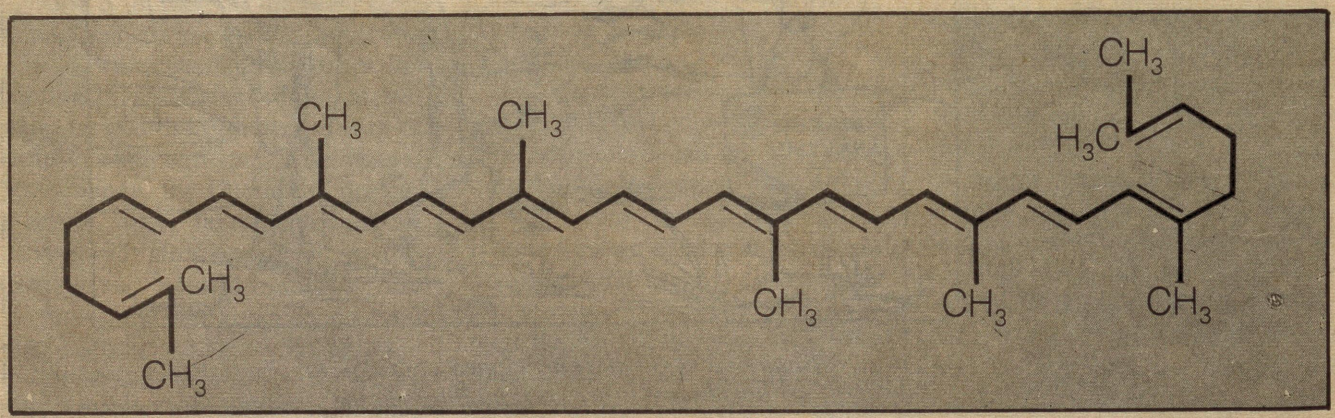
CAROTENOIDS are semiconductors in the solid state. The interesting aspect about the semiconducting properties of the carotenoids is that they are very sensitive to the ambient atmosphere. As ambient gas molecules get absorbed on carotenoid crystals, their conductive properties change significantly (Fig.2). In the presence of methanol vapour the conductivity of β-carotene in a sandwich cell increases by six orders of magnitude.

Presence of nitrogen dioxide, hydrogen sulphide, ammonia, methanol, nitric oxide, acetone, etc., enhances the conductivity of β-carotene by 10^4—10^6 times, but only moderate increase is observed with methylacetate, nitrous oxide, etc. With nitrogen, hydrogen, oxygen and helium gas there is no significant change. β-carotene shows a low response to methylacetate, but vitamin A alcohol cell senses methylacetate vapour very efficiently. Thus different polyenes respond differently to different gases as regards their electrical conductivity. By using different polyenes, therefore, it is possible to develop a sensor specific to a particular gas.

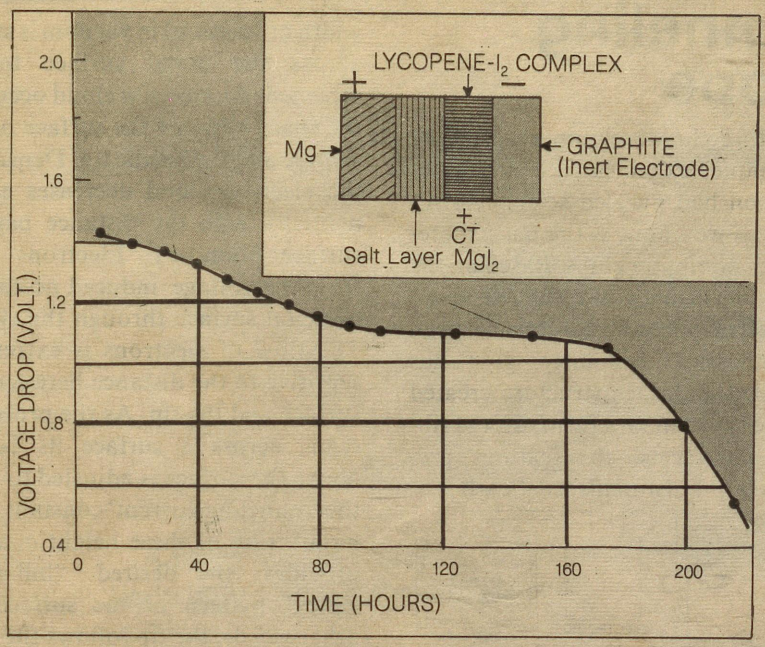
THE basic property required for an optical switching device is a substantial reduction in the resistance of a high-resistance material under action of light. Some of the polyenes possess this property to a good extent.

The current-voltage characteristics of dark and photocurrent of crocetinaldehyde crystals in a sandwich cell are shown in Fig. 3. If one chooses a working voltage of 40V, it is seen that the current increases 10^4 times due to the action of light. It is possible to design a cell with large surface area to increase the photoconductivity by a few orders of magnitude more. These materials can, therefore, be used in optical switching devices.

WORKING of a carotenoid based solid-state battery was reported in 1988 by K.M. Jain of Government Science College, Rewa, who used Vitamin A acetate-I_2 complex as the cathodic material and zinc as the anode. Lycopene-I_2 complex is a better material for solid state battery. In such batteries no metal salt is used in the cell assembly, but it is formed during the operation of the battery. The battery assembly is shown in the inset in Fig.4. A magnesium anode and lycopene-I_2 complex in a pressed pellet form as the cathode are used. These are then backed with graphite electrodes. I_2 is released from the charge transfer complex and a MgI_2 salt layer is formed at the interface. The electrochemical current is derived from the reaction of Mg with I_2. An open circuit voltage of 1.65V has been obtained against theoretically expected 1.84V. The salt layer is permeable to the I^- ion but insulating to electrons and this keeps the battery operating. In the initial stage voltage-current plot is linear which is evidently due to the internal resistance of the battery. At this stage the overvoltage is negligible At higher



Lycopene molecule



Performance of lycopene battery

current drain, voltage drops more rapidly as polarisation of the electrodes set in. The value of overvoltage increases abruptly for a current of about 200 μA. The battery has satisfactory discharge characteristics as shown in Fig.4. When 14 μA current is drawn, there is negligible drop of voltage upto 160 hrs. The power density of such a battery is 2.3 W/kg.

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Treating Irregular Heartbeats By Controlled Release of Drugs

THE human heart is one of the most complex and sensitive mechanisms known. So when it goes out of gear one has to deal with it with extreme caution. Often drugs administered for a specific reason do not only help treat the specific condition with varying degrees of efficacy but also have some side effects, not all of them innocuous. So in modern medicine much effort is put in to decide on optimum dosage of chosen drugs and their controlled delivery to specific locations in the body at the right intervals.

Now research results reported at the annual meeting of the American Chemical Society in the last week of April 1990 have indicated the possibility of treating arrythmias—or irregular heartbeats—with minimal side effects through a new technique that puts minimal doses of medication directly into the heart. Arrythmias can complicate heart attacks and frequently are difficult to control. In the United States alone about 600,000 patients are taking medication for this condition.

The new technique developed by Dr Robert J Levy of the University of Michigan's Department of Paediatrics involves implanting rubber–like polymers impregnated with the drug directly into the hearts of animals. The polymers release the drug in a controlled manner, a little at a time, thus ensuring optimum drug efficiency and reducing drug dosage. Dr Levy found that small doses of verapamil, one of the first calcium channel blockers but one that has never before been used to treat life–threatening arrythmia, was highly effective when combined with a polymer and applied directly to the heart. According to Dr Levy, the technique is also effective in preventing rejection of a transplanted heart when a drug–containing polymer is placed in the new heart at the time of transplantation. The technique has been tried to prevent calcification of blood vessels and implanted heart valves.

In another set of experiments, Dr Levy has been successful in implanting the drug–polymer composite in a functioning synthetic heart valve without it being washed away by circulating blood or without it interfering with valve function.

Controlled–release implants are better than conventional medical therapy as one can ensure high local concentrations but relatively low net doses, thus optimizing therapy where it is needed and avoiding high–level drug exposure.

These implants are made by combining a chosen drug with either a non–degradable polymer such as silicone rubber or a biodegradable compound such as a high molecular weight polyanhydride. Already some controlled–release cardiac systems are in use such as an anti–inflammatory drug (dexame – thasone) imbedded in a silicone rubber, used to prevent scar tissue build up at the tips of implanted pacemaker electrodes.

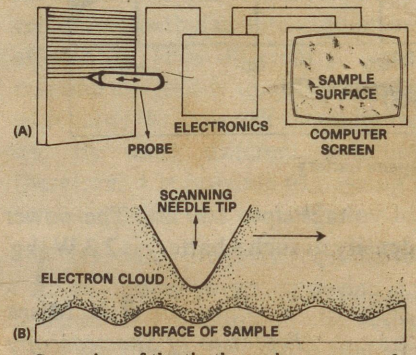
Subbiah Arunachalam

Scanning Tunneling Microscope

SCIENTISTS have always been yearning to look intc the smallest objects—animate or inanimate—which they could not do with naked eyes. This curiosity led to the discovery of optical microscopes—the instruments which magnified things severalfolds. They however could not satisfy the scientists and as a result non-optical microscopes such as electron microscope, field ion microscope, etc. appeared on the scene. In these instruments the illuminating medium is not light waves but electrons, the tiny negative particles which sorround the positive nucleus of an atom. The image of the sample to be explored is formed on a cathode screen through the help of a computer. The magnification provided by these microscopes is so enormous as to make it possible to see even individual atoms.

Furthering the electron scanning technique, two scientists of IBM Research Laboratory, Zurich, Switzerland, Gerd K Binnig and Heinrich Rohrer, invented Scanning Tunneling Microscope (STM) in 1981. This technique is capable of generating topographic images of metallic surfaces such as silicon, gold, nickel, etc. which were previously unseen. The images of surfaces are magnified to a order of a hundred million times. In addition to that, STM views can reveal flaws and contaminants in atomic surface structure. The technique was found so useful in the study of metallurgy, magnetism, semi-conductor technology and biology that Binnig and Rohrer were awarded Nobel Prize for Physics in the year 1986 alongwith Ernst Ruska, Fritz Haber Institute, Berlin who developed working model of an electron microscope

Before the development of STM technique, exact surface nature of sili- con had puzzled scientists. Silicon, as we know, is the basic material for computer chips. Based on the image of silicon, now observed, many models of silicon structure have been hypothesised. Similarly, gold has revealed a surface structure created by the spontaneous formation of ribbon-like facets—the features previously not distinguished clearly.



A. Sweeping of the tip through a pattern of parallel lines yields three-diamensional image of the surface
B. A voltage-induced flow of electrons through the cloud is extremely sensitive to the distance between the surface and the tip

We must understand the nature of electrons and characteristics of the metal surface before we proceed to know the working principle of STM. According to quantum mechanics, the electrons of the metal are not point charges but are relatively extended waves or an electron cloud. The cloud is the consequence of the undeterminancy of the electron's location due to its wave-like properties. As such, if two metallic surfaces are brought close to each other in vacuum, there is a certain probability that some electrons pass from one metal to another. This is what we call "tunneling effect". The STM works on this principle.

IN STM technique, a needle tip (probably of tungsten with the width of an atom) in vacuum is swept across the metal surface to be screened. An electron cloud occupies the space between the surface of the sample and the needle tip. Density of the electron cloud decreases exponentially with the distance beyond surface boundary. Electrons flow from the voltage-induced needle tip to metal surface through the cloud. The flow of electrons is extremely sensitive to the distance between the surface and the tip. As the probe tip scans across a surface its height above the surface is adjusted to keep the 'tunneling current' constant. The monitoring of these height changes provides the desired "hill-and-valley" pattern of the surface. In other words, the tip follows the contours of the metal surface and its motion is read and processed by a computer and displayed on a screen or plotter. By sweeping the tip through a pattern of parallel lines, a high resolution, two-dimensional, image of the surface is obtained. To procure good results, the microscope should be protected against all vibrations, even sound of foot-steps in the laboratory.

STM, besides providing metal surface topography, also reveals atomic composition and information regarding properties of semiconductors and high temperature superconductors. One of the unique advantages of STM imaging is that, unlike other imaging techniques, it does not alter or destroy the sample under observation. IBM team at Zurich and researchers at the Swiss Federal Institute of Technology have scanned the surface of DNA and observed a series of zigzags which conform to its helical structure. Researchers at University of Madrid have made detailed examination of viruses. Biological molecules in water and air are also being studied by STM.

C.B. Sharma

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