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DECEMBER 1978

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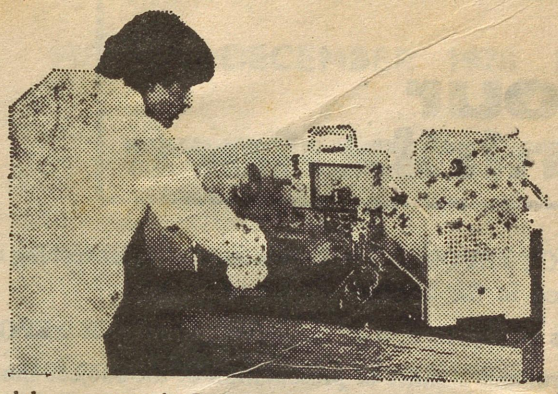

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Cover : **Scanning electron micrograph of a red spider mite enlarged 700X. (*Transparency* : P. Dayanandan)**

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Star charts

Sir, I find it difficult to agree to A. Jagdeesh's suggestion (*S. R.*, Sept. 1978) that the column **Planets and their positions** is not very popular and should be replaced by some other feature. This column gives the positions of the wandering planets and constellations which is available in no other science magazine in this country. This information is of vital importance to amateur as well as professional astronomers, and under no condition should be discontinued.

S. K. GURTU
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Delhi 110054

II

Sir, A. Jagdeesh's views (*S.R.*, Sept. 1978) regarding discontinuance of star charts in *S.R.* is not justifiable: A science magazine (especially for the layman) is incomplete without star charts. In fact, it is the point wherefrom an amateur in the field usually begins with.

If readers in his town are not interested in the column, does the same hold good for all towns. In our town, on the other hand, the subject has become so popular that even a local Hindi newspaper has started publishing star chart.

VIJAY NICHANI
49, Telephone Nagar
Indore 450001

III

Sir, Re. A. Jagdeesh's letter (*S.R.*, Sept. 1978), you will have one subscriber less if you should ever discontinue your regular column **Planets and their positions**. After all, astronomy is one of the oldest sciences known to man.

TREVOR M. ROSARIO
Park House, Jail Road
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Dialysis

Sir, Shashidar B. Nargund has given the readers of *S. R.* an excellent account of dialysis in kidney failure (*S.R.*, June 1978). At the same time, he has not mentioned certain interesting and important points.

Experiments have shown that dialysis also removes radioactive substances such as Sr^{90} from the blood, preventing them from being deposited in bone or excreted by natural kidney. Recent studies in Switzerland have shown that schizophrenia can be cured by dialysis.

Many ions diffuse rapidly through blood and bath fluid during dialysis but much more slowly between blood plasma and cell. Thus dialysis can upset the normal ratio between the concentration of ions in the cells and the surrounding fluid. The body acts to correct acidosis by increasing the respiratory rate. In the artificial kidney excess acidity is corrected by adding bicarbonate in the bath fluid. If in an attempt to correct acidity by dialysis bicarbonate is added too rapidly, the HCO_3^{2-} level within the cell would lag behind. Respiratory rate then continues at high rate. The result is sudden change in the patient from "metabolic acidosis" to "respiratory alkalosis".

Similarly, in patients with chronic uremia, compensatory mechanisms gradually develop within the cells over months. The rapid correction in the blood takes some time to be reflected in the cell. After a session on the artificial kidney there is a paradox of marked improvement in the blood composition with little improvement in the patient. He is chemically well but clinically sick. The ability of the artificial kidney to alter drastically the composition of body fluids makes it a dangerous tool in the hands of inexperienced operators.

S. SUJAKUMAR
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Some more ideas on aether

Sir, Thanks for publishing an article on aether by P. C. Jain and a short note by D. M. Salwi on **The drifting new aether** (*S.R.*, Aug. 1978). Here I wish to mention an important suggestion given by P. A. M. Dirac to bring back the idea of aether, in order to reconcile the theory of relativity with the laws of quantum mechanics. He has argued that though the theory of relativity is elegant, it does not describe a natural phenomenon completely. To describe a phenomenon completely one has to consider quantum mechanics also. The velocity V between any two frames of references moving uniformly with respect to each other is always assumed to be given. However, one has always to measure this velocity and whenever a measurement is carried out, the system's properties (here the velocity V) get disturbed in accordance with the Heisenberg's Uncertainty Principle. The phrase 'given velocity V' is therefore a myth of our imagination. Two frames of references moving with a given constant velocity do not exist and will never.

Another difficulty appears because of the finite speed of interaction

between two particles. So to study a two particle quantum relativistic system, one has to solve mathematical equations which not only obey the laws of quantum mechanics but are also consistent with the theory of relativity. However, all exact solutions of such equations give divergent solutions. Only approximate convergent solutions have been found.

To solve such problems, Dirac has suggested that "there could be an aether whose velocity is uncertain. The velocity of aether may have a definite probability for having a definite value. In that case the idea of aether does not contradict relativity. The aether velocity would just be a new kind of field." Such an aether involves viscous effects, but such effects have been completely ruled out by Michelson-Morley experiment. To get rid of the viscous effects, E.C.G. Sudarshan has suggested that if the aether is like a superfluid, this problem can be avoided because a superfluid does not exert any force on a body moving in it (below certain critical velocity). It therefore does not contradict the Michelson-Morley experiment. Recently, K. P. Sinha, C. Sivaram and E. C. G. Sudarshan have argued that one can regard aether as a superfluid state (ground state) of fermions and anti-fermions, in an anology to the theory of super conductivity. They have also mentioned the possibility of a connection between the 3 K radiation and this superfluid.

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Malabar squirrel

Sir, This giant squirrel, 90 cm to 120 cm in length from nose to tail tip, is an easy prey to gunmen. Its frequent loud staccato sounds and bright colour make it a prime target; hunters relish its soft flesh. It is wrong to say that it is not endemic to Malabar region. Here J. M. Johnson (*S.R.*, May 1978) is mistaken. Perhaps it may not be found in profusion in southern Malabar (Travancore) but in some forest areas of North Malabar districts it is the dominant arboreal fauna. So the name Malabar squirrel is appropriate. In my estate, in the Iritty-Makote area, hundreds of them used to be found and a single hunter could take half a dozen in a couple of hours (not the correspondent).

The animal tames easily, especially if reared from a tender age and is a lovable pet, but the mature ones sometimes bite viciously. Though arboreal, it can run about on the ground and the tame ones easily hop about in homes. Even now it is widely distributed in the forests of North Kerala districts. Unless strict protective measures are taken, this lovable, defenceless creature will also meet the fate of the lion-tailed monkey, Nilgiri Langur or the Nilgiri Tahr, all of the same region, now fast disappearing.

K. S. BAGYA
792 Jews St., Cochin-11

Gene isolation

Sir, This is with reference to the article **Progress in gene isolation** by R. K. Choudhuri (*S. R.*, July 1978), wherein some of the statements, to say the least, are misleading.

On page 446, third column last part as well as on page 448, first column, last part the author has used 'T' in RNA chains and 'U' has been shown complementary to 'G'. I do not think, these should come in normal cases.

The DNA diagram is also misleading (page 447). For pyrimidine bases, the hexagons have been drawn properly but in purines, hexagon and pentagon associations are not clearly lined.

Today, most authors conclude their discussions on the topics as above with a few lines from genetic engineering the present author also appears to be no exception. I am afraid, how at this growing stage of knowledge with HAP chromatographic method for isolation of DNA-RNA hybrids (according to the author, Hydroxy-apatite chromatography technique is most advantageous), metabolic disorders can be thought to be corrected in differentiated cells. A metabolic disorder is detected only after differentiation and eukaryotes show more genetical complications in cell differentiation. To me, this seems an oversimplification of the process.

M. M. BHATTACHARYA
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Helical DNA

Sir, What advantage does *DNA* have in being usually helical in shape? What is the functional , rather adaptive, significance of helical shape of DNA?

M. B. S. CHAR
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The question raised above has partially been answered in one of the articles entitled **Can man make a gene?** (*S. R.*, March 1977). The helical shape is the most stable one of all the shapes which DNA could possibly have. Why the DNA helix is stable can be explained by the following two reasons.

The phosphate molecules present in DNA molecule are negatively charged and hence there is an elec-

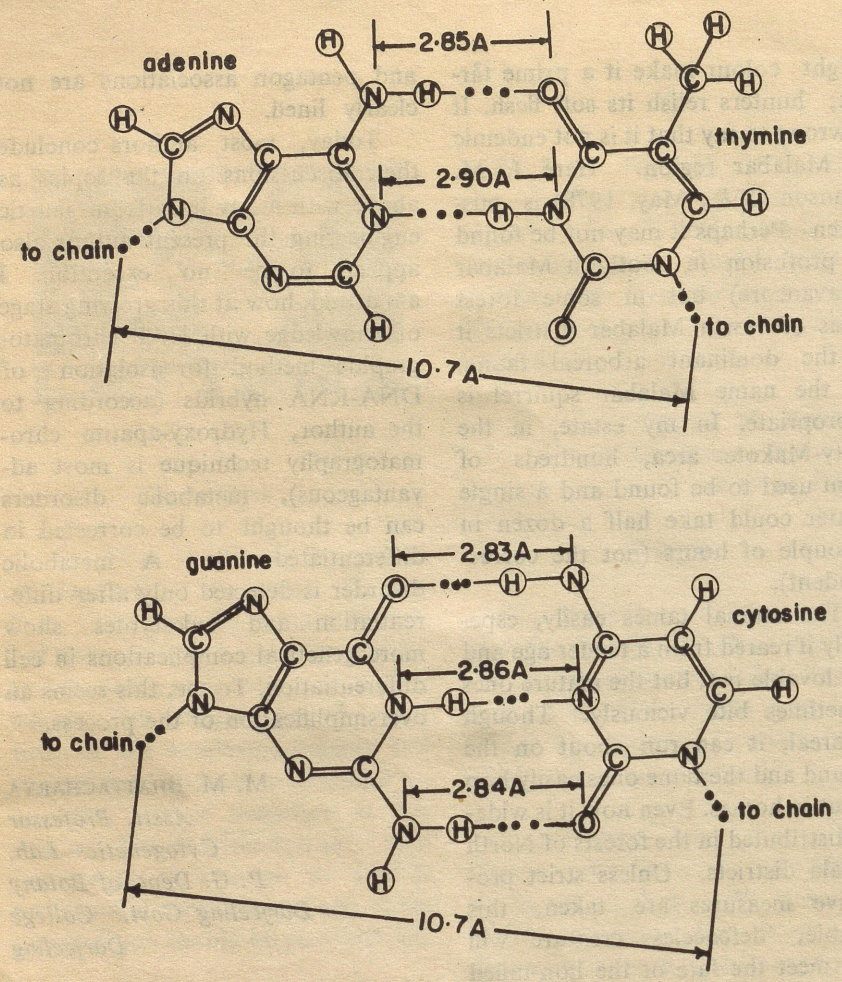

Fig. 1. Hydrogen-bond pairing and molecular distances between adenine and thymine, and guanine and cytosine

trostatic repulsive force acting between them. This is overcome by the unique stacking of the bases, through hydrophobic interactions between their flat aromatic surfaces. This tends to minimize the destabilizing repulsive forces and, consequently, stabilize the helical structure.

The A-T base pair has two and G-C base pair three hydrogen bonds which help fit complementary bases together. A hydrogen bond can be formed between a covalently bonded hydrogen atom having positive charge and an acceptor atom with negative charge. For instance, the hydrogen atoms of the amino group ($-NH_2$) are attracted by the negatively charged keto ($-C=O$) oxygen atom (Fig. 1). The hydrogen bonds are highly directional; stronger hydrogen bonds are those which point directly at the acceptor atom (Fig 2).

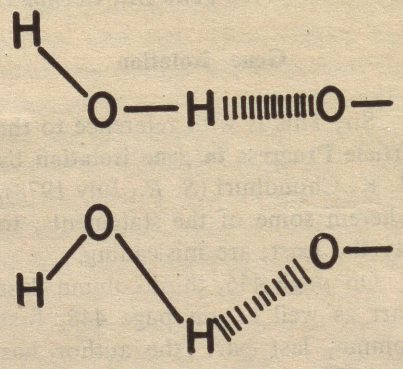

Fig. 2. Directional properties of hydrogen bonds in (a) the ractor along the covalent bond O-H points directly at the acceptor oxygen, thereby forming a strong bond; in (b) the ractor points away from oxygen atom, resulting in a much weaker bond (adopted from J.D. Watson's *Molecular Biology of the Gene*)

In DNA molecule, hydrogen bonds between the bases point directly, and therefore, ultimately make the helix strong. Above all, because a large number of them occur throughout the length of the double helix, they give sufficient stability and rigidity to the molecule so that, if by chance a break occurs at the physiological temperatures in the DNA helix, it is most likely that the hydrogen bonds would be formed again to restore the original helical shape and hence no damage would occur. Also, since the G—C pairs are held together by three hydrogen bonds, the DNA double helices having high (G+C) contents are more stable than those having high (A+T) contents, as A—T are held by two hydrogen bonds. This amounts to the fact that more the number of hydrogen bonds, more is the stability.

The double helical structure of DNA explains satisfactorily the requirements which a "substance" should fulfill if it has to function as genetic material. The requirements are:

(a) It should replicate itself precisely, (b) should be a stable structure so that mutations, either spontaneous or induced, are not frequent, (c) should be in a position to carry all essential of genetic informations; and (d) should be able to transmit genetic information to the cell.

The helical structure of DNA explains the above functional processes satisfactorily.

The classical double helical structure of DNA in which two strands are coiled helically around each other or are intervened, has recently been challenged by two groups of scientists working independently. The scientists are V. Sasisekharan and N. Pattabiraman of the Indian Institute of Science, Bangalore, and R.H.T. Bates and R.M. Lewitt of the Department of Electrical Engineering, and G.A. Rodley and R.S Scobie of the Department of Chemistry University of Canterbury, New Zealand. The

structure they proposed recently maintains the complementary base pairing but avoids intervening of the two antiparallel DNA strands. It has been suggested that "DNA is not the right-handed double helix but instead is an alteration of right-and-left-handed segments. The two strands go part-way around one another, first in one direction and then in the other (*Current Science*, **45**, 781-783). It is proposed that this structure explains more effectively the replication process than the classical DNA helix. But before this structure is accepted, more research is required to be done.

SUBHASH S. ARORA
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Bacteriophages

Sir, I thank you for the interesting and informative article **Bacteriophages** by James Mathew (*S.R.*, Feb. 1978). I would like to know: (1) How population studies of phages can help in forecasting epidemics of bacterial diseases in nature; (2) How can they be isolated in laboratory? and (3) Can they be used for curing human bacterial diseases?

SUDHIR U. MESHRAM
Dept. of Plant Pathology
College of Agriculture
Nagpur (M.S.)

In nature, bacteriophages are seen in close association with the specific host bacterium and their populations are directly correlated. In Japan, the bacterial leaf blight disease of rice is forecast by periodically estimating the phage population in the irrigation water of paddy fields.

Phages can be isolated from severely diseased plant materials and soil. There are standard methods for it. A method for isolation of bacteriophages from severely infected specimens of bacterial disease of crop plants is described here. 15g-20 g of finely chopped diseased material is suspended in 50 ml of distilled water in a 100 ml flask and incubated at the specific temperature for the bacterium for 24 hours. The supernatant liquid is filtered through an ordinary filter paper, and 1 ml chloroform is mixed with every 10 ml of the filterate. A bacterial proof filter can be used instead of adding chloroform later. The clear filterate is used for spotting on a previously poured, cooled solidified suitable medium in petri-plates seeded with specific host bacterium. Plates may be incubated and after 24-48 hours, the clearly lysed areas in the (spotted) plate may be transferred aseptically into 5 ml sterile water blanks and stored in a refrigerator. The phages so isolated may be purified further by two cycles of single plaque technique. For further details the reader may correspond with me or refer to the book *Bacteriophages* by Mark Adams.

Much work has already been done in the area of controlling human bacterial diseases with phages. But the application of bacteriophages in the control of disease is very much limited due to a number of clinical and other seasons.

JAMES MATHEW
Asstt. Prof. of Plant Pathology
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Trivandrum, (Kerala)

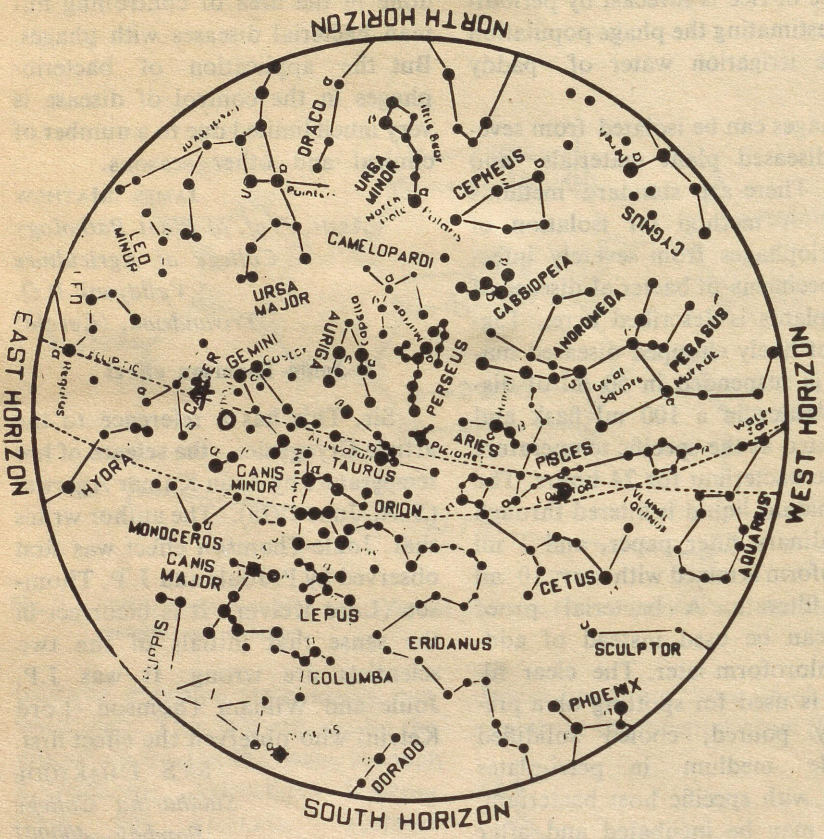
Joule-Thomson effect

Sir, This has a reference to the article **Cryogenics—the science of low temperature** by Arun Kumar Agarwal (*S. R.*, June 1978). The author writes that Joule-Thomson effect was first observed by P. Joule and J. P. Thomson (Lord Kelvin). It is incorrect in the sense that initials of the two scientists are wrong. It was J.P. Joule and William Thomson (Lord Kelvin) who observed the effect first.

S. S. DHAKTODE
Siddhartha College
Bombay—400001

Planets and their positions

January 1979



MAGNITUDES

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PLANET

4 JUPITER

MOON

D FIRST QUARTER 5TH

O FULL MOON 13TH

The moon

FULL moon occurs on the 13th at 12-39 p.m. and new moon occurs on the 28th at 11-50 a.m. I.S.T.The moon passes four degrees south of Jupiter on the 14th, about two and a half degrees south of Saturn in the night of the 17th and two degrees north of Venus in the early hours of the 25th. The lunar crescent becomes first visible after the new moon day in the evening of the 29th. The moon is at apogee or farthest from the earth on the 15th and at perigee or nearest to it on the 28th. The earth is at perihelion or nearest to the sun on the 5th.

The planets

Mercury (Budha), a morning star, rises about an hour before sunrise during the first three quarters of the month. Thereafter, it is too near the sun to be visible. It moves from Scorpio (*Vrischika*) to Capricorn (*Makara*) through Sagittarius (*Dhanus*). Its visual magnitude is about —0.3.

Venus (Sukra), visible in the morning, sky, rises about three hours after local midnight during the month. It passes 8 degrees north of the star Antares (*Jyestha*) around midnight of the 15th. It is at the greatest western elongation of about 47 degrees from the sun on the 18th. It moves from Scorpio (*Vrischika*) to Sagittarius (*Dhanus*). Its visual magnitude is about —4.2.

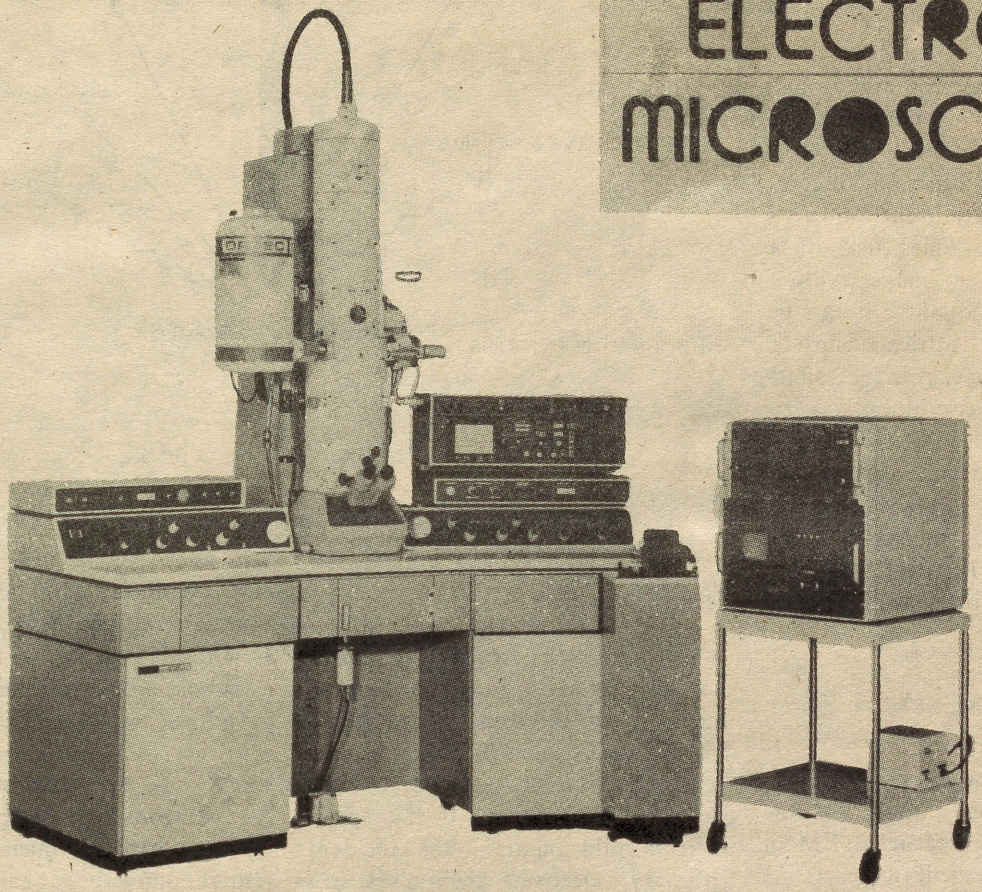
Mars (Mangala) is too near the sun to be visible during the month being in conjunction with the sun on the 20th. It moves from Sagittarius (*Dhanus*) to Capricorn (*Makara*).

Jupiter (Brihaspati) rises at about sunset and sets at about sunrise being at opposition with the sun on the 24th. It is in Cancer (*Karkata*). Its visual magnitude is about—2.2.

Saturn (Sani), visible in the morning sky, rises about two and a half hours before local midnight during the first half of the month and about three and a half hours before it during the second half. It is in Leo (*Simha*). Its visual magnitude is about 0.8.

SOURCE: Nautical Almanac Unit, India Meteorological Department, P-546, Bloog ·N‘ (1st floor), New Alipore, Culcutta 700053).

THE SCANNING ELECTRON MICROSCOPE



P. DAYANANDAN

Exceptionally high resolution combined with an unusually great depth of field endows scanning electron microscopy with a versatility found in few other scientific tools

THE human eye can only resolve objects larger than one tenth of a millimeter. But a veritable world of objects, organisms and activities lie beyond the vision of the naked eye. To peer into this microcosm one needs a microscope, that 'most valuable scientific instrument that the world has ever seen'. But the resolution of a light microscope (LM) is only about 2000A° (200 nm). As the wavelength of light has a limiting effect, no amount of technical sophistication can improve the resolution of a LM. So a LM cannot resolve objects beyond 200 nm, e.g., an average sized virus. The transmission electronmicroscope (TEM), which employs electrons (instead of the light waves of a LM), can resolve objects as small as an atom (about 2A° in diameter). The TEM has proved to be a valuable tool for our understanding

Dr. Dayanandan teaches botany at Madras Christian College, Tambaram, Madras 600059.

of the ultrastructure of living cells and materials. But the use of the TEM involves preparation of thin specimens (about 600A°) and gives images that lack three dimensional quality.

The scanning electron microscope (SEM), which can routinely operate at resolutions in the range of 100A° (10 nm), has many other advantages. It has an unusually great depth of field (300 to 500 times that of a LM) that results in images with a three dimensional quality; it can be used to examine intricate surface features of large specimens; it offers a wide range of continuously variable magnifications (from 15× to 100,000×); it is easy to operate and can be used to produce excellent stereo-micrographs. It is also a versatile instrument in that it offers a variety of modes of specimen observations.

Development of the SEM

Two German scientists, M. Knoll and E. Ruska are credited with the construction of the earliest TEM in 1932. They suggested, as early as 1935, the possibilities of using an electron beam to scan surfaces and record the emitted current as an image. Although the prototype of a SEM was built in 1938 by M. von Ardenne, its development did not keep pace with that of the TEM. C. W. Oatley and his colleagues in England, who started work in 1948, eventually produced the first commercial SEM in 1965. Now there are more than a dozen companies that produce commercial SEMs of a wide range of capabilities, from compact table-top models to highly sophisticated analytical models. The Central Electronics Limited is expected to market the first Indian-made SEM within a year as a result of cooperation between four research laboratories.

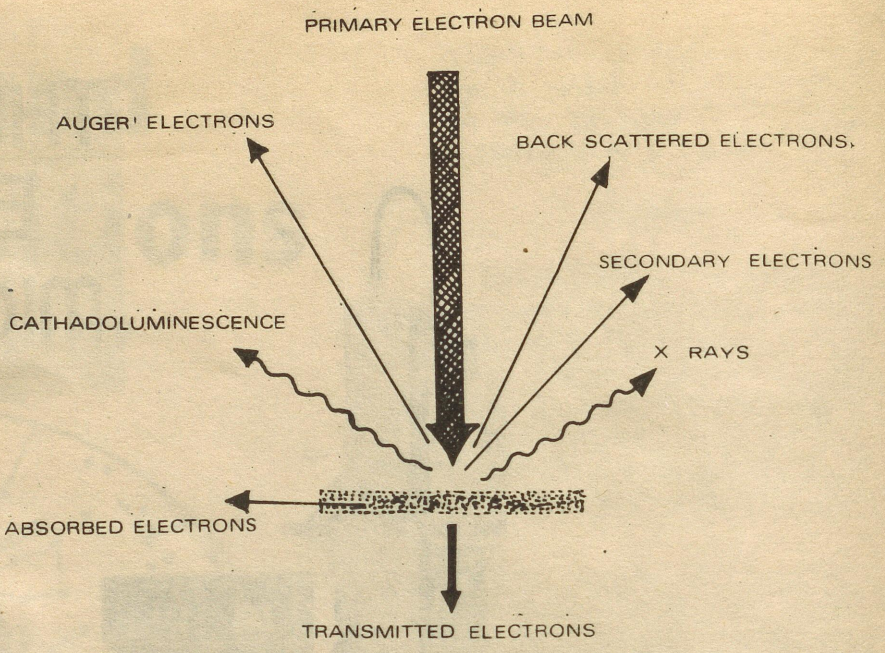


Fig. 1. Electron-specimen interactions resulting in the emission of electrons and electromagnetic waves

Principles

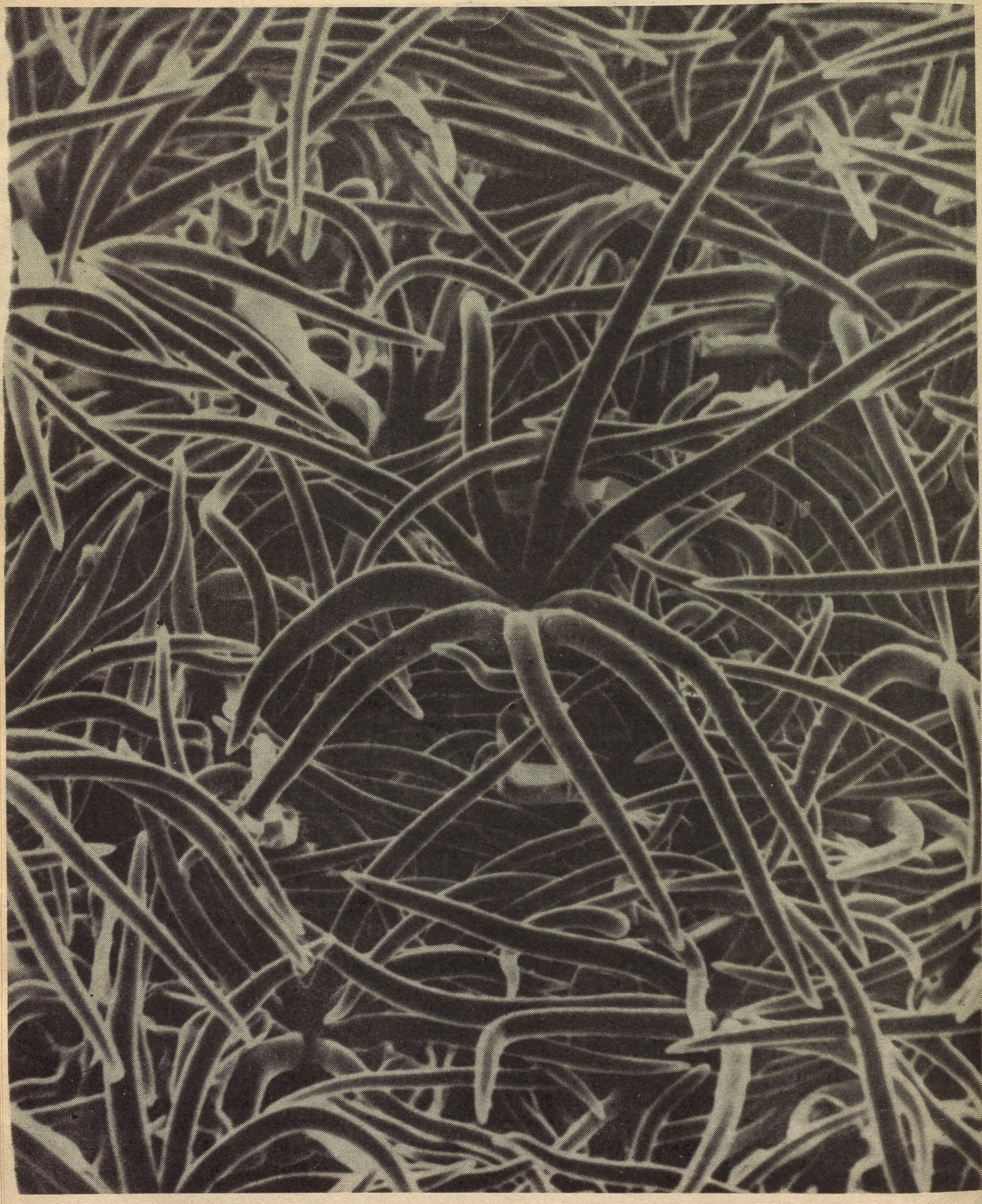
In order to appreciate the operation of a SEM an understanding of the role of electrons is essential. Fig. 1 depicts what happens when a beam of electrons impinges on the surface of an object. If the specimen is thin enough, the incident (primary) electrons themselves can pass through. While penetrating the specimen, the electrons are scattered either elastically (with no loss of energy) or inelastically (with some loss of energy). Transmitted electrons are employed in TEM and in scanning transmission electron microscopy (STEM). Some of the incident electrons are backscattered with high energies (90 eV to 180 eV). These backscattered electrons, whose number is proportional to the atomic number of the elements present in the sample, can be collected to produce an image. Auger electrons (emitted by excited atoms), which are somewhat lower in energy, can also be collected to form a different type of image.

By far the most important kind of electrons for SEM are the secondary electrons. These electrons are emitted from atoms of the specimen as a result of excitation by primary electrons. The secondary electrons have low energies (0 eV to 50 eV) and are generally obtained from the outer 100°A of the specimen surface. As electrons are also conducted through the specimen, the differential conductivity can be used to produce 'absorbed electron' images.

Primary electrons can also excite atoms in the specimen to produce X-rays fluorescence in the visible region (cathodoluminescence). These electromagnetic waves can be collected with appropriate detectors to form images. X-ray analysis is a powerful means of determining the distribution of different elements in a specimen. Most modern SEMs are built to accept a wide range of accessories so that the same specimen can be examined in the secondary, back-

***Escherichia coli*, the common intestinal bacterium. The bacteria along with the culture medium were critical → point dried to obtain this picture. 10,000X.**





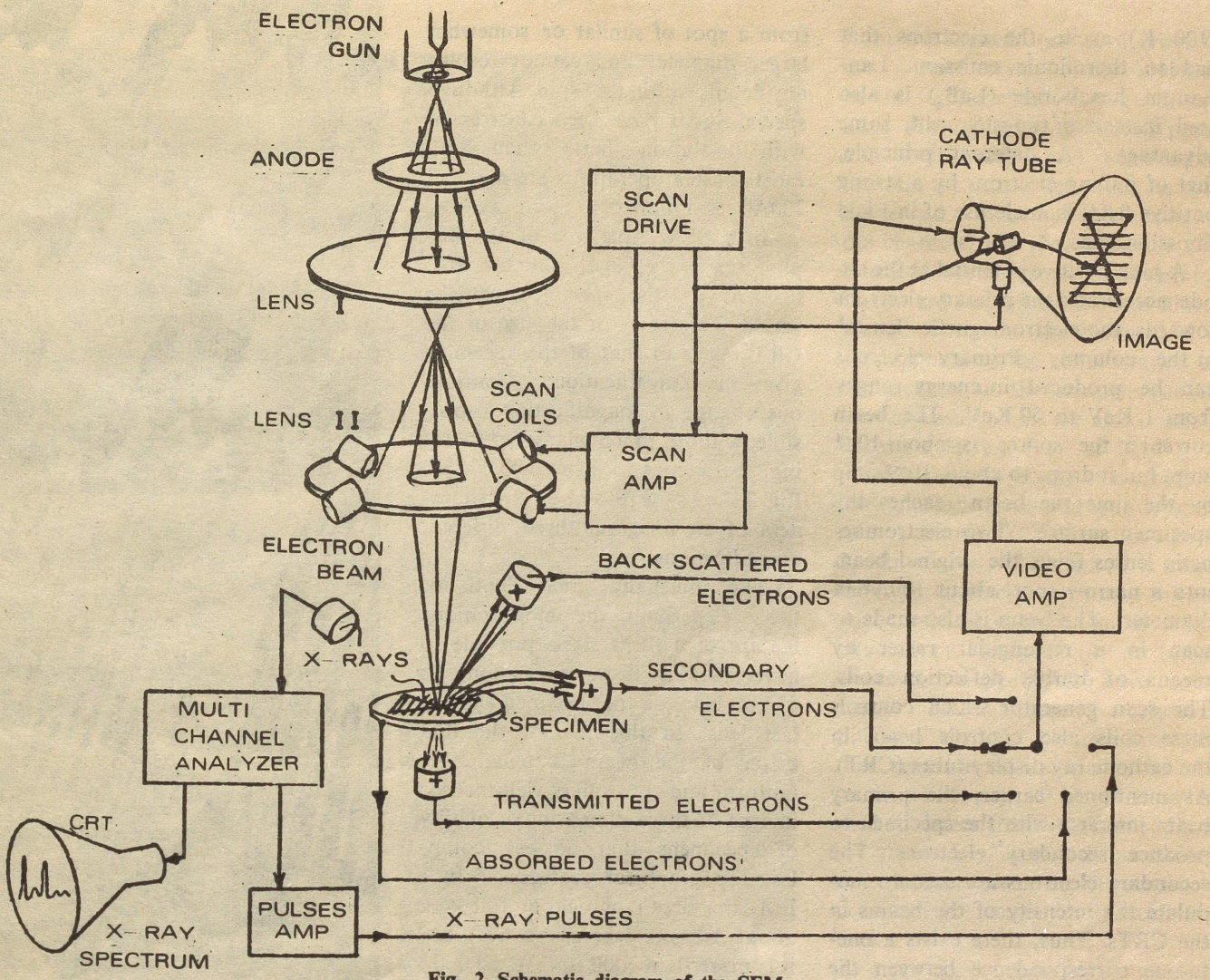


Fig. 2. Schematic diagram of the SEM

scattered, absorbed and transmitted electron modes as well as in the X-ray mode.

From electrons to an image

We perceive the world around us as images because of the interplay between light waves and objects. But only the narrow range of the visible spectrum can deliver such information to our brain through eyes. It may therefore seem surprising how electrons emitted from the surface of a specimen can form images we can see.

←**Hair covering the under = surface of an oak leaf. Fresh specimen.**

Let us consider the secondary electrons which were used to produce all but the X-ray images appearing in this article. When a narrow beam of primary electrons hit the specimen surface, secondary electrons are emitted from that spot. The yield of secondary electrons depends on the angle between the direction of primary electrons and the specimen surface. A flat surface produces minimal number of secondaries. If the beam is moved to another spot, there too the yield of secondary electrons would depend upon the topographical features of this region and may be more or less than the first spot. Thus, by continuously moving or "scanning' the beam over the specimen surface, a corresponding signal output is achieved. If the secondary electrons are also continuously collected and displayed on a cathode ray tube (CRT), an image appears which is comparable to the topographical details of the specimen. The scanning of a narrow beam of electrons over the specimen surface—much like in a TV camera or tube—distinguishes a SEM from a TEM or LM.

Operation

Fig. 2 summarises the basic features of a SEM. The source of electrons in most SEMs is a tungsten filament which is heated to (about

2900 K) excite the electrons that lead to thermionic emission. Lanthanum hexaboride (LaB_6) is also used instead of tungsten with some advantage. A different principle, that of pulling electrons by a strong positive field, is made use of in Field Emission guns.

A high positive potential at the anode accelerates the primary electrons towards the electromagnetic 'lenses' in the column. Primary electrons can be produced in energy ranges from 1 KeV to 50 KeV. The beam current at the source is about 10^{-4} amp, but it drops to about 10^{-12} amp by the time the beam reaches the specimen surface. Two electromagnetic lenses focus the original beam into a narrow spot, about 100A° in diameter. The beam is also made to scan in a rectangular raster by means of double deflection coils. The scan generator which controls these coils also controls beam in the cathode ray display tubes (CRT). As mentioned earlier, the primary beam interacts with the specimen to produce secondary electrons. The secondary electrons are used to modulate the intensity of the beams in the CRTs. Thus, there exists a one-to-one correspondence between the specimen that is scanned and the image displayed.

The secondary electrons are collected by a cup that is positively charged at 200V to 400V. Then they fall on a scintillator which is maintained at about 10 kV. The electrons striking the scintillator produce photons which travel down a light pipe to a photo-cathodemultiplier. The photocurrent produced is further amplified to modulate the beam in the CRT.

Resolution, magnification and depth of field

The diameter of the primary beam is the most important factor that determines resolution. A beam of 100A° diameter gives signal output from a spot of similar or somewhat larger diameter and cannot resolve any details within that spot. Although special SEMs have been constructed with resolution better than 5A°, most routine operations are made at 200A° resolution.

In a SEM, the area of the display screen is fixed, but the area scanned on the specimen can be varied. This ratio of the size of the CRT raster to that of the specimen gives the magnification. Continuous change in magnification is possible, without much change in focusing, between 15× and 100,000×. Fig. 3 shows the resolution and sharpness of an image at three different magnifications.

The unusually great depth of field is perhaps the most unique feature of a SEM. It is possible to have working distances as long as 48 mm between the specimen and the last lens. In this region, the diameter of the beam is remarkably uniform and thus offers well-focused images of three dimensional quality of specimens that possess complex topographical features. In a LM, the depth of field at 100× is about 10 μm whereas in a SEM it is more than 1000 μm! At 20,000× the SEM still retains a depth of field of about 10 μm (with a resolution of about 100A°).

Stereomicrography

A consequence of the great depth of field and the ability to tilt the specimen inside the chamber is that excellent stereomicrographs can be obtained that can offer truly three dimensional images (Fig. 5). After taking a picture of an area of the specimen, the specimen is tilted to about 7° and the same area is rephotographed. This technique pro-

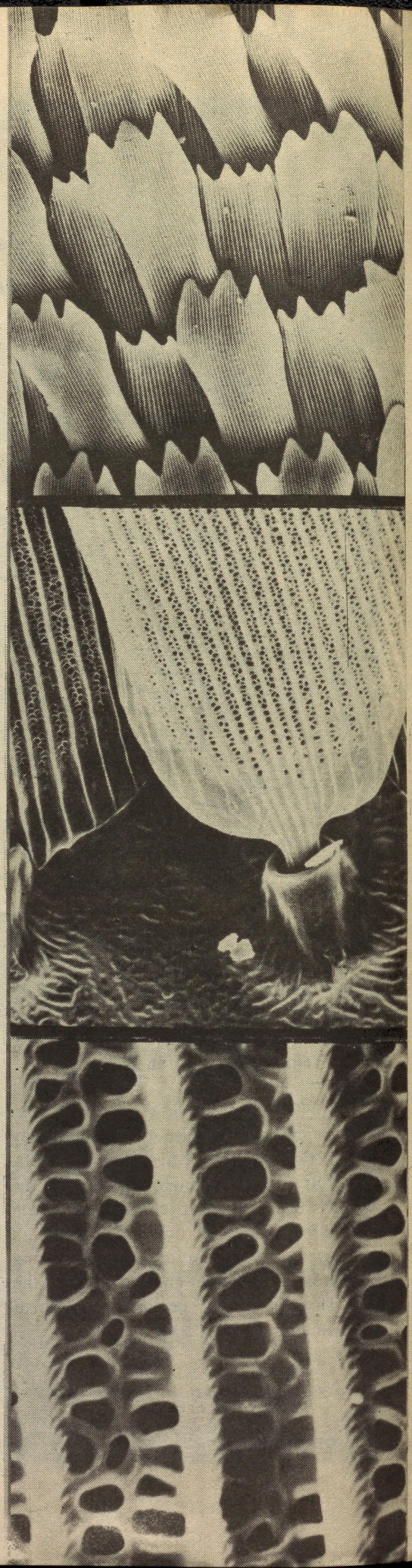


Fig. 3. Scales on the wings of a common Indian butterfly, the Crimson Rose (*Polydorus hector*) at three different magnifications ; (Top) 300× ;(Middle) 1500× : (Bottom) 10,000

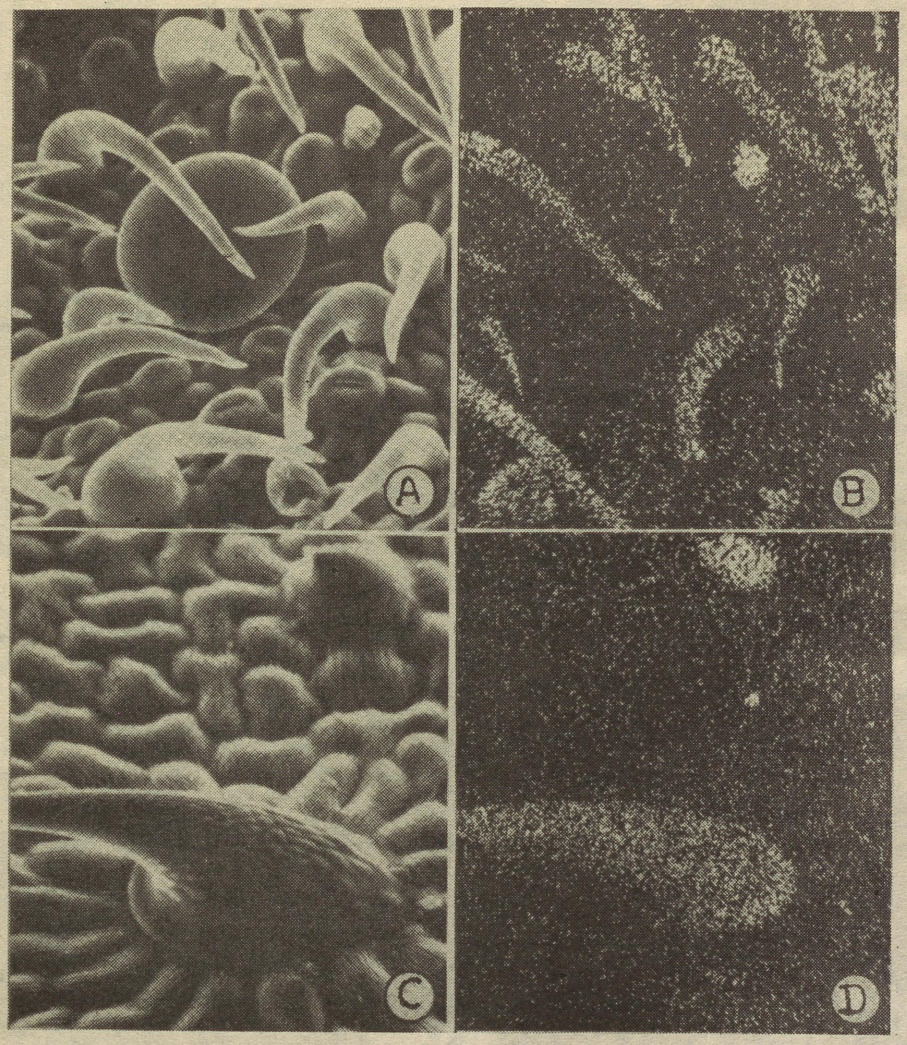


Fig. 4. Secondary electron (A&C) and silicon X-ray images (B&D) of the surface of *Cannabis sativa* leaf. The X-ray image reveals that Si is located only on the unicellular hairs and not an other epidermal cells, stomata or the gland which contains tetrahydrocannabinol

vides two images, much like what the two human eyes perceive of the same object. The two pictures can then be viewed with a stereo viewer. With some training, the two images can also be viewed with unaided eyes to enjoy the full impact of a three dimensional effect. A number of processes are also available to project stereomicrographs for a larger audience. Stereomicrography with SEM can resolve many controversies of structural arrangement at the submicroscopic level.

The image displayed on the CRT can be recorded with a 35 mm or a larger format camera. Polaroid film can be used to record images to observe the results instantly. Increasing sophistication in electronic technology has brought focussing, astigmatism correction and photography under the control of push buttons. For example, the Dynamic Focusing Unit lets one focus within 0.7 sec. after pushing a button!

X-Ray microanalysis

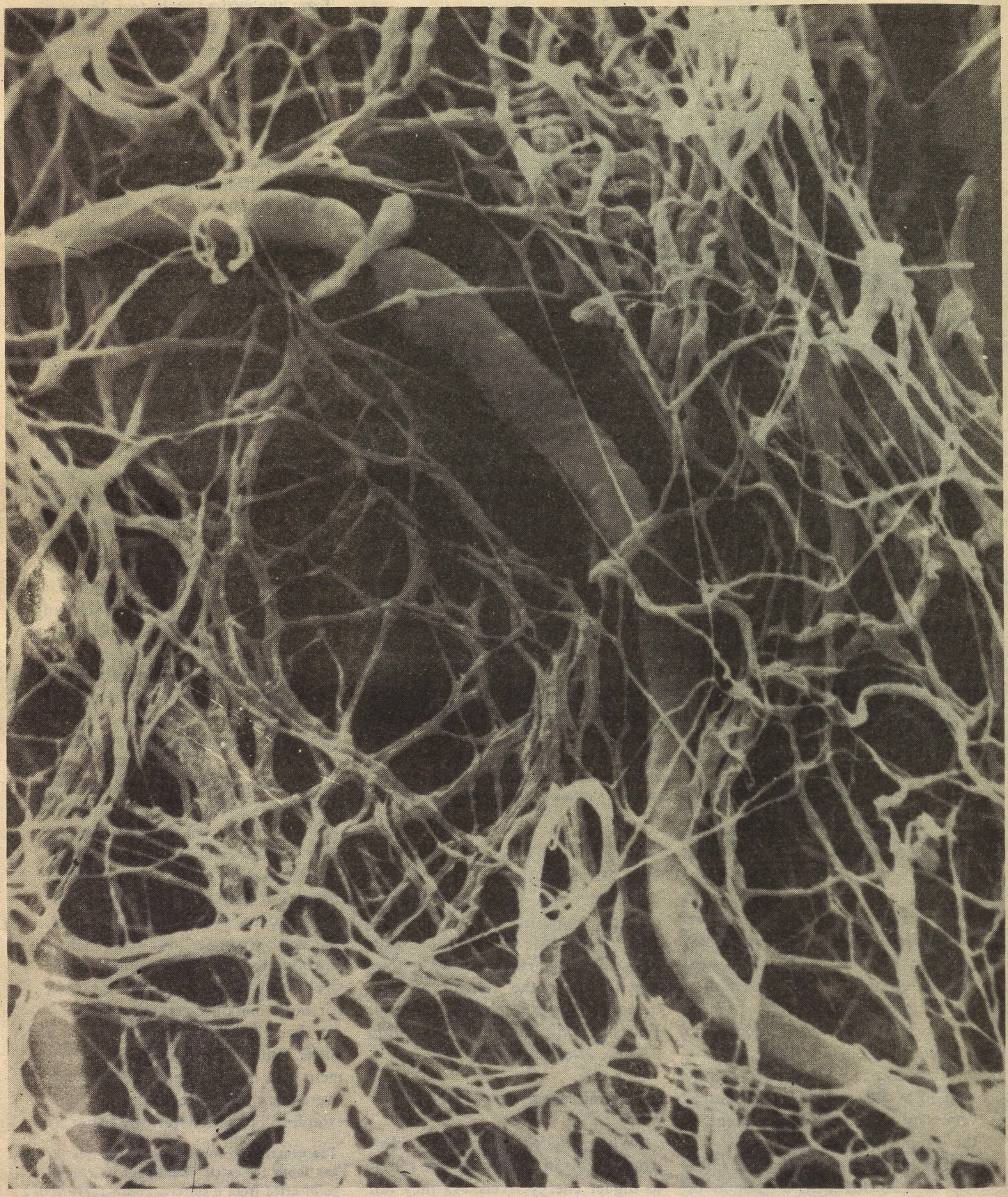
When excited by primary electrons, atoms in a specimen are raised to higher energy levels. As they fall from the excited state to a lower or the ground level, X-ray emission occurs. The characteristic X-rays have sharp discrete spectrum peaks and their energy and wavelengths are characteristic of the element concerned. With suitable detectors the characteristic X-rays can be collected to form images to determine the nature and distribution of different elements. As the X-ray yield is proportional to the concentration of the element in the sample, quantitative measurements are also possible upto a detection limit of 10^{-16} g.

Wavelengths of the characteristic X-rays can be measured with crystals and is known as Wave Dispersive Spectroscopy. The method is commonly used in electron probe microanalysers, instruments that are constructed on the principle of SEM. However, most SEMs have solid state semiconductor detectors (lithium drifted silicon detector) that generate current pulses in response to X-rays. This method is used to detect elements from sodium to uranium. Fig.4 demonstrates how the presence of an element such as Si can be located at the cellular level.

Specimen preparation for SEM

As electrons are employed in SEM, the microscope column must be kept free of air molecules. The column is maintained at a vacuum of about 10^{-5} torr. Wet specimens, if introduced, can contaminate the column with water molecules. So the specimens are dried before introduction into the chamber. (This problem of course, does not exist for most metallic, ceramic and similar hard structures as bone and shell). But drying biological specimens can distort them. This can be overcome by freeze-drying the samples, or better yet, by what is

The nematode eating fungus Dactylaria has loops to catch nematodes. Critical point dried from a culture 1700× *(Overleaf)*



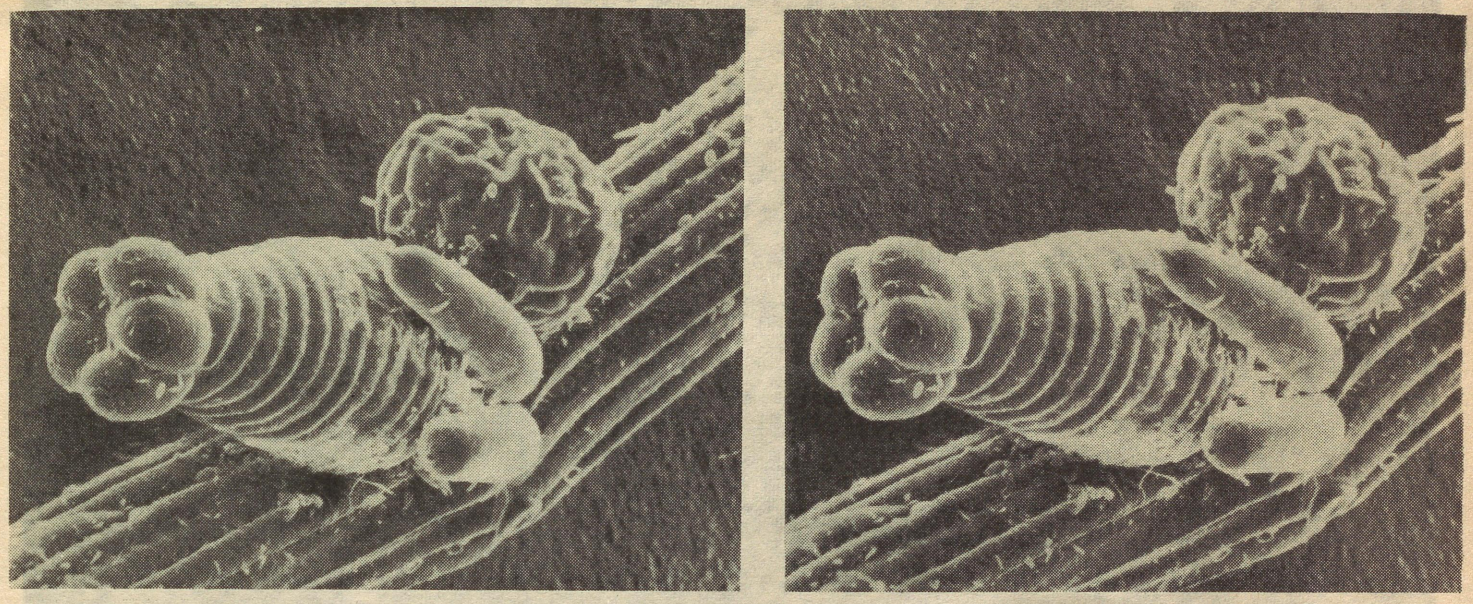
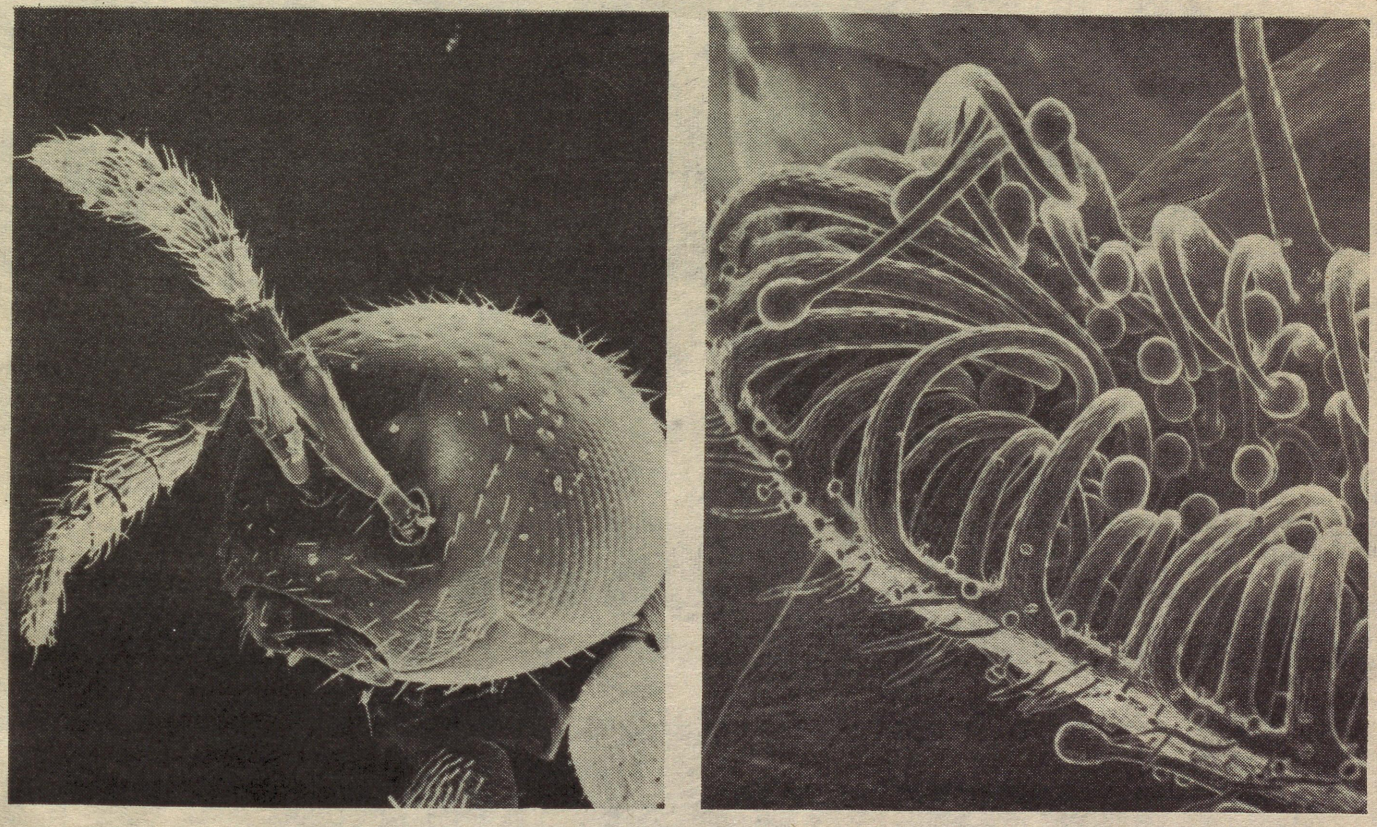
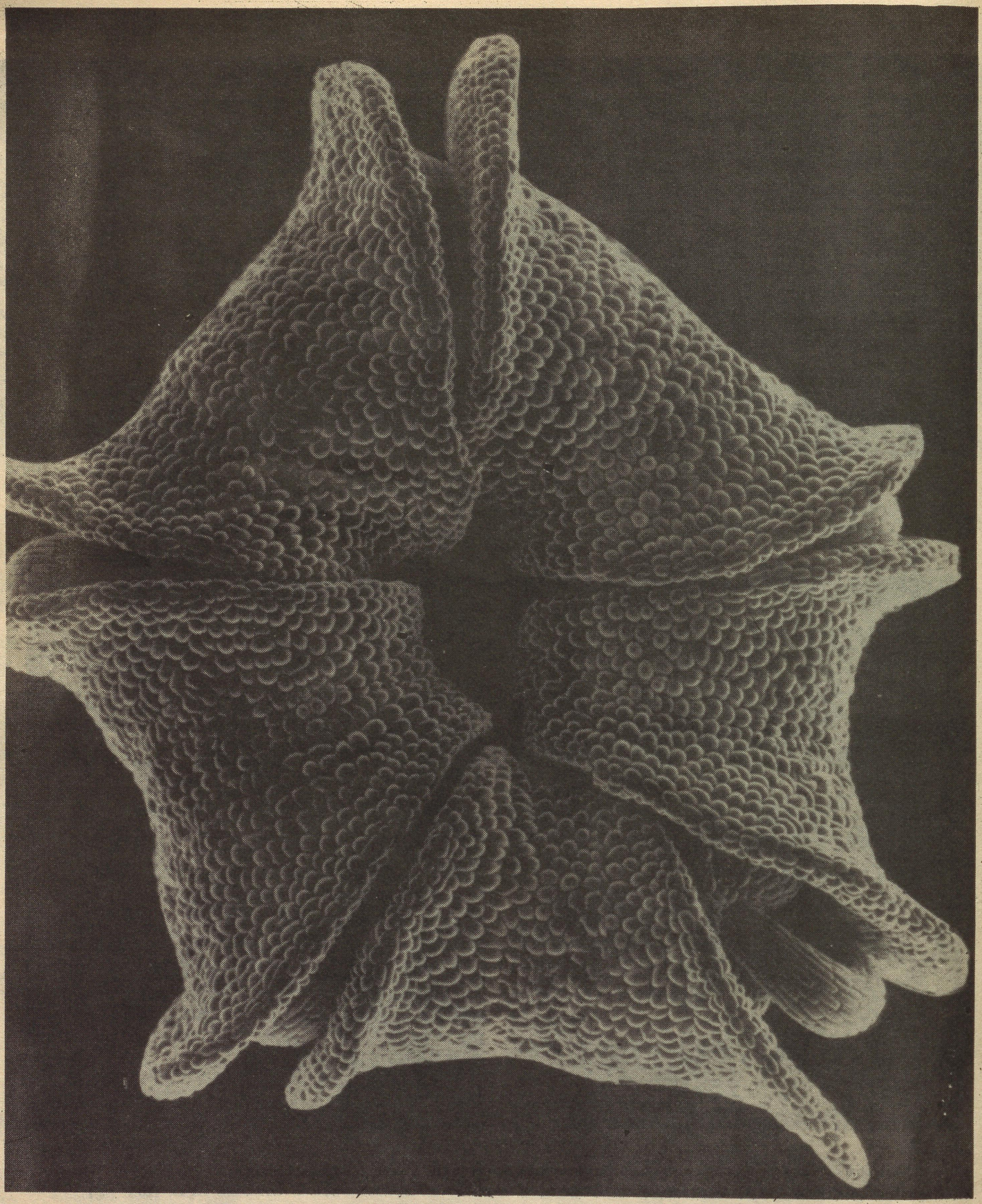


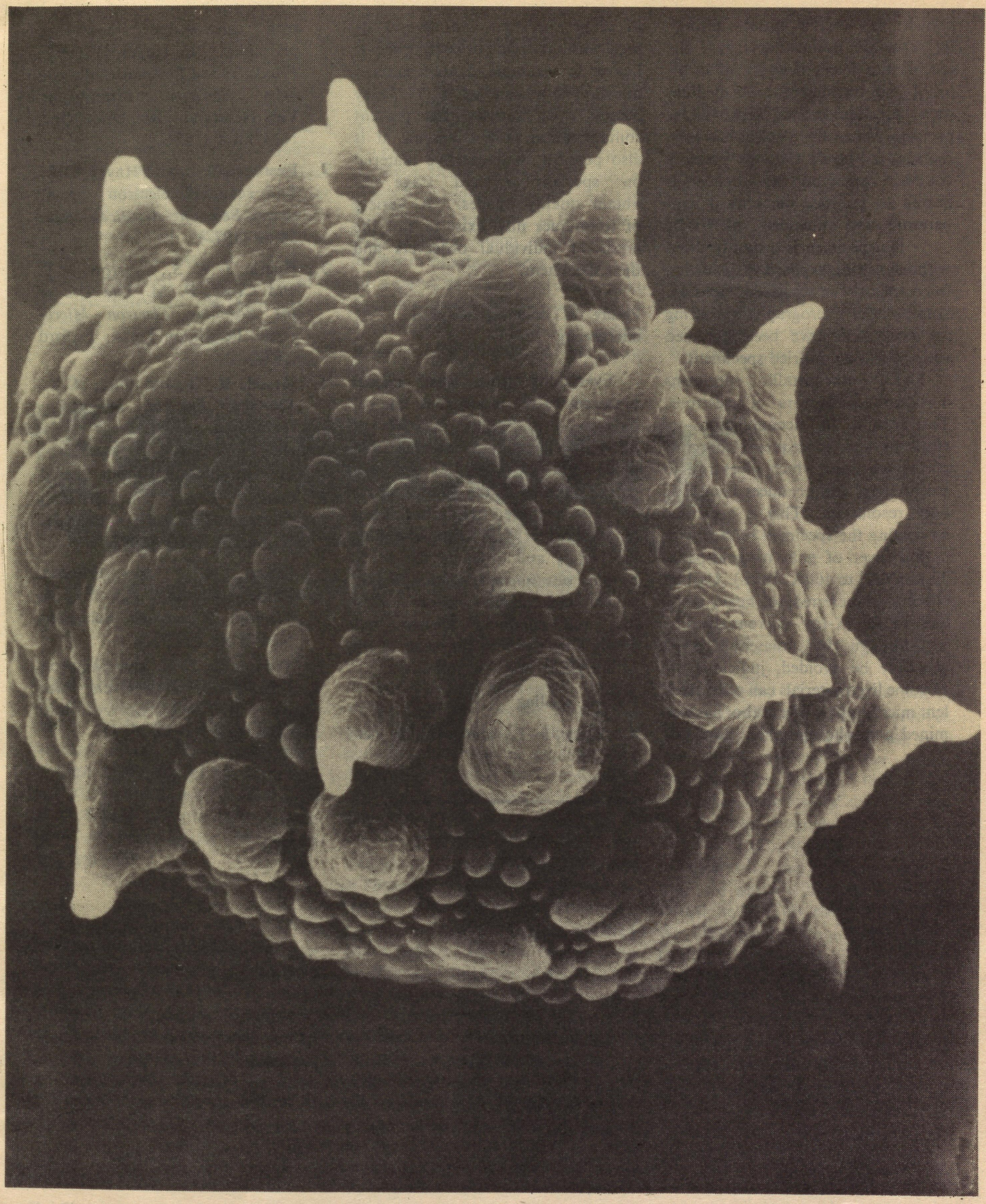
Fig. 5. Stereopairs of alga *Chara*, showing sex organs. This specimen was critical point dried and photographed at two different angles (left 45°, right 38°). If a stereoviewer is not available try the following: Focus your eyes on a distant object and bring this stereopair to the line of vision. With some practice the two images can be combined and perceived as three dimensional (100 ×)



Insectivorous leaf of Drosera whose glandular hairs have closed down on a prey. Fresh specimen 45X (*right*)
Head of a small wasp that parasitises the caterpillars of a common Indian moth, *Diaphnia vertumnalis* **CPD. 120X.** (*left*)



A flower bud of a member of the carrot family. Photographed from a fresh, untred specimen. 100×.



A single air-dried spore of the fern Pteropsis 6000. ×.

known as 'critical point drying'. In critical point drying, the specimen is fixed, dehydrated in alcohol and transferred to a medium such as liquid CO_2 kept under pressure. When the alcohol has been replaced by liquid CO_2 the pressure chamber containing the specimen is heated to produce the critical temperature and pressure of CO_2 the specimen is instantly dried without getting exposed to distorting forces such as surface tension. Some of the micrographs appearing in this article have been obtained with critical point dried specimens.

Dried non-metallic specimens are poor conductors of electrons. This results in accumulation of electrons and consequent 'charging' of the specimen which gives rise to bright spots and produces images of poor resolution. This is overcome by coating the specimen surface with a thin layer of gold or gold-palladium (50A° to 100A° thick). Carbon coating is preferred to heavy metal coating for X-ray microanalysis.

Although wet materials must generally be avoided, judicious use of some live materials can offer excellent micrographs. The author has examined and photographed hundreds of plant specimens and several insects without drying or coating them. Leaves for example, contain enough moisture to be conductive. Yet, they possess thick cuticles that prevent contamination of the column. It is also possible to freeze live material on specially prepared stage and obtain quality images. A variety of techniques now exist to suit the needs of individual observers and their specimens.

Future of scanning electron microscopy

Everything from fossil microorganism to the moon rock has today come under the scrutiny of SEM. Specimens once examined and understood with the LM are now re-examined with the SEM. Above all, SEM has given us another means of looking at and comprehending the beauty and order of the world beyond our normal vision. Further developments in the field of electronics and computer science will surely alter the very character of the future SEM and its potentials.

Further reading

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TOPOLOGY
a geometry without measurement

PRASANTA CHOUDHURY

Popularly called 'rubber-sheet geometry', topology concerns itself with properties which remain intact when a surface or figure is subject to continuous deformation of size, shape or area but without cutting a hole or tearing the surface in any manner

IN the mid-19th century a comparatively new trend began in geometry in Europe, which is now considered a major branch of modern mathematics. In this period lived a geometer named A. F. Moebius (1790-1868) in Germany, whose lack of self-assertion destined him to the career of an insignificant astronomer of a second-rate observatory. In 1858 Moebius sent a 'Memoir', which contained some results of a new geometry, to the Academy of Sciences, Paris. Seeing that Paris Academy was oblivious about it, Moebius himself made the results public after some years. This new trend eventually came to be called *Analysis Situs* (the study of positions) or Topology. At the same period some of the results of this new geometry were also discovered, independently, again in Germany by J.B. Listing (1808-1882) of Göttingen.

The Descartes-Euler formula

It is true that one or two results of *analysis situs* were known previously to the Swiss mathematician L. Euler (1707-1783), or even earlier to Rene Descartes, the distinguished French mathematician of the 17th century. An example is the interesting relation which exists between numbers of edges, faces and vertices of a cube, pyramid and other solid figures known as "simple polyhedra". Polyhedron is a solid whose surface consists of a number of polygonal faces. A polyhedron is simple if there are no holes in it. In the case of regular solids, all the polygons are congruent and all the angles at the vertices are equal, for example, a cube, a pyramid with a triangular base, etc.

For any such solid figure, the following relation holds. Number of faces+number of vertices=Number of edges+2..

So a cube has 6 faces, 8 vertices and 12 edges, and it is readily seen that the aforesaid relation holds. Likewise, for a pyramid with triangular base, the numbers of faces, vertices and edges are 4, 4 and 6 respectively. The same relation holds good for a pyramid with a square base which is a simple (but not regular) polyhedron. If we cut a hole through any of these figures, a relation slightly different from the aforesaid formula also holds true.

Some of the key concepts of this new geometry were explained in a popular manner by Moebius with the help of a fairy tale.

Moebius's fairy tale

A king of a certain country in the Far East had five sons. The kind made a will that after his death his kingdom will be divided into five parts, one for each prince, but that each one of the parts will be contiguous to any other. Moreover, there will be roads connecting each one of the parts with any other, subject to the condition that a road connecting any two of the five parts will not pass through any third part or even touch it at any point. In other words, the roads connecting any two parts will be wholly contained in the two parts. In Fig. 1 the kingdom has been divided into five parts A, B, C, D, E. It is clear that any road connecting A or B with D must pass over a third part such as E or C, or touch E or C at the point O, which violates the second stipulation in the will. So there is no feasible solution.

After the king's death the five princes faced an impasse, being un-

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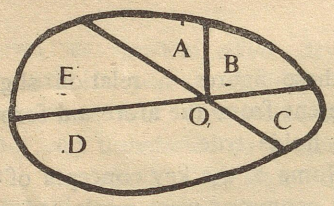


Fig. 1

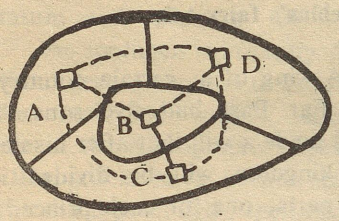


Fig. 2

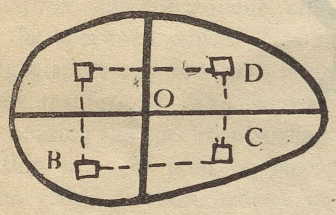


Fig. 3

able to resolve the issues arising out of the conditions stipulated in the will. After some years a keeper of royal records announced the existence of an earlier will in which the stipulations were the same as in the last will but the kingdom was to be divided into four parts instead of five. This will was made prior to the birth of the fifth and the youngest prince, who was far younger than the the fourth prince.

This problem can however be easily solved. Fig. 2 illustrates the solution. The constructions in Fig. 3 cannot yield any solution subject to the imposed condition. Any road in Fig. 3 connecting A with C must pass over a third part B or D, or touch these at the point O.

Now, can the problem, as posed in the final will, be solved? Closer considerations (the details of which we need not discuss here) show the problem to be unsolvable. The story, however, does not end here.

Several years went by and the five princes were in despair for not being able to find a solution. Then one day a travelling Wizard came to the kingdom and announced that he knows a solution to the problem. The solution proposed by the Wizard is quite simple and is illustrated in Figs. 4 and 5. It will be seen from Fig. 4 that the parts A, B, E and C out of the five parts A, B, C, D, E into which the kingdom has been divided are contiguous to each other. The parts B, C, D, A are also contiguous to each other but the part E is not contiguous with D. The Wizard proposed that E be connected with D by a hanging overbridge as shown in Fig. 5. Since there is nothing in the king's will barring such a construction, the solution proposed by the Wizard was a feasible one. The princes were pleased at this and so amply rewarded the Wizard for helping them out of the impasse. It may be noticed from Fig. 5 that paths joining one palace with any other palace passes through the respective kingdoms only.

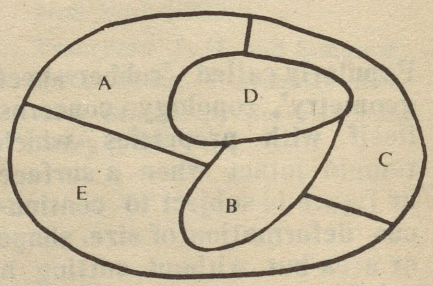
One may now look a little more closely at the proposed solution. The construction of an overbridge implies that the solution envisaged rules out any solution feasible for a plane or a flat surface. In fact there would be none if it had been insisted upon in the will that the solution must be confined to plane or flat domain. But there is no such condition in the king's will. Hence there is no bar to the construction of a bridge between any two non-contiguous domains and this is what the Wizard proposed.

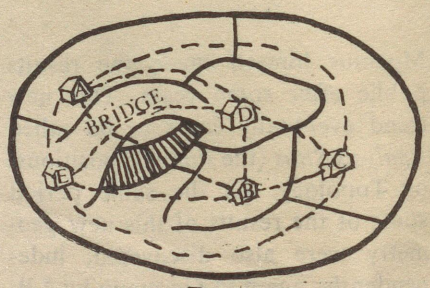
The problem of neighbouring domains

The key concept in this problem is "the problem of neighbouring domains" in topology. The definition of a "neighbouring domain" is implied in the two stipulations made in the King's will. It is seen that there cannot be more than four neighbouring domains in a flat or plane surface. Moreover, the concepts in topology ignore any consideration of size and shape. The problem would have remained the same whatever the size and shape of the kingdom, that is, if these were altered or deformed in any way (without making holes or tearing the surface) as if the whole surface were made of rubber. There is no stipulation as to the area of the kingdom a prince should receive. In topology use of the measuring rod is nowhere implied.

If the kingdom in the above tale was enlarged to encompass the whole of spherical earth, four would still remain the largest number of neighbouring domains possible. So on a sphere, too, there would be four neighbouring domains, but never five.

Consider the fundamental changes in the problem due to the Wizard's proposal that a bridge be built. The overbridge may be thought





– indicates palaces

indicates path joining palaces

Fig. 4 (top), Fig. 5 (bottom)

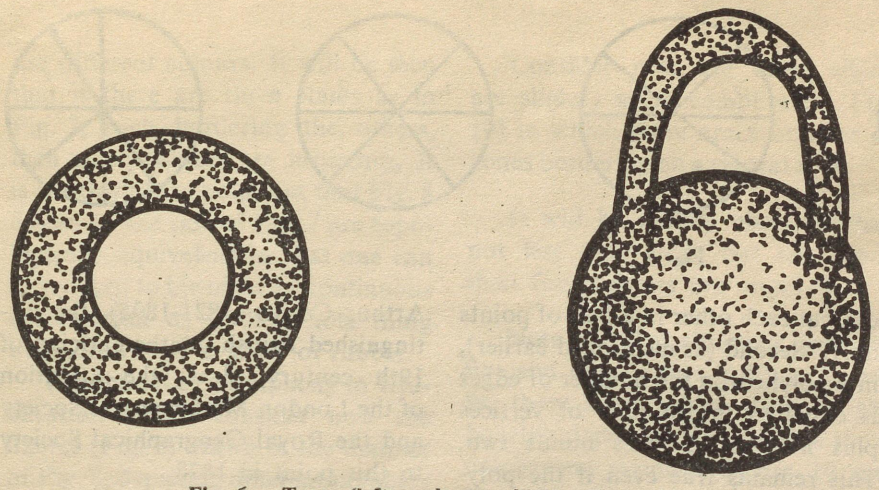


Fig. 6. Torus (left), sphere with handle (right)

of as a covered one shaped like a tube and the kingdom in question as the spherical earth. The situation then can be pictured as similar to a massive bridge, tubular in shape, connecting two distinct places on earth. A small scale model of this would be somewhat like the one shown in Fig. 6.

This picture now represents what may be termed as a sphere with a handle. If the sphere with a handle is made of rubber-like substance, by stretching and compressing it suitably it may be possible to reduce it to the shape of a 'torus' or 'doughnut'. The problem of neighbouring domains remains the same whatever the size and shape of the sphere or torus, whether it is as big as the earth or a small one the size of a football or a balloon. Incidentally, it may be noted that a torus is formed if one cuts a hole through an entire sphere; also that a torus and a sphere are non-equivalent surfaces from the stand point of *analysis situs*, as a torus cannot be changed into a sphere by continuous deformation even if it is made of a malleable rubber-like substance.

So it is possible to have five neighbouring domains on the surface of a torus. But the number of neighbouring domains on a plane or a spherical surface cannot be more than four. Similarly it is possible to show that on a torus there can be 6 or even 7 neighbouring domains, but not more. If the king in Moebius's tale had two sons more, that is, in all seven sons, the Wizard's proposal to construct an overbridge would still be a satisfactory solution. But the princes would have to face a dilemma again if they were eight in number. This dilemma could however be solved by constructing two overbridges instead of one. The problem would reduce to that of a surface called 'double torus', i. e., a sphere with two handles.

Problem of neighbouring domains can again be posed for cases of spheres with 2, 3, 4 or more and, in general, p handles.

A conjecture by the English mathematician P. J. Heawood (1861-1955) states that the maximum number of neighbouring domains is the integral part of the number obtained from the following formula for different values of p:

$$\tfrac{1}{2}\left[\,7 + (\,1+48\,p\,)^{\frac{1}{2}}\right]$$

Heawood was able to prove this conjecture for a few small values of p. Later investigation has shown the correctness of Heawood's conjecture (actually in 1968).

One of the basic standpoints of topology concerns itself with enquiries about properties which remain intact when a surface or figure is subject to continuous deformation of the most drastic sort which changes size, shape or area just as if the whole thing were made of rubber allowing stretching and compression in any manner. One condition must however be obeyed, namely, that one must not cut a hole or tear to break the continuity of the material (this is one of the reasons why topology is often popularly referred to as 'rubber-sheet geometry'). Topology deals with questions in which notions of continuity or neighbourhood are of paramount importance. For example, if three points A, B and C are marked out in any line (straight or not) on a surface such that the point B lies between A and C, then after any kind of deformation obeying topological conditions, the line though may become very irregular, nevertheless to pass from A to C along the line one has to a cross the point B coming from A before reaching C.

Recapitulating the ideas of Topology somewhat on the lines of H. Poincare (1854-1912), the famous French mathematician, it can be said—geometers usually distinguish two kinds of geometry, one is called the 'metric', the other 'projective'. In metric geometry, the measuring rod is all important, and it is based on the idea of 'congruence' familiar to us in the works of Euclid. In 'projective geometry' two figures are considered equivalent if one can

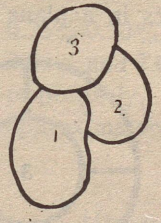


Fig. 7

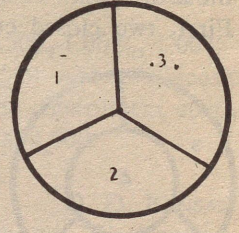


Fig. 8

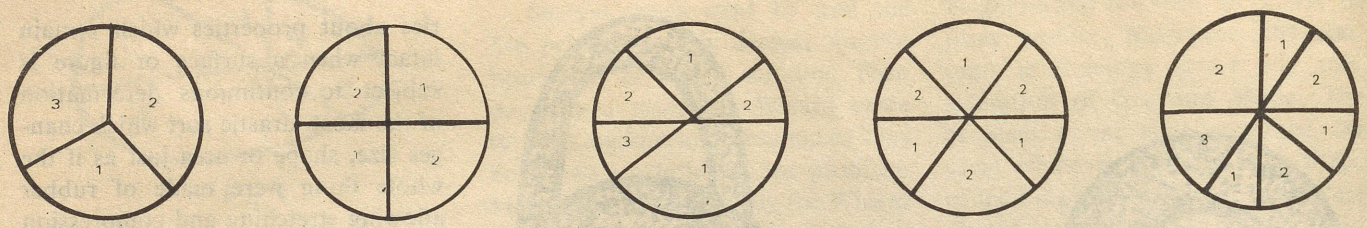


Fig. 9

pass from one to the other by a straight line projection. So a shadow of a figure thrown by a candle on a wall is equivalent to the figure itself. This is from the standpoint of projective geometry even though the shadow is much larger, because one is derived from the other by straight line projection (light travels in a straight line). This geometry is often considered qualitative. In a way this may seem correct when one compares it with metric geometry but strictly speaking it is not so, because the idea of straight line involves the use of the measuring rod however indirect.

Topology is the third kind of geometry in which the use of measuring rod is nowhere implied and which is purely qualitative. In this discipline, two figures are considered equivalent if one can transform one into the other by a process of continuous deformation, which may be quite arbitrary in character, except that it must not violate the continuity of the figure. So a circle is equivalent to an ellipse or any kind of closed curve, but is not equivalent to a straight line. This is because a line is an open-ended figure unlike a circle.

Topology is an important part of geometry. It has given rise to a series of theorems as closely connected as those of Euclid. To cite two instances: First, two closed curves in a plane can cut each other in a pair of points only. Second (as mentioned earlier), in a polyhedron the number of edges is equal to the number of vertices plus number of faces minus two. This remains true even if the polyhedron is deformed in any manner subject to conditions of continuity.

One of the interesting and challenging problems in topology is 'Map colouring Problem' which is discussed briefly here.

Map colouring problem

Map makers have noticed for quite a long time that in making maps, for distinguishing bordering states or provinces with dissimilar colours, more than four colours are never required. In 1850, Francis Guthrie, a mathematics student of Edinburgh, thought that if this empirical finding be true for all possible maps it could be a subject matter of a mathematical theory. He discussed this question with his brother Frederick Guthrie who brought this point to the notice of his teacher Augustus De Morgan (incidentally Augustus De Morgan was born in India in early 19th century. He was blind of one eye). British mathematicians of the 19th century like P. G. Tait and others learned about this conjecture from De Morgan. Arthur Cayley (1821-1895), the distinguished British mathematician of 19th century, drew the attention of the London Mathematical Society and the Royal Geographical Society to this point in 1878.

The problem of map-colouring posed by Guthrie still remains something of a challenge although it appears to have been proved recently in an unusually long proof covering 400 pages. Earlier mathematicians were able to show that, like Fermat's Last Theorem, the result holds good in many specific instances. P. J. Heawood who happened to find out a mistake in an alleged proof by Kempe was, however, able to demonstrate in 1890 that more than 5 colours are never necessary. The proof is not very difficult and depends on the Descartes-Euler Theorem about relationship between edges, faces and vertices of regular polyhedra.

This problem is quite independent of the size and shape, or any other property dependent on measurement of the states or provinces in the map. The only necessary condition in colouring of the maps is that two states or provinces having a common frontier must be coloured differently to distinguish them. If, however, the two meet at a point only, it is not necessary to

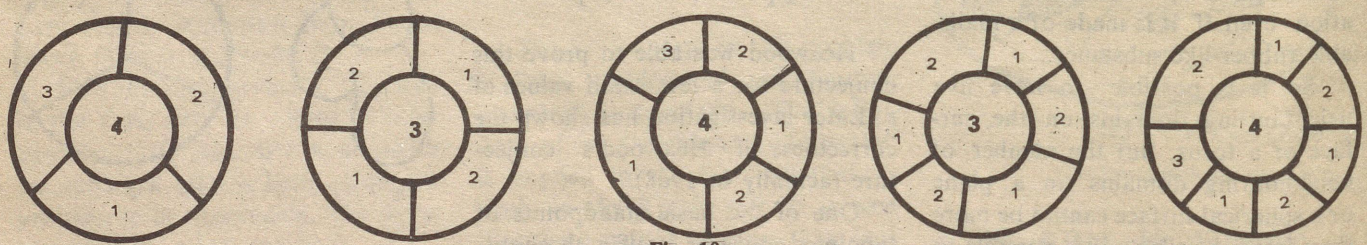


Fig. 10

use different colours. It will be seen that if there are three states as in Fig. 7, each bordering the others, then three colours are necessary. It is worthwhile to point out that Fig. 8 drawn by the side of Fig. 7 are topologically equivalent in that one can be reduced to the other by continuous deformation as if the whole thing were drawn on a sheet of rubber.

For the sake of simplicity in visualisation let us consider now the figures (Fig. 9) drawn in the manner of Fig. 8, depicting different numbers of zones to be coloured in a hypothetical map, namely, 3, 4, 5, 6 and 7. Now these figures, somewhat idealised in content, can by topologic deformation be made to resemble a variety of actual map making situations and a study of these will give us some insights into the problem.

Note that for the first figure with three zones, not less than 3 colours (we designate these by numbers 1, 2, 3) will do. What about the next figures having four and six zones? It is clear that two colours would suffice. For the figure with five zones, not less than three will suffice. For the last figure with seven zones three colours will be needed. Now it can be generalised, that, for simple maps which are topologically equivalent to the above figures, two colours are needed for even number of zones, and three colours are necessary if the number of zones is odd.

Consider now the cases which are slightly more complicated (Fig. 10) in which there are a number of zones bordering on a central zone.

It will be readily observed that not less than three but not more than four colours are required.

Note also that although there are five and seven zones in Figs. 9c and 9e, there are nowhere three 'neighbouring domains', nevertheless three colours are required. In Fig. 10 and 10e, which have six and eight zones, it is noted that there are nowhere four neighbouring domains, nevertheless four colours are necessary in both cases.

So there are maps in which there are less than three or four 'neighbouring domains' nonetheless three and four colours are required respectively in such cases. Again, there may be four neighbouring domains and four colours are required as in Fig. 10a; also three neighbouring domains and three colours are required as in Fig. 9a. It can be concluded therefore that the number of colours required is either equal to or greater than the number of neighbouring domains existing in the map. As it is seen that there cannot be more than four neighbouring domains in a plane surface, it follows that in colouring maps of all possible variations four or more colours are required.

Heawood demonstrated that not more than five colours are required in colouring any map. Either 4 or 5 colours are the minimum number of colours necessary to colour all possible maps.

In conclusion, a recent work must be mentioned. In 1976, K. Apple and W. Hakins, two American mathematicians, are reported to have given a solution to this problem. However, the biggest snag in their solution lies in its length—it runs to 400 pages. It also took 1200 hours of computer time. The problem has perhaps been solved. But to give a final verdict, some time must be allowed for a thorough checking and rechecking. For, just now there would not be many mathematicians sufficiently motivated to undertake the checking work which involves 400 pages and 1200 hours of precious computer time.

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MEDICAL NOTES (*Continued from page* 842)

centration of urinary glucose. The colour in case of urine negative for glucose is blue.

After dipping in urine, the strip is placed in the test well of the instrument. Here a timing period of 30 seconds is automatically initiated. Now, a light beam is transmitted through reagent strips in the audio-urine glucose analyser. At the end of 30 seconds, a series of audible pulses start coming out with a sufficient pause between each series. The pulse rate can be counted and the urine glucose level deduced. One to five audible pulses give 0%-0.1%. 0.25%-0.50%, 0.50%-1.00%, 1.00%-2.00% and 2.00% or more of glucose respectively. The instrument costs approximately Rs. 2,000.

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C. K. ANANTHASUBRAMANIAM

Solar eclipses are more than simply spectacular sights. There is a lot of science behind them and they are of great help in some astronomical studies

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A total eclipse of the sun is one of the marvellous spectacles of nature. It can occur only at the time of the new moon, that is, when the moon is between the earth and the sun. The moon when comes in between the earth and the sun, cuts off light to cause an eclipse. Unlike a total eclipse of the moon which is visible over the whole moonlit hemisphere, a total eclipse of the sun is visible only over a maximum narrow strip of about 250 km in width and 10,000 km in length on a part of the earth's surface. So at any locality, it is a rare phenomenon seen only once in about 350 years. A total solar eclipse never lasts for more than 7½ minutes and sometimes it is even less than a minute in duration. The ratio of lunar and solar eclipses is about 1:1.5, two lunar to three solar eclipses. Although solar eclipses are more frequent than lunar, a person in any locality can see many more eclipses of the moon than of the sun.

Both planets and satellites of the solar system cast shadows out into space. As such bodies are smaller than the sun, their shadows must be conical in shape and the point of the cone is always away from the sun. These shadows are invisible except when they fall upon some celestial object and darken it. The shadow of the moon may fall upon the earth and the shadow of the earth upon the moon, causing the eclipses of the sun and the moon respectively (Figs. 1 and 2).

Each eclipse, either of the sun or the moon, belongs to a series. The eclipses of a given series follow each other at intervals of 6585 1/3 days. This period is called a "Saros" and was discovered by the Chaldeans about 2500 years ago. Any two successive eclipses of a series, either lunar or solar, resemble each other so closely that one is spoken of as a repetition of the other. The first one of a series is always a very small partial eclipse near the north or south pole. At successive repetitions, the partial eclipses tend to become total, finally remaining total (or annular) for some time. They again become partial and leave the earth by way of the opposite pole. A series of eclipses of the sun runs through some 70 or 71 Saros and so lasts about 1260 years. Since the period between eclipses of the same series is 1/3 day more than a whole number of days, each eclipse repeats itself one third of the way around the earth to the west of where it occurred before.

Many circumstances must combine to produce a total eclipse of the sun. The prediction of an eclipse would be simple if the orbit of the moon around the earth lay in the same plane as the orbit of the earth around the sun. Then an eclipse of the sun would occur at every new moon and an eclipse of the moon at every full moon. But the orbit of the moon is inclined at an angle of 5°8′ to the plane of the orbit of the earth, and the points at which these two orbits intersect are called 'Nodes'. A solar eclipse always occurs if the sun is within 15° 21′ of a node at the time of a new-moon. An eclipse may sometimes occur with the sun anywhere upto 18° 30′ of a node. These are called minor and major ecliptic limits for a solar eclipse.

By a cosmic coincidence, the apparent diameters of the sun and the moon as seen by us are nearly the same: the mean angular diameter of the sun is 31′59″; the angular diameter of the moon at its mean distance is 31′5″. But as the moon is nearer to the earth when at perigee than at apogee, its apparent angular diameter may at times be as great as 34′8″ This is sufficient to cover the sun with about 2′ of arc to spare to cause a total eclipse. On the other hand, if an eclipse occurs when the moon is farthest from the earth, it will leave uncovered a bright ring 1′ 35″ all around the edge of the sun. This is known as an annular eclipse.

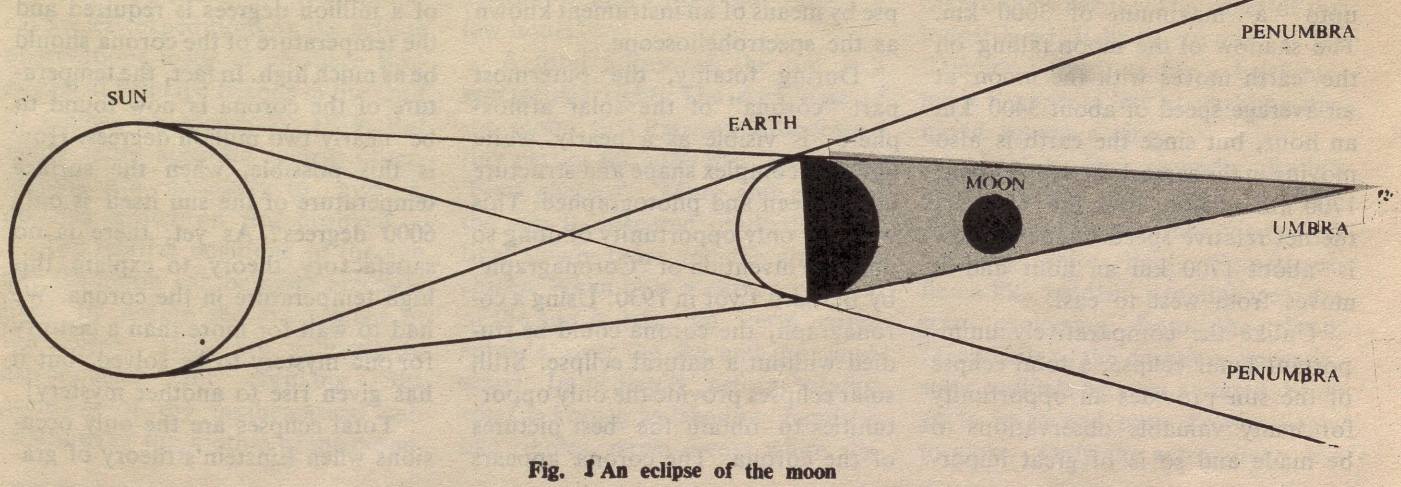

Fig. 1 An eclipse of the moon

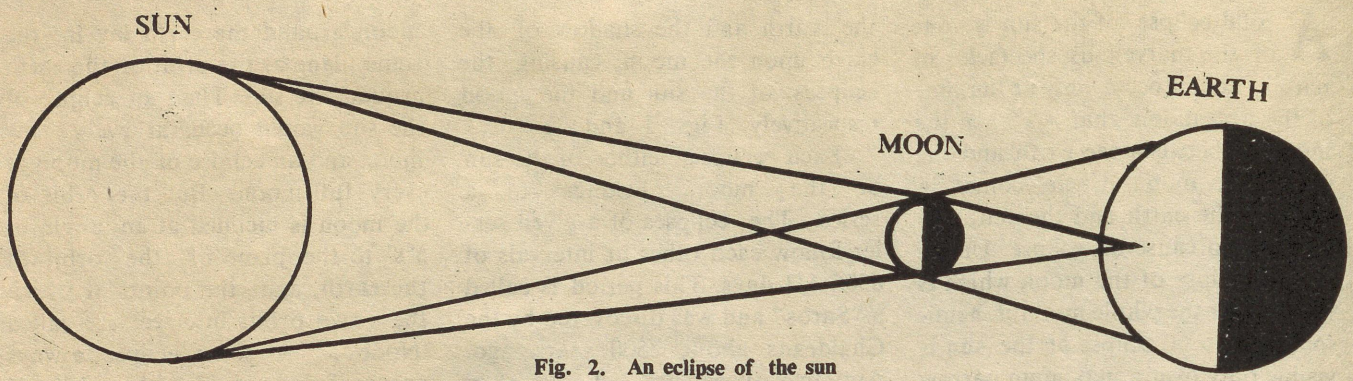

Fig. 2. An eclipse of the sun

The average length of the moon's shadow is 375,000 km, which is less than the average distance of 385,000 km between the earth and the moon. But the length of the moon's shadow differs with its distance from the sun. The distance between the earth and the moon also differs at different times because of the eccentricity of the lunar orbit. The longest possible shadow will occur when the sun is farthest (at aphelion). The shortest distance of the moon from the earth is when the moon is at the node and new, which is 350,000 km. When the above two circumstances coincide, the shadow of the moon is long enough to extend far beyond the surface of the earth and the shadow thrown on the earth by the moon is the largest possible. A total eclipse then occurs within this shadow. The penumbra is much wider than the umbra and so the partial eclipse can be seen on either side of the zone of totality, sometimes upto a maximum of 3000 km. The shadow of the moon falling on the earth moves with the moon at an average speed of about 3400 km an hour, but since the earth is also moving in the same direction at about 1700 km an hour near the equator, the net relative speed of the shadow is about 1700 km an hour and it moves from west to east.

Unlike the comparatively unimportant lunar eclipse, a total eclipse of the sun provides an opportunity for many valuable observations to be made and so is of great importance to astronomers and physicists. The solar atmosphere can be best studied during a total eclipse. The following outer envelopes of the sun are visible during a total eclipse, in order: the reversing layer, the chromosphere with the prominences, and the corona. The dark absorption lines in the solar spectrum caused by various chemical elements are formed in the reversing layer. Immediately above this is the chromosphere. The chromosphere can be seen as a reddish crescent for a few minutes before and after totality. The chromosphere gives rise to an emission spectrum (bright lines) which can be photographed at this time without the absorption spectrum (dark lines) of the eclipsed reversing layer and is known as the "Flash spectrum." Any prominences, red flames of gas projecting from the chromosphere, are also visible during totality; they are observable without an eclipse by means of an instrument known as the spectrohelioscope.

During totality, the outermost part "corona" of the solar atmosphere is visible as a pearly white light. Its complex shape and structure can be seen and photographed. This was the only opportunity of dong so until the invention of "Coronagraph" by Bernard Lyot in 1930. Using a coronagraph, the corona could be studied without a natural eclipse. Still, solar eclipses provide the only opportunities to obtain the best pictures of the corona. The corona appears radically different in shape at different times, depending upon the condition of the sun. During low sunspot activity, the corona will extend farther from the disc of the sun above the solar equator than it does above the poles. Its outline is then more elliptical and its edge is fairly regular and even. During high sunspot activity, the corona will extend much farther uniformly, with no greater difference between the equatorial and polar regions (Fig. 3).

The corona also gives rise to some bright spectral lines which do not fit in with any of the lines of the known chemical elements. So it was thought to be caused by an unknown element called "Coronium". But in 1942, a Swedish physicist Bengt Edlen proved theoretically that these bright lines are caused by the atoms of the known chemical elements—iron, nickel and calcium—whose outer electrons are all stripped off. To effect this reaction, a temperature of a million degrees is required and the temperature of the corona should be as much high. In fact, the temperature of the corona is now found to be nearly two million degrees. How is this possible, when the surface temperature of the sun itself is only 6000 degrees? As yet, there is no satisfactory theory to explain this high temperature in the corona. We had to wait for more than a century for one mystery to be solved, but it has given rise to another mystery!

Total eclipses are the only occasions when Einstein's theory of gra-

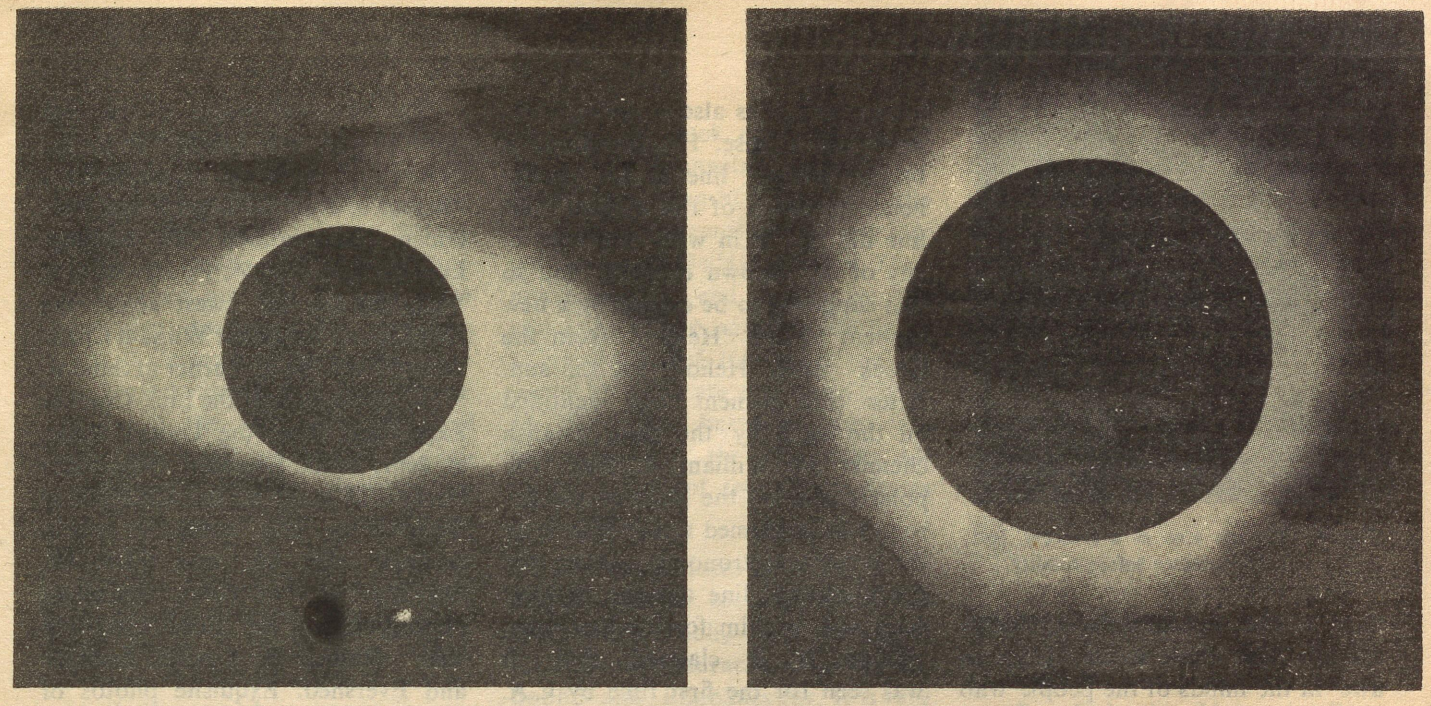

Fig. 3. Sun's corona as seen at total eclipse,(left) Sunspot minimum; (Right) Sunspot maximum

vitation can be verified. Einstein predicted that one effect of the Theory of Relativity would be that the rays of starlight passing close to the sun would be deflected towards it by the gravitational attraction, and the star would consequently appear to be displaced away from the sun. To test this, the star-field surrounding the eclipsed sun is photographed during totality and this photographic plate is compared with the same star-field photographed six months later; the position of the star images on the plates can be precisely measured and the displacement determined. The predicted displacement is 1.75". This was first confirmed by the Royal Astronomical Society expeditions at the eclipse observations made at northern Brazil and at Principe Islands in the Gulf of Guinea on March 29, 1919. But many more accurate eclipse observations are necessary to give a decisive verdict on this problem.

The relative positions of the sun and the moon can be more precisely fixed by noting the exact times of the eclipse. These are valuable to astronomers for checking the accuracy of the mathematical calculations of the motion of the moon.

With these problems in view, astronomers proceed to remote corners of the earth, where prediction indicates that a favourable total solar eclipse will occur for some precious minutes. Scientific instruments and other equipments are transported over thousands of kilometers, and set up for the occasion months in advance, sometimes in a dense forest or in an uninhabited island in the mid-ocean. Then, there is the weather to contend with. For, on a few occasions, these efforts were ruined due to bad weather, as it happened during the June 20, 1955 eclipse in Ceylon. At present the total time the sun was observed at total eclipses does not exceed a few hours!

A total eclipse of the sun is a spectacular sight. The dark disc of the moon first appears, obscuring a tiny part of the solar disc, known as 'First contact'. More and more of the sun is obscured gradually. The light slowly fades and the air grows chiller. When only a narrow crescent of the sun is left, an eerie pallor spreads over the sky and the landscape. Immediately before totality, what is known as 'shadow bands'—like ripples, move across white surfaces. A few seconds before 'Second contact', a beautiful phenomenon known as "Baily's beads", which resembles a shining necklace, is seen. Baily's beads, named after Francis Baily, an English astronomer who first saw it in the total eclipse of May 15, 1836, are caused by sunlight shining through the great gorges and valleys of the mountain ranges on the moon.

Another rare phenomenon known as the 'Diamond ring' may also be seen at times when conditions are favourable. Some larger depressions or irregularities on the surface of the moon allow a beam of light to persist longer and will be of larger dimension than Baily's beads. The effect of this longer-lived light is to create the 'Diamond ring', as for a brief moment it appears like a sparkling diamond set on a ring.

After a few seconds, Baily's beads vanish and with totality, the corona bursts into view with a pearly white light. Sometimes, flame-like reddish prominences are seen projecting from the limb. Meanwhile as the darkness creeps in, some animals become agitated, birds go to roost and some flowers begin to close. Only the astronomers are

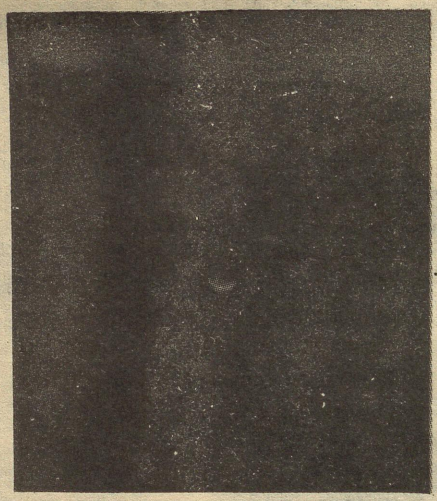

Fig. 4. The sun seen as a crescent just a few minutes before totality.

busy at their instruments, in hushed silence. The whole scene creates an awe in the minds of the people who witness it. Recently some primitive tribes in Kenya and Somalia were terror-stricken and went into hiding on seeing the total eclipse on June 30, 1973.

The earliest recorded solar eclipse was on October 22, 2137 B.C. as mentioned in the Chinese chronicle *Shu Ching*. The royal astronomers Hsi and Ho got dead drunk and so they failed to predict this eclipse. The Emperor beheaded them for their grave fault. Perhaps no astonomer dared to get drunk at the time of a solar eclipse since then! The Austrian astonomer T. Oppolzer published a monumental work in 1887 called *Canon der Finsternisse* in which he described 8000 solar eclipses and 5200 lunar eclipses occurring between 1207 B.C. and 2161 .A. D. He also gave 160 charts showing the approximate tracks of solar eclipses.

During the 19th century, four total solar eclipses were seen over India. In 1843, on 21st December, the track of a total eclipse seems to have passed over South India, but no authentic records of this eclipse are available. In 1868, the total eclipse of the sun on 18th August was observed at Masulipatnam by the Madras astronomer N. R. Pogson. J. Janssen, the great French astronomer, was also in India to observe this eclipse. He discovered a bright yellow line in the prominence spectrum of this eclipse. This line did not fit in with the lines of any of the known elements and so was supposed to be caused by a new element named "Helium' from the Greek word 'Helios'' for the sun. Later this element was identified on the earth by the great English chemist Sir William Ramsay. The polarisation of the light of the corona was confirmed at this eclipse by the Madras astronomer. Also, the green coronal line appears to have been seen by him for the first time, though it is claimed that it was seen for the first time by C.A. Young at the subsequent August 7, 1869 eclipse.

The central shadow path of another total eclipse also passed across the then Madras Presidency on December 12, 1871. The station selected by the Madras astronomer was Avanashi in the Coimbatore district. Here, too, three successful photographs of the totality showing the corona and other phenomena were obtained by this party. Sir Norman Lockyer, the great English astronomer, was also present in India to observe this eclipse. The track of this eclipse over the peninsula was almost identical to the one that occurred in 1843, and so it is said that many inhabitants of Calicut, Coimbatore and Madurai witnessed two total eclipses in 28 years, an extremely rare event!

The last total eclipse of the 19th century seen over Central India on January 22, 1898 was observed by a number of eminent English and American astronomers. Sir Norman Lockyer and Prof. A. Fowler were at Viziadrug on the west coast, the Astronomer Royal Sir William Christie and Prof. H. H. Turner at Sahdol, W. W. Campbell of the Lick-Crocker Expedition from the United States at Jeur, John Evershed (who later became Director of the Kodaikanal Observatory and made it world famous) with Mr. and Mrs. W. Maunder were at Talni. Excellent photographs of the 'Flash spectrum' were obtained by Fowler, Lockyer and Evershed. Exquisite photos of the corona were obtained by Campbell, while Mrs. Maunder obtained a photo of the corona extending to six solar diameters. The coronal line hitherto assumed to be 5316.8°A was found to be 5303° A by the precise measurements made at this eclipse by Lockyer, Fowler and Evershed. A new epoch of accuracy in photographing the chromospheric spectrum began with these measurements. As a result of better definition, the spectrum photographs exhibited a wealth of detail that added greatly to our knowledge of solar physics.

The Government of India deputed the late A. K. Das of the Kodaikanal Observatory to lead an expedition to observe the total solar eclipse on June 20, 1955 in Ceylon, and the author was a member of this team.

Table 1

Place	*Approximate duration of totality*	*Approximate time in I.S.T. of central eclipse*
	m s	h m
Karwar	2—50	15—40
Gadag	2—45	———
Raichur	2—40	15—45
Dornakal	2—30	———
Puri	2—20	15—55

We had carried five tons of instruments to Ceylon and set up our camp several weeks in advance. Astronomers from Britain, France, Germany, Switzerland, Holland, Japan and the United States had also assembled in different parts of Ceylon to observe this eclipse. Unfortunately, the skies became cloudy at the crucial moment all along the track of totality, though according to weather statistics the conditions should have been favourable.

Of the sixty total solar eclipses during this century, only three were visible in India. The eclipse of June 30, 1954 ended at sunset over Jodhpur and so is not important. The last eclipse of the century will be visible over Northern India on October 24, 1995.

The eclipse occurring on February 16, 1980 will be visible over the Indian peninsula. It will begin at sunrise over the Atlantic Ocean south of Northwest Africa, then sweep over Equatorial Africa, the Indian Ocean, and thence across the Indian peninsula, passing over Burma and will end at sunset in China. The approximate track of totality over the Indian peninsula is shown in the Map. Beginning at Karwar on the west coast, the centre of the shadow will pass over Gadag, Raichur, Dornakal and will end at Puri on the east coast. The approximate duration and times of totality for the different localities are also given (Table 1). These are based on the data furnished by the Nautical Almanac Office of the United States of America.

The other places from where the eclipse can be seen as total are Dharwar, Hubli, Mahbubnagar, Khammam, Bhadrachalam, Koraput, Bobbili and Bhubaneswar. It is rare for an astronomical observatory to be within the track of a total solar eclipse. The Nizamiah Observatory at Hyderabad will be just 21 km beyond the northern limit of totality, according to the computations of the U.S. Nautical Almanac Office—a narrow miss indeed.

An examination of the climatological records for several years of a number of stations within and adjoining the belt of totality, furnished by the Deputy Director-General of Observatories (Climatology), Pune, reveals that the skies are likely to be clear within the belt of totality during February. So, a large number of astronomers and other scientists from all over the world are expected to assemble in India to study this eclipse. Those of us who are lucky will be witnessing one of the most wonderful spectacles of nature to be seen in India during this century, which will never be forgotten in one's life time.

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Corrigenda

S.R. October 1978, p.685, col. 1, 2nd para 6th line, please *read* (2n−2) instead of (2n=2). In col. 2, 8th line on the same page *read* 2n−1 instead of 2n=1.

S.R. November 1978, p. 751, col. 1 last para, first line, both the words are Cyclohexene and not Cyclohexane.

In the article **Drugs in mental and emotional illness** the legends for the two figures should be as follows:

Fig. 1. General structure of the nervous system

Fig. 2. The Autonomic nervous system

On p. 772, in the item **Squaring made simple,** the seventh line in col. 3 should be $1 \times 1 = 1$.

Carolus Linnaeus: 200 Years of Biological Nomenclature

A. K. MAITY
JAGDEEP SAXENA

This brilliant, hardworking Swedish naturalist, who died 200 years ago, brought order to the chaotic systems of classification of living organisms

CLASSIFICATION of living things in some way or the other by man probably originated with the origin of man himself. At the beginning, man was merely able to distinguish between plant-like and animal-like forms of life. On accumulation of more knowledge about nature, he began to classify animals and plants and also non-living objects such as rocks and minerals into categories and sub-categories, although their terms were very broad and vague such as "Worms", "Bugs", "Beasts", "Birds", "Fishes", etc. The oldest document of classification belongs to the 5th century B.C. Later on, the gerat Greek philosopher Aristotle (384-322 B.C.), the "Father of Zoology", proposed a comparatively accurate system of animal classification. There were many flaws in the Aristotelian classification, yet for centuries naturalists adopted either no system of classification at all, or Aristotle's system to classify newly discovered animals and plants. In the pre-Linnaean period, it was John Ray, an Englishman (1627-1705), who initiated plant classification on a scientific basis, and was the first biologist to have a modern concept of species.

In the 18th century, knowledge of plants and animals grew enormously, leading to an utter confusion regarding their true systematic position. The common animals were known by different names in different countries, and even in the same country they had different local names. At that time manuscripts and most books were written or printed in Latin, which was known to only a few people. When printed books began to appear in the languages of various countries of Europe, Latin was retained for technical descriptions and names of organisms. But even then, the scientific names of plants and animals were long and descriptive. For example, the mocking bird was designated as *Turdus minor cinereo-albus non maculatus*, i.e., Thrush, small, grayish-white without spots.

Although these polynomial names were useful, it became impossible to use them in practice. How long these verbose, unwieldly names bogged down progress of our knowledge of living world we do not know. It was only at the advent of a brilliant, hardworking Swedish naturalist (born in 1707) that the methods and procedures of classification of living plants and animals came into existence. He was the "Father of modern systematics", Carl von Linne, who died two hundred years ago in the year 1778. Linnaeus, in the year 1735, first published a complete book on classification entitled, *Systema Naturae* which was a methodical catalogue of plants, animals and minerals known upto that time. It was arranged in larger and subsidiary groups, but the names were still designated in Latin polynomials. Later on, in the 10th edition of this great book (1758), Linnaeus developed the techniques of classification into the modern system now known as binomial nomenclature, i.e., each ogranism is described by only two names; first the generic name, and second the specific name. In order to popularise this system and to prove its usefulness, he also reduced his

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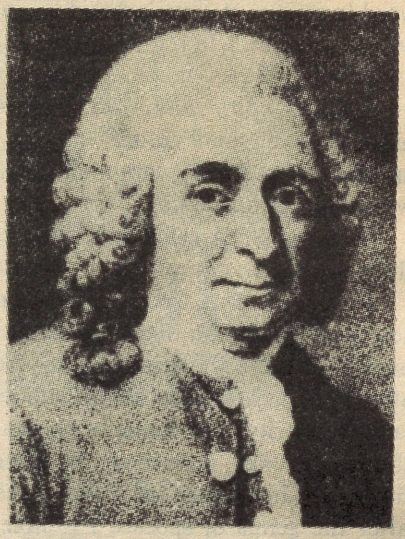
own family name only to two words *Carolus Linnaeus*.

The system of binomial nomenclature brought about a radical change in the system of classification of plants and animals, and was accepted by all countries for naming living organisms scientifically. Linnaeus named the mocking bird *Mimus polyglottos*. When a species is divided into sub-species, the latter are expressed in trinomials. He named the common house sparrow (*Gauriyya* in Hindi) as *Passer domesticus*; but the bird inhabiting continental Europe is *Passer domesticus domesticus*, the last name designating sub-species.

Linnaeus proposed a complete hierarchy of classes, orders, genera and species. An animal classified at that time might have changed its position to a different class or order today; the basic framework of classification not only remains valid even today but has also gained universal acceptance due to its fundamentally sound approach. This testifies to the genius of the great Swede. He was no armchair theorist, but a tremendous personal force and a lifelong lover of wild nature. His firsthand observation of nature was so thorough that from his knowledge of the diurnal rhythms in multicellular plants, he suggested constructing a flower clock which was actually set up in the town of Uppsala in the 20's of the 18th century. This clock began performing at 3 a.m. to 5 a.m. when the flowers of salsify opened up and stopped telling time at midnight when the flowers of torchthistle closed.

Carolus Linnaeus

From the age of 25, Linnaeus was constantly exploring and inspiring pupils to explore. His stimulus to field work was immense. He, or his agents, travelled not only the whole of Europe, Lapland and Arabia but also Egypt, Palestine, the Cape, the



Linnaeus

Antarctic, Java, Sri Lanka and North America. The tradition that every expedition should have a naturalist as a member was laid down during Linnaeus' time. It was because of him that naturalists such as Joseph Banks and Solander accompanied Captain Cook's first Voyage in 1768-71.

Linnaeus perfectly realised the artificiality of sticking on certain characters to classify organisms. Before his death, he however started working on a more "natural" system; that is, one in which more and more characters were taken into account. But this was not based on evolutionary concept as Linnaeus probably had no sense of evolution and continuity!

In the post-Linnaean era, anatomy and classification were subjects of great interest in life sciences throughout the nineteenth century. Many systems were proposed but the most influential post-Linnaean contribution to systematics was by the Frenchman, Cuvier (1769-1832). His taxonomic theory was an extraordinary mixture of antiquated concepts (such as *a priori* weighting of characters on the basis of their physiological importance).

After the death of Cuvier, no worthwhile work on systematics was done till the publication of the *Origin of Species* by Charles Darwin (1809-1882) in 1859. Although this was a masterpiece on evolution, it made fundamental contribution to taxonomic theory also. Darwin rejected *a priori* weighting of taxonomic characters as practiced by Linnaeus and Cuvier. He proposed, instead, a number of empirical rules on how to discover taxonomically useful characters, that is, how to undertake *a posteriori* weighting.

In the most significant and decisive post-Linnaean development, Ernest Haeckel in 1864 and E. Ray Lankester in 1877 outlined the principal features of the zoological classification which are in use today. Later, thousands of animals and plants were discovered by different naturalists in different countries and again a great confusion arose. Sometimes the same name was given to different animals (*homonyms*) or different names to the same animal (*synonyms*). To end this confusion, zoologists and palaeontologists in England, France, Germany, Russia and America drafted some rules for nomenclature. So an international code came into existence. This was adopted in principle at the First International Zoological Congress (Berlin, 1901) but was issued after the Sixth Congress (Bern, 1904) as the *Regles Internationales de la Nomenclature Zoologique* (Paris, 1905). Its most recent edition was published in 1964, after the Sixteenth Congress at Washington. This code consists of a Preamble, 86 Articles (Article 31 was repealed in 1963), five Appendices, an official Glossary, and a detailed Index. All items were given in parallel English and French versions. It is a very useful document for every systematic zoologist.

According to this code, different modern categories are as follows: (indicated in parentheses are the standardized endings for the names).

Kingdom
Phylum
Subphylum
Superclass
Class
Subclass
Cohort
Superorder
Order
Suborder
Superfamily (*-oidea*)
family (*-idae*)
Subfamily (*-inae*)
Tribe (*-ini*)
Genus
Subgenus
Species
Subspecies

A few important rules of scientific naming, according to the present *International Code of Nomenclature*, are as follows :

1. No names are recognized prior to those included by Linnaeus in *Systema Naturae* (10th edition, 1758).

2. Scientific names must be either Latin or Latinized and preferably printed in italics.

3. The genus should be a single word (nominative singular) and begin with a capital letter.

4. The species name should be a single or compound word beginning with a small letter (usually an adjective agreeing grammatically with the genus name).

5. When a new genus is proposed, the "type species" must be indicated.

If a genus or a species has been described more than once, the earliest name and author, according to the above rules, is recognized under the law of priority. The name of the author, who has described the type first, may be written or abbreviated after the genus or species. Example: *Passer domesticus* Linnaeus (or Linn. or L.).

In recent years, a considerable work has been done on biological sciences, and in all these works systematics plays a key role. An American scientist G.G. Simpson (1945) put it very well when he said that "Systematics is at the same time the most elementary and most inclusive part of zoology; most elementary, because animals cannot be discussed or treated in a scientific way until some taxonomy has been achieved and most inclusive, because in its various branches it gathers (together), utilizes, summarizes, and implements everything that is known about animals whether morphological, physiological, or ecological."

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Physical approaches in etymology

ETYMOLOGY is a branch of philology which explains the origin of words. We are familiar with the etymology of the scientific terms LASER and SONAR. Glancing through the languages, interesting cases would be seen where a word can be written in two ways. Such is the situation with the Devnagri word OM. It is written as (ओ३म, ओं) and also as (ॐ). It is speculated that the duality in representation has a phonetic origin which is discussed here.

In an orally produced sound, the air forced through the lungs causes the larynx to vibrate. This generates pulses which contain harmonics upto high order. According to the Helmholtz theory of speech, the spectrum of these pulses is shaped by the mouth-nose-pharynx cavity which functions as an adjustable filter. This augments the harmonics in certain ranges, designated as formants. The formant ranges establish a characteristic difference in vowels. Further the formant position is independent of whether the vowel is spoken by a man or woman. The formant ranges in some of the spoken vowels are shown in Fig. 1, and have been taken from Meyer and Neumann's, *Physical and Applied Acoustics*. Section (i) shows the spectrum of vowel O, as in moan, having the sound of (ओ), section (ii) shows the vowel A, as in *far*, having the sound of (आ), section (iii) shows the vowel E, as in *well*, having the sound of (ऐ), section (iv) shows the vowel E, as in *free*, a sound of (ई) and section (v) shows the vowel U, as in *bloom*, having the sound of (ऊ). It is observed that while all the vowels have full formants ranges, those in sound of (ओ) are restricted. The energy here is predominantly concentrated in a narrow frequency range in the first formant. It may also be noted that the sound of (ऊ) also shows an identical pattern. In all the spoken sounds, consisting of voiced or unvoiced consonants and vowels, the position of these sounds

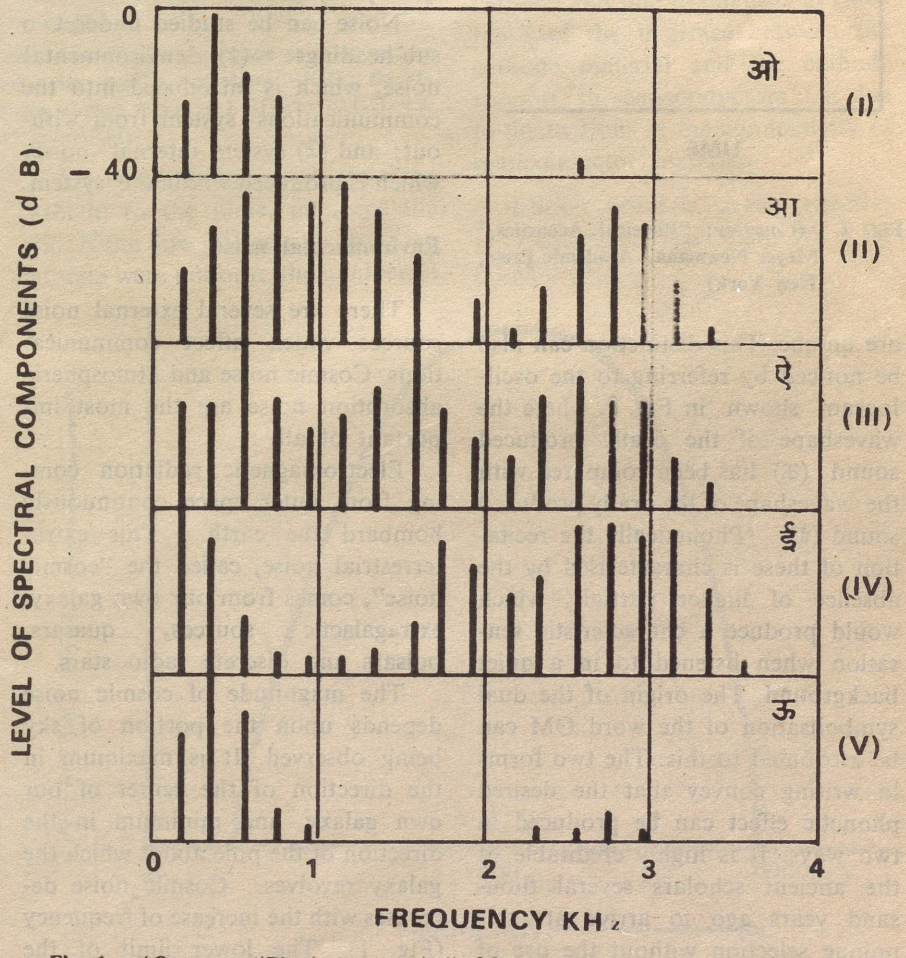

Fig. 1. (*Courtesy*: "Physical Acoustics", Meyer Newmann. Academic Press New York)

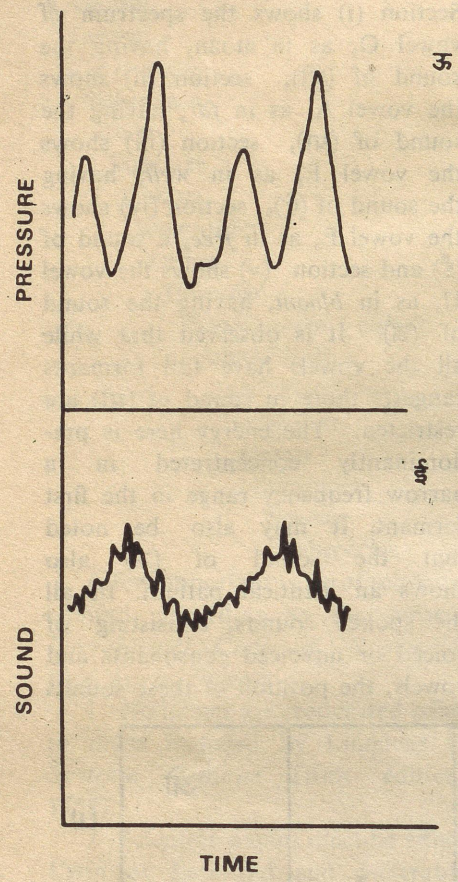

Fig. 2. (*Courtesy*: **"Physical Acoustics," Meyer Newmann, Academic Press, New York)**

are unique. This distinction can also be noticed by referring to the oscillogram shown in Fig. 2, where the waveshape of the orally produced sound (ओ) has been compared with the waveshape of the orally produced sound (ॐ). Phonetically the recitation of these is characterised by the absence of higher partials, which would produce a characteristic sensation when listened to in a quiet background. The origin of the dual symbolisation of the word OM can be attributed to this. The two forms in writing convey that the desired phonetic effect can be produced in two ways. It is highly creditable of the ancient scholars several thousand years ago to arrive at this unique selection without the use of sophisticated instruments like spectrum analysers and the oscilloscope. It can however be considered feasible on the basis of acoustical Ohm's law which states that the individual partials of a musical sound can be more or less well perceived by a sensitive ear, performing a kind of Fourier frequency analysis.

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Noise in satellite communications system

ANY unwanted electromagnetic signal is called "noise" in communications engineering. It superimposes itself on the wanted signal and changes the signal's characteristics. It is one of the main factors which determines the range of usable frequencies for, and the quality of, satellite communications.

Noise can be studied under two sub-headings: (1) environmental noise, which is introduced into the communications system from without; and (2) system internal noise, which is produced within the system.

Environmental noise

There are several external noise sources which affect communications. Cosmic noise and atmospheric absorption noise are the most important of all.

Electromagnetic radiation coming from outer space continuously bombard the earth. This extra-terrestrial noise, called the "cosmic noise", comes from our own galaxy, extragalactic sources, quasars, pulsars and discrete radio stars.

The magnitude of cosmic noise depends upon the portion of sky being observed. It is maximum in the direction of the center of our own galaxy, and minimum in the direction of the pole about which the galaxy revolves. Cosmic noise decreases with the increase of frequency (Fig. 1). The lower limit of the satellite communications frequency band is determined by the cosmic noise.

According to the theory of black-body radiation, any body which absorbs energy radiates the same. As atmosphere partly absorbs microwave energy, it radiates the same, which is called "atmospheric absorption noise."

Atmospheric absorption is at minimum when the antenna is vertical (pointed at the zenith) and is at maximum when it is directed along the horizon.

As shown in Fig. 1, atmospheric absorption noise predominates above 10 Ghz (10,000,000,000 cycles per second), while cosmic noise below 1 Ghz. The minimum environmental noise is therefore in the band 1 GHz to 10 GHz, which is called the "space window". This window is used for satellite communications.

System internal noise

Even if a "channel" (see p. 317, *S.R.*, May 1978) is screened from all external noise, there remains a minium level of noise called "thermal noise."

Thermal noise, also called Johnson noise or white noise, is inherent in all systems that operate at temperatures above absolute zero. Because of the thermal energy associated with every electron in a conductor above – 273°C, the electrons are in a continuous, random motion. Motion of electrons constitute an alternating current which causes thermal noise.

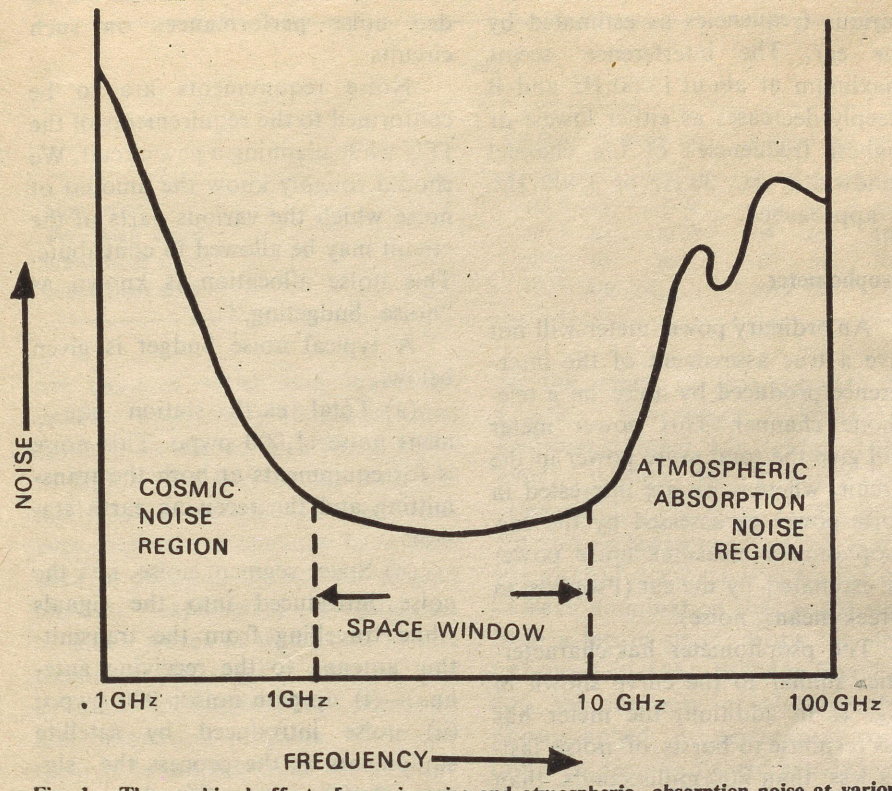

Fig. 1 The combined effect of cosmic noise and atmospheric absorption noise at various frequencies. Below 1 GHz, cosmic noise rises rapidly, and above 18 GHz, the atmospheric absorption noise. In the space window region of 1 GHz to 10 GHz the noise contributed by both the factors is minimum

Thermal noise spectrum is uniform, i.e., the energy is present equally at all frequencies. However, in the far infrared region (frequencies greater than 3,000 GHz) the spectrum is no longer uniform. It decreases rapidly with increase in frequency.

Another random noise is "shot noise)". This arises because electrons emitted at random intervals from the cathode arrive non-uniformly at the anode. The random arrival of electrons give rise to a random noise current. Shot noise is effective above 1 KHz, upto the maximum frequency at which the tube works.

In a tube such as pentode, in which there are more than one positive electrode, the current divides between the anode and the positive screen grid. Since the distribution of emitted electrons is random, the distribution of current between the various positive electrodes will also be random. The noise thus introduced is called "partition noise."

Electrons, as they move from the cathode to the plate, intercept the grid. If the flow of electrons from the cathode were uniform, the number of electrons approaching the grid would equal the number receding from the grid, and the net induced current would be zero. But because of the random emission of electrons a net current is induced in the grid circuit. The fluctuations in the grid current are noise-like in character and give rise to what is known as "induced grid noise."

This noise increases with increase in frequency and above 100 Megahertz (100,000,000 cps) it is the principal limiting factor in the operation of low-noise amplifiers.

At low frequencies there exists a noise mechanism which gives noise power inversely proportional to frequency. This is called "flicker noise" or "1/f noise". It is caused by changes in emission from large areas in the cathode and due to changes in resistance of the interface between the cathode material and the cathode support. In semiconductors it is due to fluctuations in the conductivity of semiconductor material.

Flicker noise is largely effective at frequencies less than 10 KHz (10,000 cps).

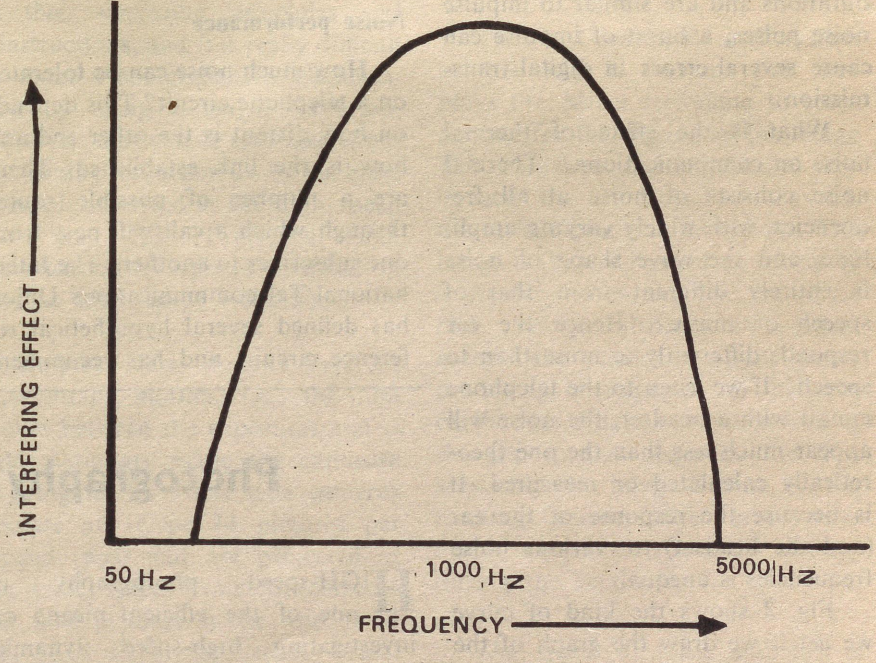

Fig. 2 The response of the ear to interference at various frequencies. At about 1,000 hertz the interference is maximum

Impulse noise

Impulses are signals which are sporadic in nature and occur in bursts rather than being uniformly distributed. The discrete impulses may be the result of several causes. They may be natural, being caused by lightning, sudden outbursts from "radio" stars, or such other electrical disturbance. Most of them are man-made. Power lines and their associated switching cause strong impulses. Dialling and switching impulses in a telephone exchange also cause impulse noise.

Impulse noise hardly affects speech communications, even though the magnitude of individual pulses may be more than those of speech signals. Noise impulses are too brief to produce a serious disturbance to speech, the tone and other qualities of which are determined by a large number of speech waves over a time period long compared to that of impulses.

Impulse noise, however, greatly deteriorates the quality of digital communications such as data transmission, telegraph channels, etc. As the data pulses are of short durations and are similar to impulse noise pulses, a burst of impulse can cause several errors in digital transmission.

What is the effect of thermal noise on communications? Thermal noise consists of noise at all frequencies, with widely varying amplitude, and the wave shape of noise is entirely different from that of speech or music. Hence the ear responds differently to noise than to speech. If we listen to the telephone circuit with a headset, the noise will appear much less than the one theoretically calculated or measured. It is because the response of the ear (and the headset) to various noise frequencies is unequal.

Fig. 2 shows the kind of curve we get if we draw the graph of the interference produced by noise at various frequencies as estimated by the ear. The interference seems maximum at about 1,000 Hz and it steeply decreases as either lowest or highest frequencies of the channel bandwidth, viz., 30 Hz or 3,400 Hz, is approached.

Psophometer

An ordinary power meter will not give a true assessment of the interference produced by noise on a telephone channel. This power meter will give the total noise power in the circuit, whereas we are interested in noise power as assessed by the ear. Psophometer measures noise power as estimated by the ear (Psophos, in Greek means, noise).

The psophometer has characteristics similar to the curve shown in Fig. 2. In addition, the meter has less response to bursts of noise lasting less than 200 milliseconds, than those lasting more than 200 milliseconds. This is to stimulate the response of the human ear. The noise measured by psophometer is known as psophometrically weighted noise designated as "pwpo" (pw=pico watt).

Noise performance

How much noise can be tolerated on a telephone circuit? This depends on how distant is the other end and how is the link established. There are a number of possible routes through which a call will pass from one subscriber to another. The International Telecommunications Union has defined several hypothetical reference circuits and has recommended noise performances on such circuits.

Noise requirements are to be conformed to the requirements of the ITU while planning a new circuit. We should roughly know the amount of noise which the various parts of the circuit may be allowed to contribute. This noise allocation is known as "noise budgeting."

A typical noise budget is given below.

(a) Total earth station equipment noise: 1,000 pwpo. This noise is for equipments at both the transmitting and the receiving earth stations.

(b) Space segment noise, i.e., the noise introduced into the signals while travelling from the transmitting antenna to the receiving antenna:—(i) up-path noise: 900 pwpo; (ii) noise introduced by satellite equipments as the process the signals: 3,100 pwpo; (iii) down-path noise: 3,500 pwpo.

The total space segment noise sums up to 7,500 pwpo.

(c) Interference from any other sources: 1,000 pwpo.

The total noise contributed by these factors is 9,500 pwpo. The recommendation requires that the total noise should not exceed 10,000 pwpo. The margin of 500 pwpo is kept as a buffer for degradations due to causes not taken into account.

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Photography at high speeds

HIGH-speed photography is one of the efficient means of investigating high-speed dynamic processes which are widely used for solving many scientific and practical problems. It helps to reduce the action involved to purely abstract or mathematical terms. There

Table 1

	Exposure time in sec.	*Frames per sec.*
High speed	10^{-2} to 10^{-3}	10^{2} to 10^{3}
Very high speed	10^{-3} to 10^{-5}	10^{3} to 10^{5}
Ultra high speed	10^{-5} to 10^{-7}	10^{5} to 10^{7}
Super high speed	10^{-7} and less	over 10^{7}

are cameras which can make exposures upto many thousand times faster than needed to arrest a bullet in flight. This may sound both unlikely and of no practical use. However, high speed cameras have been used in research studies on plasma physics, explosions, propagation of shock waves in water and in air, mechanism of spark discharges, gas dynamics and aerodynamic processes and detonation of gases. Without them it is unlikely that the present knowledge of these subjects would be as advanced as it is today.

A question is often asked, "What would be the use of higher speeds?" In a way this is akin to the question put to a mountaineer: "Why climb mountains?" There are two common answers equally applicable to both questions, "because they are there" and "to see the other side". A new camera with a higher speed always gives a new view and brings to light some unsuspected variant.

One of the earliest ways of analysing a dynamic process was simply to take a cinema film and project it at a reduced speed. To check the behaviour of a machine while it is in operation, it is necessary to take a series of pictures in quick succession with each shot having an exposure short enough so that the movement is frozen. When this sequence is projected back—as slowly as possible—the differences between the frames reproduce the original motion.

Historically four names come to the mind in this context; Sir Charles Wheatstone (1802-1875), Eadweard James Muybridge 1830-1904), William Henry Fox-Talbot (1800-1877), and Boys (1855-1944). Charles Wheatsone, English scientist in 1832 demonstrated by the use of flash illumination that water runs from a tap in small drops. By this technique in 1851 William Fox-Talbot, the inventor of photography, photographed a newspaper rotating on a disk. Eadweard Muybridge, English photographer in 1877 studied how horses move. He also recorded many human activities to demonstrate actions and positions of the limbs.

Modern high-speed photographic methods are extremely diverse in their operating principles and constructions, and it is really difficult to make a comprehensive classification by using a single criterion. However, they can be classified either by framing frequency or by the basic principle involved in the high speed recording. Table 1 gives a rough classification of speeds involved in various high speed techniques.

Amateur cine cameras have an intermittant motion, i.e., the film moves between the exposures and is held stationary while the exposure is being made. These cine cameras operate at 16 or 24 pictures per second (pps) and are projected at the same speed. Amateur cameras can take pictures at the rate of 64 pps which when projected at normal speed, say 16 pps, show the actions 4 times slower than actual. This is called slow-motion photography but is equally high-speed photography. To increase speed with the same action requires specially designed cameras which, using 35 mm film, reach 300 pps, and with 16 mm film go upto 600 pps. Beyond this speed, the film cannot withstand the start-stop stresses involved.

It is possible to move the film much faster in continuous motion but the image will obviously be blurred unless some method of compensating for the relative movement of the image and the film is used. Once again the limit is set by the strength of the film and the maximum speed which can be obtained by continuous motion is 4000 pps.

By attaching a film to a drum some increase in speed is possible but it is apparent that moving film systems cannot make much progress. Using stationary film and a moving image, however, offered worthwhile improvements.

Rotating mirror camera

The most commonly used system in this field is the one that employs the Miller technique to compensate for the motion of the image The event to be recorded is first imaged by an objective lens on the surface of a rotating mirror. The image is then re-imaged by a ring of a similar lenses on the recording film. As the mirror rotates, lenses accept the incident light beam producing a sequence of pictures on the film. Image movement during the exposure is slight as the film sees only the image formed by the rotating mirror. This makes the event appear to tilt only slightly during the exposure.

The speed of these cameras is limited by the strength of the mirror material. At very high speeds, the

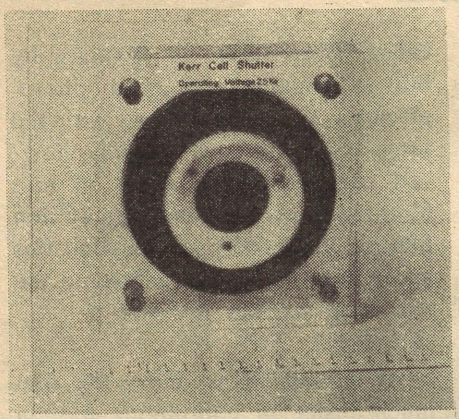

Fig. 1. Complete Kerr-cell shutter

mirror will burst due to its own centrifugal forces, and beyond 80% of the bursting velocity it begins to distort. With the strongest available materials, mirrors have been rotated upto 500,000 rpm. Usually, the number of pictures in a sequence is limited to between 30 to 200, and the taking rate can be as high as 10^8 pictures per second.

Kerr-cell camera

Single pictures with very short exposures cannot be taken by using mechanical systems owing to the necessity for rapid and precise synchronisation. Single-shot photography of self-luminous events always requires a shuttered camera. A simple camera can be used if a fast shutter is available. The shutter used for these purposes depends on various optical phenomena which can be controlled electronically. Hence the term "electro-optical shutters". The most common nowadays is the Kerr-cell shutter although Faraday cell and Pockels cell are also used in special applications. The latter cells use a pulsed magnetic field and an electric field respectively.

John Kerr in 1875 observed that some liquids under the influence of an electric field become birefringent. In other words, light travels at different speeds along the two axes through such liquids. In the Kerr-cell nitrobenzene is always used as the liquid and an electric field is applied between a pair of plates parallel to the light path. The cell when placed between two crossed polarisers constitutes a Kerr-cell shutter (Fig. 1).

When no voltage is applied, the velocity of light along each axis is the same and no change occurs as light passes through the cell. The light polarised by the first polariser cannot pass through the second polariser, and the system transmits no light. If correct potential is applied across the Kerr-cell plates, generally between 10 kilovolts to 25 kilovolts, the velocities differ and a phase difference occurs between the light beams transmitted along the two axes. If this phase difference is exactly one half of the wavelength the light is fully transmitted by the second polariser. Such shutters have achieved exposures as short as one nanosecond (10^{-9} sec.). Exposures of 10^{-7} sec. and 10^{-8} sec. are quite normal with this technique.

Though Kerr-cell shutters are ideal for such short exposures; the drawback is that its polarisers absorb 80% of the light. Another drawback is that a fairly high voltage pulse is required to operate a Kerr-cell. However, a great advantage is that a Kerr--cell can be made to operate in exact synchronisation with the event to be photographed. Using a battery of Kerr-cell it is also possible to take a sequence of photographs at precisely predetermined intervals.

The Pockels cell is unsuitable for high-speed photography because it only works with nearly collimated beams. It has recently become important as a modulator of laser beams which are, of course, highly collimated.

Image tube camera

An image tube consists basically of a light sensitive surface, the photocathode, which emits electrons when light falls on it, an electron lens to focus these electrons, and a fluorescent screen which emits light where electrons strike (Fig. 2). They can have several favourable features: there can be a light gain, the output pictures being brighter than the input pictures; there can be wavelength transformation; electrons are much easier to interrupt, accelerate and deflect than are the light beams; and the light sensitive surfaces are about 100 times more efficient than the photographic emulsions.

The shuttering of an image tube is obtained by switching the whole tube or by deflecting the electron beam across a small aperture at a position where the beam is narrow. The image tube can also be used as a streak camera or a framing camera by deflecting the electrons inside the tube, either with a magnetic field from coils outside the tube or with an electric field from deflection plates inside the envelope. As a streak camera, image tube can give time resolution better than one nanosecond, and by adding a dispersing system time resolved spectra could be recorded at any rate. With image tubes exposures down to 10^{-7} sec. are common and claims have been made of exposures down to 10^{-9} sec.

Image dissection camera

Rotating mirror cameras are often complex pieces of mechanical and optical engineering justified by the large amount of information they can collect per second. However, sometimes not much information is required and the event has no symmetry. Streak photography is a solution. To do this, a simple technique called image-dissection is used. The event to be recorded is first imaged on a grid consisting of narrow transparent bands, separated by wider opaque bands. The resulting banded image is focussed on to a film via a rotating mirror. The

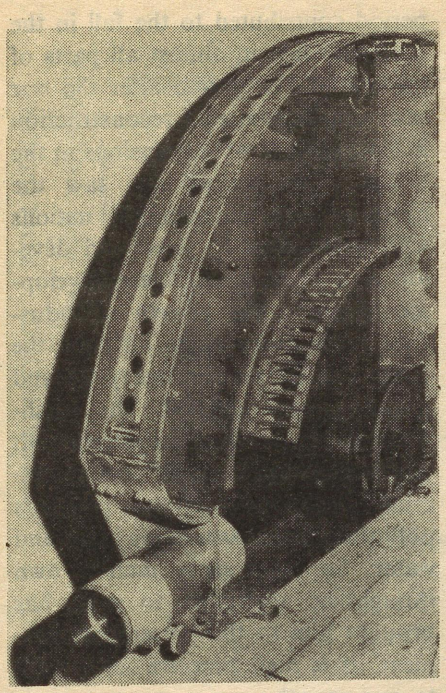

Fig. 2. Rotating mirror camera under development at CS I0

mirror rotation causes each transmitted narrow band to move in time across the intervening space between bands, producing a sequence of interwoven records. Unscrambling can be done mechanically by printing through a grid of the same type, moving the grid one bandwidth between the prints. Framing rates of 10^8 pps have been achieved with this technique.

Streak or smear camera

In these cameras, a narrow segment of the event is selected and the light variations within the segment are recorded. The event is normally imaged on a slit which selects the portions of the event to be examined. The mirror rotation moves the slit image across the film in a direction at right angles to the slit axis.

The speed of these cameras is usually quoted as the distance the slit image moves along the film in a given time. All writing speeds are possible, the fastest rotating mirror camera achieves 40 mm per second. Time resolution depends on the slit image width and resolution in order of 10^{-8} sec has been obtained.

The image tubes and their development will become more important in high-speed photography as they are multichannel devices with tremendous information capacity. Suppose it is possible to display 1000 information bits in each dimension of the tube face and 100 intensity information bits are available. If the exposure is 5 nanosecond, the information rate will be 2×10^{16} bits per second. Even a streak picture on an image tube can give 2×10^{14} bits per second.

What is the ultimate limit to the rate at which information can be presented visually? In image tubes at present, the limit is technical skill and electronics but these are constantly advancing. The final limit may be set by the photoelectric effect itself and the velocity of light. One of the biggest problem in photography today is the investigation of an object surrounded by a medium which, for some reason, scatters light.

The variety, range, and precision of methods available in high-speed photography are increasing speedily. Optically driven Kerr-cells can give exposures of a few pico-second and scientists have been successfull in recording a light pulse (blob) travelling through milky water with pico-second exposure times. The introduction of lasers has allowed to take interferograms either directly or by using holographic techniques with short exposures and at short intervals. X-rays can be used at nanosecond exposures and sub-microsecond intervals for penetration of several inches of steel or to take records through smoke or flash. In short, one can say that the realisation of camera speeds and exposure times comparable to the time taken by light to travel only relatively short distances has made it possible to record the existing fastest dynamic process.

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What is futurology ?

FUTURE holds a charm of its own and all of us at some time or other are curious to know about our future. According to astrology, an individual's course of life is more or less predetermined by the positions of the sun, the moon and the planets (excluding earth) in the Zodiacal signs at the time of his birth. Futurology is concerned not with the fate of an individual but with the nature of the possible futures of a nation or even mankind as a whole. The future of a country depends not on the positions of the celestial bodies but upon how its government plans to use and allocate its resources for the coming five or ten year periods. There are several ways of doing this planning and, accordingly, there are several possible futures to choose from. Again, nowadays no country can draw up its plans without taking into account others. To set up a new industry raw materials may have to be imported from other countries. In fact, this inter-dependence is almost indispensable because no nation can claim to be fully self-sufficient in at least two of the essential items for living—food and fuel. For this reason the study of global futurology, or the nature of planning for the future of the entire mankind, is gaining importance day by day. Futurologists strongly feel that the survival of mankind is crucially

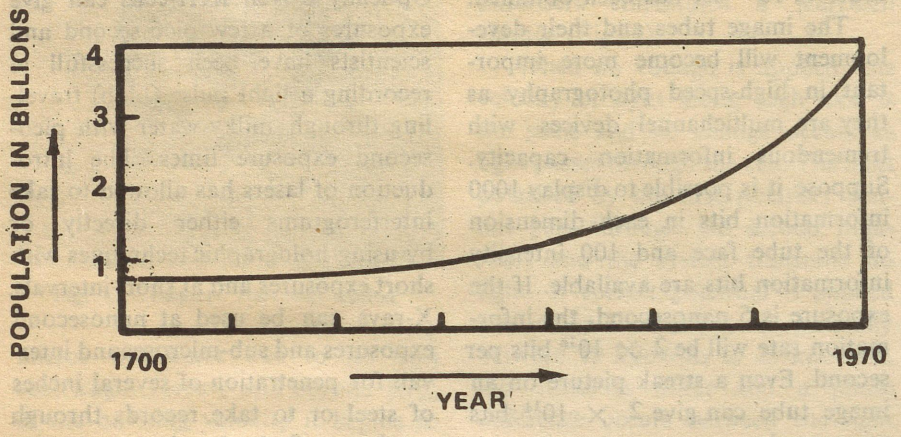

Fig. 1

dependent on how successfully the different nations combine their efforts to solve the three outstanding problems that confront mankind today, namely : (1) The population growth; (2) the gradual depletion of the non-renewable resources like petroleum, coal and wood; and (3) the increasing environmental pollution (Figs. 1—3).

The subject of futurology was a result of our awareness of the existence of these three problems. This awareness perhaps came to us in the late nineteen sixties with the initiation of the famous 'The Club of Rome' project. The object was inspired by the ideals of the Italian engineer and economist Dr. Aurelio Peccei,whose profound concern for humanity led many to think about the world's long-term problems. The project report appeared in a book form in 1972. Through the frequent publication of their international seminar proceedings, the two organisations of the UN, FAO and WHO have made us conscious of the gravity of the food problem and the hazards of environmental pollution. Then there are individuals whose writings have laid the subject of futurology on a broader foundation. Notable amongst them is Alvin Toffler whose book *Future Shock* is one of the most widely read books on the shape of things to come. A few books by Herman Kahn and his colleagues at the Hudson Institute, New York, study and analyse the causes of the present malady prevailing on the earth.

It appears that the overpopulation, the lack of fresh air to breathe and the depletion of the precious natural resources are off-shoots of the Second World War. During the War many life-saving medicines were discovered which in the post-war period contributed to the fall in the mortality rate in almost all parts of the world. The period after the war saw unprecedented reconstruction in Europe and vast expansions in the U.S.A. This period also saw the birth of new independent nations with aspirations to grow and develop at a rapid pace. These developments led to the growth of industries on a grand scale all over the globe with consequent heavy demand on steel, coal and oil. The mushroom-like growth of industries with unplanned and in some cases indiscriminate disposal of waste products polluted the surrounding air and water. So in a sense man's own thoughtless aspiration to grow has brought him to the present predicament. It is high time we set a limit to our growth.

This is precisely the warning given by the futures' experts. They have worked out several models of the futures which may be broadly classified as: (1) Pessimistic Models and (2) Optismistic Models.

Pessimistic Models assert that because of the continued industrialisation on a grand scale in the near future, the non-replaceable resour-

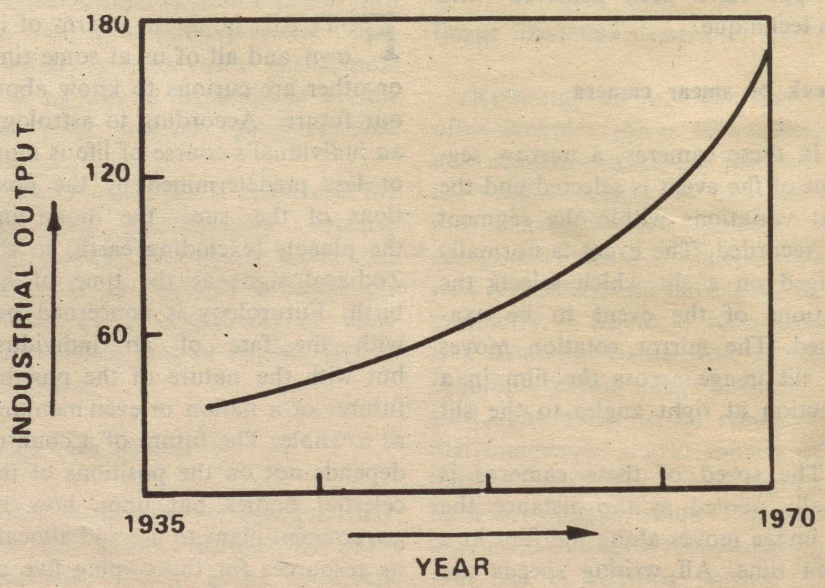

Fig. 2

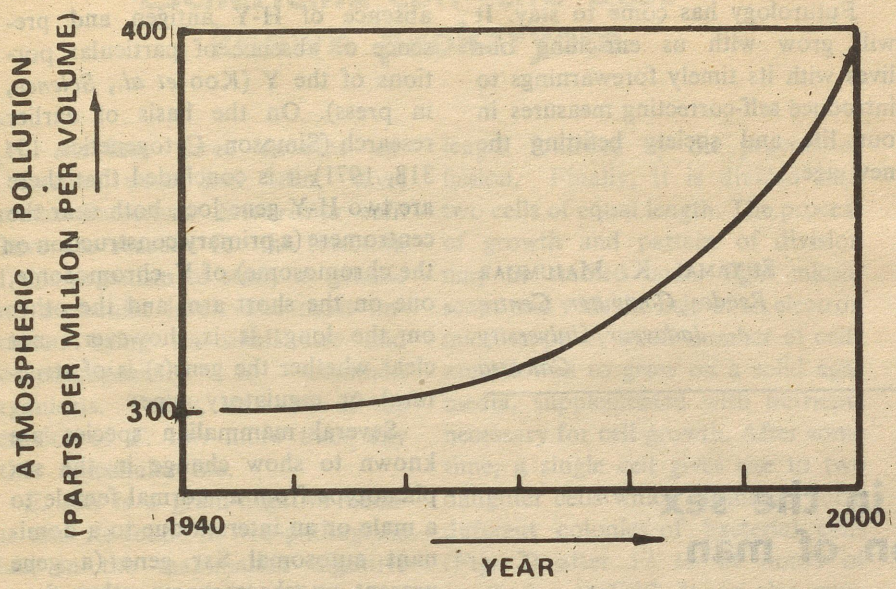

Fig. 3

ces will get depleted in next fifty years. There will not be any equitable distribution of wealth. On the other hand, rich will become richer and poor will become poorer due to industrialisation. Food will become scarce because of the growing population and the fertility of the cultivated land will drop. Twentyfirst century will witness the doom of mankind resulting from large scale damage to the environment and ecology of many areas. Billions will die of hunger, pollution and war because the rich and the poor nations in the world will never be able to sit together and evolve a common policy for the good of all.

Optimists think that man has become aware of the problems that threaten his survival. He will take self-correcting measures so that there will be an equitable distribution of wealth and poverty all over the world. Birth rate will be made equal to the death rate. There will be controlled growth of industries so that too much strain is not put on the available natural resources. Man will devise means of controlling pollution. With a fixed population, food problem will not arise. Man is entering the most creative and expansive period of his history. Unlimited living space and may be new resources will be available with the colonization of the solar system. Man should face the future with courage and confidence because he is the master of his own fate.

Forecasting futures is not the only preoccupation of the futurists. They also suggest remedial measures against our failure to adjust ourselves with the new and novel items inducted into our daily lives by the advancement of technology. A conspicuous characteristics of these items is their impermanence. An item under research in the laboratory today finds its place in the consumer market tomorrow. It may be a new gadget, a new foodstuff or a latest design for ladies' wear. However, they become outdated very soon giving place to new products. Are we mentally prepared to accept such changes at such short notices?

Futurists believe that to avoid the strain to keep with times, we must train our young children to get accustomed to these innovations so that they are spared from the "future shocks" that we experience now. No doubt the study of futures has been grossly neglected in our education system from school to university level. Our educational system has so far been based on models of the present and the past on the presumption that the future will resemble the present and will be influenced by the past. This premise does not include the acceleration of the preset change that is permeating all aspects of our lives. Education must incorporate this important influence of change. The school education must impart to the young minds the mental training to accept change as a part and parcel of their future lives. These changes may arise in a variety of contexts. For example, a child must be ready to accept changes in the modes of communication, transport, health habits, career, leisure and living in the near future. According to Alvin Toffler, "All education springs from some image of the future. If the image of the future held by a society is grossly inaccurate, its education system will betray its youth."

If the study of futures should form an essential part of the modern education, what should be the syllabus for such a course at the college or university level? The very nature of the subject matter rules out the possibility of framing a rigid curriculum. A tentative course on "Futuristics" must contain the study of the following core material :

(1) A study of the recent advances in bio, space and computer sciences and their import in the society of the future.

(2) Construction of Scenarios to give a vivid description of the future society born out of the achievements in the above three sciences.

For example, a scenario may describe the picture of a society in

the early 21st Century when colonies in space have been set up.

In the construction of scenarios, science fictions play an important role.

(3) How to plan for the future. Identification of factors which are most likely to play a vital role in the future society. Construction of models of the futures.

(4) Suggestions of remedial measures against imbalances, if any, arising in the human society due to startling changes brought about by the new ventures in automation, space and genetic engineering.

Futurology has come to stay. It will grow with us enriching our lives with its timely forewarnings to introduce self-correcting measures in our life and society befitting the new age.

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H-Y antigen in the sex determination of man

MAJORITY of us are aware of the chromosomal mechanism of sex determination in man. The human female is a homogametic sex (producing eggs uniformly with X chromosome) while a male is heterogamatic (producing X and Y bearing sperms in equal number). The kind of sperm that fertilizes an egg decides the sex—X-bearing sperm producing a female and Y-bearing sperm producing a male.

Thus, the presence of XX or XY (2 sex chromosomes) along with autosomes (44) in the karyotype of man (chromosomal set—a total of 46 or 23 pairs) decides the development of ovary or testis giving rise ultimately to a female or a male phenotype. From this perspective, the genetics of primary (gonadal) sex determination is a simple matter. However, it is well known that hormones also play a very significant role in sex determination. Specific hormones in definite quantities at decisive time are produced (or are not produced) by the gonads taking the development of an embryo to either of the sex phenotypes. We have often heard or read that hormonal level has changed one sex to another even in adults. Unusual karyotypes, having more or less sex chromosomes in the complement, result in sex-syndromes: individuals that can be abnormal mentally, physically or sex-phenotypically.

A male cell surface component called histocompatibility-Y antigen (H-Y antigen) occurring in males of all mammalian species so far tested including man, is a product of the mammalian testis-determining gene. Embryonic gonads are bipotential to sex and the H-Y antigen directs the initial steps leading to differentiation of the gonads as a testis. Further differentiation into male is, however, imposed by the action of testicular hormones. In the presence of gene that confers H-Y antigenicity, the indifferent embryonic gonad becomes a testis; in the absence of this gene, the gonad develops into an ovary. The gene for H-Y antigen expression is suspected to be on the Y chromosome since individuals XYY (males having one extra Y chromosome) were found to absorb more H-Y antibody on their white blood cells compared to XY individuals (normal male). It is shown that patients having broken Y chromosome (deletion) show direct correlation with respect to the presence or absence of H-Y antigen and presence of absence of particular portions of the Y (Koo *et al.*, *Science*, in press). On the basis of earlier research (Simpson, Cytogenetics, 10: 318, 1971) it is concluded that there are two H-Y gene loci, both near the centromere (a primary construction on the chromosome) of Y chromosome, one on the short arm and the other on the long. It is, however, not clear whether the gene(s) is of structural or regulatory type.

Several mammalian species are known to show change in the sex phenotype from a normal female to a male or an intersex due to a dominant autosomal Sxr gene (a gene present on chromosome other than sex chromosome—autosome). The gene Sxr (sex reversal gene) which reverses the sex of XX mice (normal female) causing them to develop as males also specifies H-Y antigen on their cells. XO (female with only one X chromosome) or XX (normal female) females with Sxr gene change to male phenotype (although sterile) because Sxr confers expression of H-Y antigen, which in turn induces testicular differentiation even in absence of the Y chromosome. It might be that the structural gene for H-Y antigen is on an autosome and that the regulatory gene is on the Y chromosome, although increased dosage of H-Y antigen in males having two Y chromosomes cannot be fully explained in this context.

At present H-Y antigen serology can serve as a valuable adjunct to more routine karyological and endocrinological measures, and that in conjunction with these, study of H-Y antigen may ultimately broaden our understanding of both normal and abnormal sexual differentiation not only in man but in mammals generally.

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Escherichia coli--the best known prokaryote

In the last three decades extensive work has been done on the bacterium *Escherichia coli*. There are reasons for the selection of this organism to study at genetic and molecular level. The most important being its small size and non-pathogenicity to common organisms. Today, we know of the genetics of *E. coli* more than any other unicellular life.

E. coli is a gram-negative bacillus and its found in non-pathogenic state in the mammalian digestive tract. The cell of *E. coli* appears as rod-shaped, about 1 μ in diameter and 2 μ to 2.2 μ in length. Its cell wall and plasma membrane have typical structure of the bacterial cell and are about 100 Å thick. Its cytoplasm is of colloidal nature and contains nearly 3000 to 6000 different types of molecule. Like any other bacterium, the genetic information of *E. coli* is carried over by a single, double-stranded, circular, and 1100 μ to 1400 μ long molecule of deoxyribonucleic acid (DNA) which occupies one-fifth of the space of a cell (Fig. 1). There are about 20,000 to 30,000 spherical particles, 200 Å thick, surrounding the DNA. They are ribosomes present in aggregate forms and termed as polyribosomes. The remaining cell is filled with ribonucleic acid (RNA), water, water-soluble enzymes and a large number of various small molecules. It has been observed that DNA of *E. coli* has a point of attachment with the plasma membrane which is regarded as the site where replication of DNA is initiated.

E. coli grows best at the body temperature (35°C to 37°C) of higher mammals. However, it was found that it can grow and divide even at 20°C. It grows by increasing in length followed by the process of fission. Finally, it is divided into two cells of equal length. The process of growth and pattern of division may be studied under light microscope and with the help of an electron microscope. A small number of cells are allowed to grow on a solid agar media, supplemented with nutrients necessary for cell growth. After some time, a single cell gives rise to two daughter cells which ultimately form different colonies of bacterial cells (Fig. 2) after 12 to 24 hours of incubation at 37°C. It can also grow in a liquid nutrient medium if supply of oxygen is normal. This can be made either by bubbling oxygen through the solution or by shaking the solution rapidly.

During exponential growth, each cell of *E. coli* contains 2 to 4 chromosomes of identical genetic composition. But in absence of proper nutrition, chromosome duplication sometimes lags behind cell division, resulting in just one chromosome in a single cell. Like most other prokaryotes, the chromosome of *E. coli* is not enclosed within a nuclear membrane. It consists of a single, circular and continuous DNA double helix about one millimeter long. O. G. Stonington and D. E. Pettijohn of University of Colorado Medical Centre, Colorado, U.S.A. in 1971 isolated *E. coli* chromosome in a folded condition and showed it to contain mostly DNA with some RNA and protein. They found the molecular weight of the DNA quite large. Its protein is predominantly RNA polymerase and the RNA is chiefly the lone messenger. The RNA component of the complex is involved in stabilizing the structure. L. S. Lerman and his associates at Vanderbilt University in 1970 believed that DNAs of several prokaryotes in solution contain high concentrations of certain neutral polymers and univalent salts which stabilize the compact structure. A. Worcel and E. Burgi of Princeton University, Princeton, U.S.A. in 1972 analyzed *E. coli* chromosomes and found each of them to have about 40 to 50 (or sometime even more) loops held together by RNA (Fig. 3). They

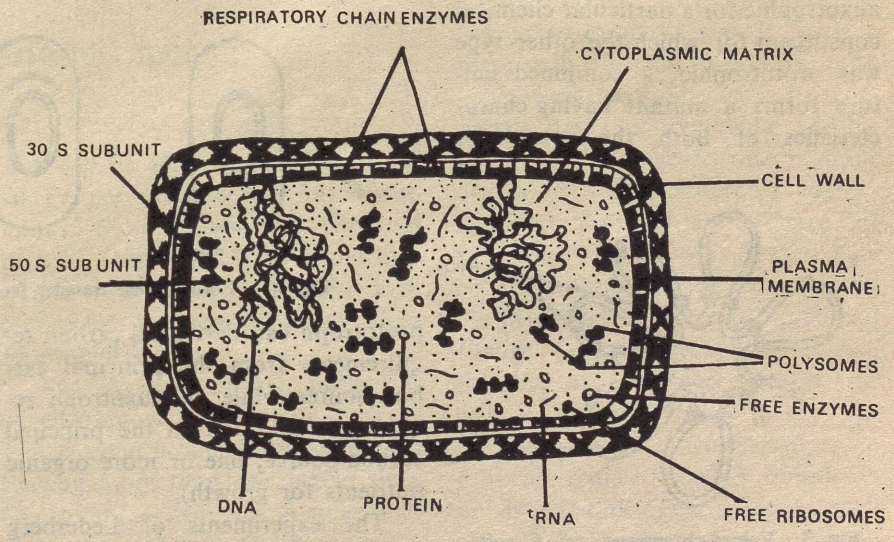

Fig. 1. *E. coli* **cell containing two chromosomes attached to the plasma membrane**

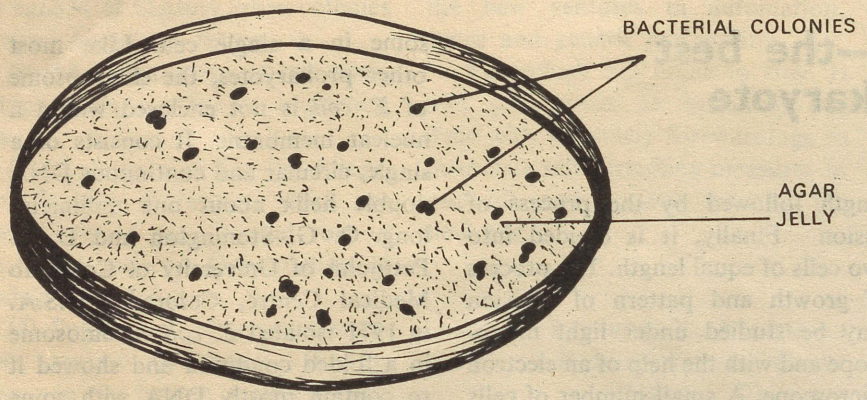

Fig. 2. *E. Coli* **cells forming different colonies in culture**

suggested that each loop may have a large number of DNA supercoils; each coil composed of 400 base pairs. The DNA-RNA interactions give a rigidity to the folded chromosome. No evidence for the presence of spindle-like region in the chromosome was found.

For a long time it was believed that all bacteria, including *E. coli*, were not capable of sexual reproductions and genetic exchange between different types was not possible. J. Lederberg and E. L. Tatum of Yale University, New Haven, U.S.A. in 1946 observed exchange of genetic material between two types of *E. coli* cells. They noticed that if one type of bacterium was auxotrophic for a particular chemical constituent for which the other type was prototrophic, a combined culture forms a mutant having characteristics of both the types. (A

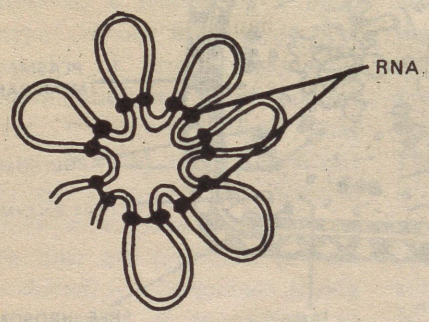

Fig. 3. Folded chromosome of *E. coli* **(there are 40 to 50 loops in each chromosome; only few are shown here)**

also exist male and female cells. The process of sexual cycle starts when both male and female cells attach to each other by a narrow bridge (a process identical to conjugation) and a part of male chromosome enters into the female cell before the mating cells separate (Fig. 4). It results in the formation of a partially diploid cell. Crossing over then occurs between female chromosome and the fragment of male chromosome, followed by segregation which gives rise to haploid progeny.

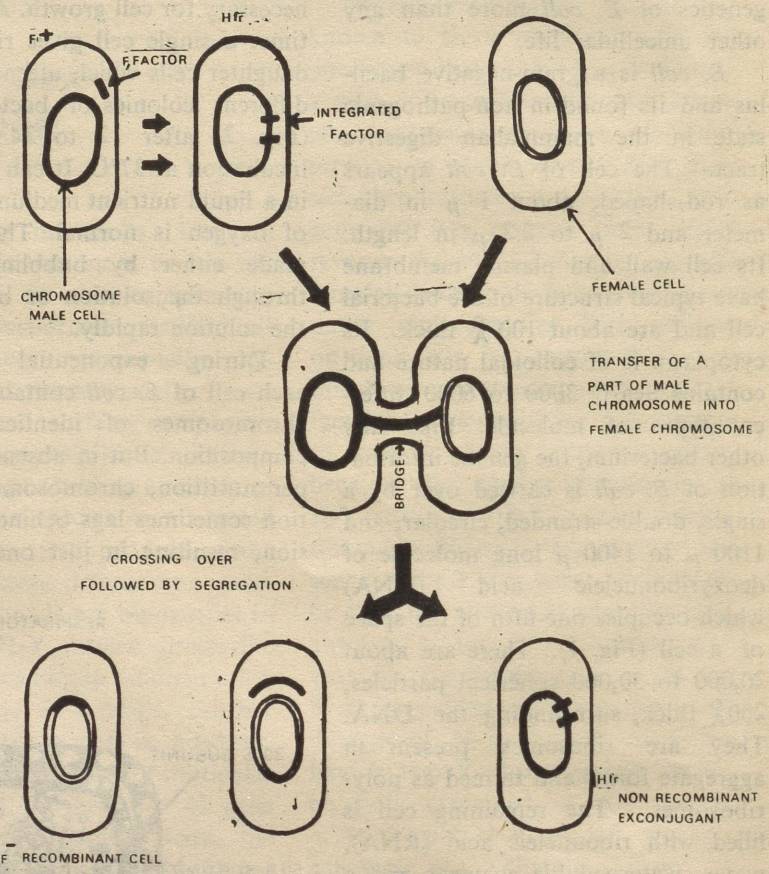

Fig. 4. Chromosome transfer from male cell to female cell of *E. coli*

prototroph can derive all carbon requirements from the principal carbon source while an auxotroph requires, in addition to the principal carbon source, one or more organic nutrients for growth).

The experiments of Lederberg and Tatum (1946) proved occurrence of sexual process in *E. coli*. Just like in other higher organisms there

E. A. Adelberg and S. N. Burns (1960) of University of California, U.S.A. described the fusion and chromosomal transfer between bacterial cells. According to them, tne sex difference between male and female cells is determined by the presence or absence of a specific genetic factor, the F factor. The presence of F factor in

an *E. coli* cell is termed as male F^+) and its absence as female (F^-). There are two types of genetic donors in bacteria and they have recognized as F^+ and Hfr. F^+ strains were characterized by possession of autonomous sex factor, randomly oriented chromosome transfer, and low frequency of recombination. Hfr strains were characterized by possession of chromosomal sex factor, uniformly oriented chromosome transfer, and high frequency of recombination. Hfr strains may be of various types but each of them contains F factor integrated into a different region of the chromosome. It is interesting to know how the F agent becomes part of the host chromosome. It is postulated that the F agent, like the chromosomes of lysogenic phages, has a circular shape and is integrated by crossing over. Both the F factor and the lysogenic phase chromosomes are called episomes which can be defined as a genetic element that can exist either free or as part of the normal cellular chromosome. The transfer of the F factor from a male to a female cell converts the latter into the former.

Now, there is evidence to believe that genetic map of *E. coli* is a circle. The male chromosomes has a capacity to break at a certain point before its free end moves into a female cell. The place where the break occurs is not the same in all strains of *E. coli*, but the break always occurs at a point where the F factor is integrated. It is evident from strains of Hfr of *E. coli*, in which in one strain some of the genes connected with the synthesis of leucine and threonine are transferred soon ater mating, whereas in another a gene involved with methionine synthesis is the first to enter the female cell. The existence of many types of strains in *E. coli* with various breakage points is helpful in determining gene location. But it is still not known what force drives the male chromosome into the female cell.

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How nitrogenase acts?

NITROGENASE, the enzymatic system that reduces N_2 to NH_2 could be isolated only from procaryotic (cells without membrane-bound organelles) organisms such as bacteria, blue green algae and actinomycetes.

The enzyme consists of two proteins, Fe protein and a Mo-Fe protein. The Fe protein has 4 Fe and 4 acid labile sulfurs and is a dimer of 55,000-65,000 molecular weight. Its properties are almost similar to ferredoxin. This component could be irreversibly inactivated by oxygen. The Mo-Fe protein has 2 Mo and 24 Fe per molecule. It has 4 sub units of two different types. The total protein (Mo-Fe) has a molecular weight of about 2,20,000. This protein is less sensitive to oxygen than Fe protein.

The physico-chemical properties of nitrogenase are given in Table 1. The enzyme is an allosteric protein (having more than one active site). One of the active sites is concerned with the substrate binding while the other active site is concerned with the activation of electrons. The whole chemical process catalysed by nitrogenase is reduction where $N \equiv N$ accepts totally 6 electrons and gets converted into two ammonia molecules ($2NH_3$).

$$N \equiv N + \underset{\text{donor}}{\text{electron}} \xrightarrow{\text{nitrogenase}} 2NH_3$$

The enzyme is localised in all nitrogen fixing cells such as heterocysts, root nodule bacteria (in the bacteroid form), in free living autotrophic bacteria such as *Chlorobium* sp., *Rhodopseudomonas* sp. and *Rhodospirillum* sp., heterotrophic bacteria such as *Azotobacter* sp. *Bacillus polymyxa* and *Aerobacter* sp. heterotrophic (anaerobic) bacteria such as *Clostridium* sp. and actinomycetes like organisms.

The enzyme nitrogenase could be isolated both from heterocyst and other vegetative cells of blue green algae such as *Anabaena* sp., *Nostoc* sp. and *Cylindrospermum* sp. However, the enzyme is in the functional condition only in heterocyst and not in vegetative cells because it is sensitive to oxgen. Heterocyst has a very thick cell wall which acts as a barrier to the free flow of external oxygen. It also lacks photosystem II which is the O_2 evolving step in photosynthesis. Therefore the partial pressure of oxygen is less in these cells than in vegetative cells.

However, the enzyme is in functional state in free-living aerobic bacteria. It is believed that in these organisms it may undergo a conformational change where it may not be sensitive to oxygen. Also it may be a membrane-bound enzyme and the membrane offers conformational change to it whenever the partial pressure of oxygen is high in the cells.

The natural electron donors in cells are either reduced ferredoxin or flavodoxins. The reduced compounds donate electron to Fe protein part of the enzyme. The Fe protein gets reduced by accepting electrons

Table 1. Properties of nitrogenase enzyme isolated from *Klebsiella pneumoniae*

	Fe protein	*Mo-Fe protein*
Molecular weight	67,000	2,18,000
Sub-unit composition	one type MW 35,000	Four sub-units two of each type MW 51,300 and 59,600
Iron (Fe) content n mol/mg protein	60	80
Molybdenum content	—	4.8
Acid-labile sulfide content (n mol/mg protein)	58	77
Cysteine content *specific activity* n mol of substrate reduced/min/mg/ protein	158	76
N_2 as substrate	275	380
C_2H_2 as substrate	980	1200

from electron donors. Electron transfer from electron donors to Fe protein of nitrogenase needs ATP in the form of Mg-ATP. From the reduced Fe protein electrons are transferred with the help of Mg-ATP to Mo-Fe protein of nitrogenase which in turn reduces the nitrogen($N \equiv N$) bound to molybdenum (Mo) to ammonia. At every step, a pair of electrons are transferred and totally 6 electrons and nearly 15-30 ATP molecules are needed for complete reduction of nitrogen to ammonia.

Table 2

$N_2 \rightarrow NH_3$

$N_2O \rightarrow N_2 + H_2O$

$N_3 \rightarrow N_2 + NH_3$

$C_2H_2 \rightarrow C_2H_4$

$HCN \rightarrow CH_4 + NH_3 + (CH_3NH_2)$

$CH_3NC \rightarrow CH_4 + CH_3NH_2 + (C_2H_4, C_2H_6)$

$2H- \rightarrow H_2$

$$N \equiv N \xrightarrow{2e} HN = NH \xrightarrow{2e} H_2N-NH_2 \rightarrow 2NH_3$$

In absence of nitrogen, enzyme nitrogenase functions as hydrogenase. It converts H^+ into H_2. However, nitrogenase needs Mg-ATP for liberation of hydrogen gas from hydrogen ions (H^+). This could be clearly distinguished in a cellular reaction where hydrogenase function of nitrogenase needs ATP and is sensitive to carbon monoxide (CO), whereas the other cellular hydrogenase needs no ATP and is insensitive to CO.

In vitro , sodium dithionate and $Na_2S_2O_4$ act as electron donors and compounds listed in Table 2 could act as electron acceptors and nitrogenase catalyses the reduction reaction.

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Cycic CMP identified

ONE of the most important functions of the animal cell plasma membrane is to receive extracellular messages and transduce them into intracellular messages that in turn activate appropriate cellular responses. The nature of this transduction phenomenon and the number of the intracellular messengers involved in cell activation will decide the function of a cell. Of particular importance in this context is the role of purine cyclic nucleotide, cyelic 3' 5' adenosine monophosphate (cAMP) and its more recent companion cyclic 3', 5' guanosine monophosphate (cGMP). Based on the apparently ubiquitous presence of cAMP as a factor in the activation of a wide variety of cell types, sutherland and coworkers developed a general model of cell activation, the second messenger hypothesis.

A second messenger is defined as a chemical signal, generated by the interaction of an external stimulus with a cell surface receptor which passes into one or more subcellular compartments and there in initiates the appropriate cellular response.

The classical second messenger model of hormone is illustrated in Fig. 1. This model proposes that in general hormone interacts first with a restricted set of receptor sites on the cell surface which in turn influences the generation of a single second messenger cAMP by way of adenylate cyclase which ultimately produces physiologic response attributed to the hormone. In many instances, however, alteration in cell function cannot be accounted

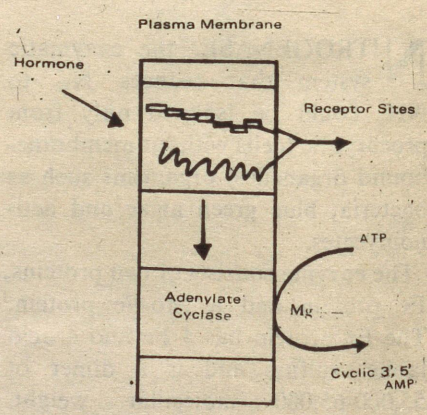

Fig. 1. Second messenger hypothesis

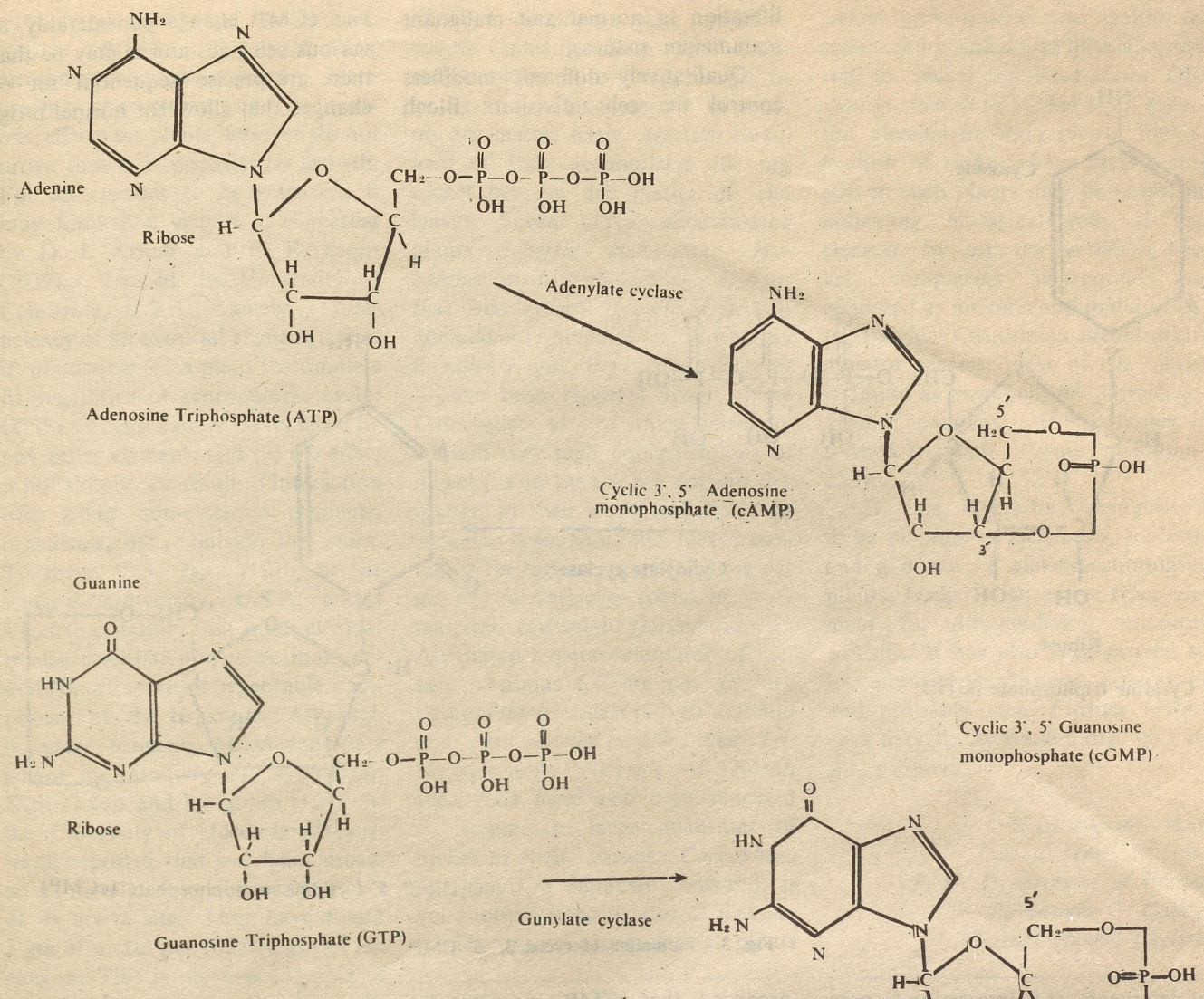

Fig. 2. Formation of cyclic nucleotide

for by corresponding or concomittant alterations in the tissue concentrations of either of the two purine cyclic nucleotides known so far. The existence of other endogenous regulatory molecules is constantly being sought.

Formation of cyclic nucleotides

All the cyclic nucleotides are confined to animal cells only. They are generated by the action of membrane-bound adenylate cyclase or guanylate cyclase on ATP or GTP. They are destroyed by the corresponding enzyme phosphodiesterase (Fig. 2).

A. Bloch (1974) the first scientist to identify cyclic 3/, 5' cytidine monophosphate as a natural constituent in malignant murine L-1210 cells in culture attributed a significant role for this first pyrimidine cyclic nucleotide in the control of proliferation of leukemic colls. After that S. Y. Cech, R. A. Gross, L. J. Ignarrow reported the presence of enzyme system capable of forming cyclic 3/ 5', cytidine mononucleotide (cCMP) from its naturally occurring substrate in murine myeloid leukemic tumours and in normal mouse liver and spleen (Fig. 3) Calilla and Delaage reported the presence of cCMP in rat liver. S. Y Cech and L. J. Ignarrow studied several characteristics and factors influencing the formation of cCMP in mouse liver homogenate fraction. Cyclic CMP formation occurs best in the presence of manganese or iron ions at a pH of 7.4 and 37°C in the absence

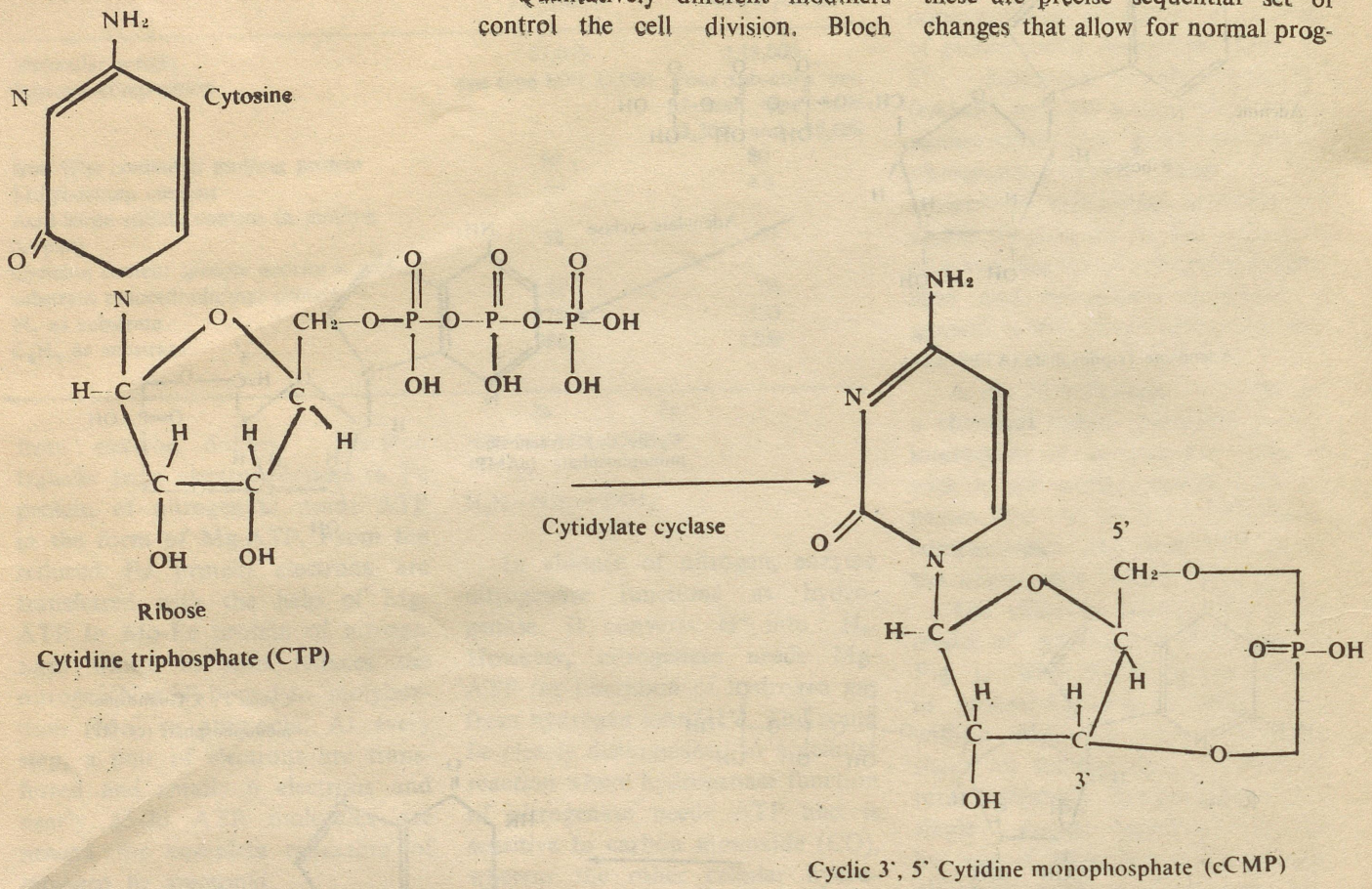

Fig. 3. Formation of cyclic 3, 5' CMP

of detergents. It is interesting to note that Ferrous ions (Fe^{++}) are as active as Manganous (Mn^{++}) in stimulating cytidylate cyclase where as they have no stimulatory effect on cyclic AMP or cyclic GMP formation. Cyclic CMP formation has been studied in several tissues from mouse and from various other species. In mouse, cyclic CMP formation is highest in liver and lowest in lung. The rate of cCMP formation has been found to be greater in rapidly proliferating than in slowly proliferating tissues. The experimental results reported so far suggest that cCMP is associated with stimulation of tissue growth and this pyrimidine cyclic nucleotide may play a role in the bioregulation of cell proliferation in normal and malignant mammalian tissues.

Qualitatively different modifiers control the cell division. Bloch proposed that cCMP may act by preventing the delay of mitosis caused by cAMP. Throughout the cell cycle the concentrations of cAMP, cGMP and cCMP change considerably in various cell lines and it may be that these are precise sequential set of changes that allow for normal progression of the programmed response.

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Is nickel essential for plants?

CHEMICAL analysis of any plant species reveals presence of a quite large number of elements, but so far only 17 elements have been considered essential for plants. Nickel is not included in the list of essential elements. However, nickel is widely distributed and is regarded as a normal constituent of plant tissues. It regulates growth and metabolism of many plants in various ways. In low concentrations, it stimulates germination of seeds as well as early growth of seedlings. In higher concentrations, it is toxic to seed germination and plant growth. It

also regulates mineral metabolism, enzyme activities and several other metabolic processes in plants. Mere presence of an element and its various effects on plants however do not prove that it is essential for growth. For an element to be essential, it must fulfil three criteria as suggested by D. I. Arnon and P. R. Stout (1939), then at the University of California, U.S.A., namely, (1) deficiency of an essential element makes it impossible for a plant to complete its vegetative or reproductive cycle; (2) the element cannot be replaced by any other element; and (3) the effect is not simply the result of interaction with other non-essential elements, organisms, etc., outside the plant. To these, C.A. Price (1970) of the Rutgers University, U.S.A. added a fourth criterion, that is, an element is also essential if it is an indispensable part of an indispensable component of the organism. Although in many instances, nickel deficiency is not indicated by any symptoms. N.E. Dixon and his group (1975) at the University of Queensland, Australia reported that jack bean urease is a metalloenzyme having nickel at its active site. They have found 2 gm of nickel per 105,000 gm of the enzyme. This is the first example of a nickel metalloenzyme. As such, nickel may well be an essential trace element in jack bean. Recently, J.C. Polacco (1977) of the Connecticut Agricultural Experimental Station, U.S.A. has suggested that free nickel (Ni^{2+}) is essential for the production of urease in soybean cell culture.

Several plant species are known to have adapted well to nickel-rich soils. These plants cannot grow normal and healthy in soils lacking in sufficient nickel and are often employed as 'indicator plants' in order to test the presence of nickel in soil. They can accumulate a large amount of nickel (more than 1 mg per gm dry matter) in their tissues and are, therefore, designated as 'nickel accumulators'. For example, the plants *Alyssum bertolonii* and *Alyssum murale* found in USSR can accumulate nickel upto 4 mg per gm in leaves and 2.5 mg per gm in seeds on dry matter basis. *Alyssum bertolonii* of Italy accumulates 10 mg nickel per gm dry matter of the leaves. Seven nickel accumulator plants—*Sebertia acuminata*, *Hybanthus austro-caledonicus*, *Hybanthus caledonicus*, *Homalium francii*, *Homalium guillainii*, *Homalium kanaliense* and *Psychotria douarrei* —have been reported from New Caledonia; all of them normally contain very high concentrations of nickel (more than 1 mg per gm dry matter) in their leaves and latex. In *Sebertia acuminata*, the nickel content is the highest (upto 257.4 mg per gm dry matter) ever found in living material *Hybanthus floribundus*, an Australian hyperaccumulator of nickel, contains 6.5 mg per gm dry tissue. *Pimelea suteri* of New Zealand and *Planchonella oxyedra* and *Trichospermum kjellbergii* of South East Asia have also been reported to accumulate large quantities of nickel in their tissues. *Coccophora langsdorfii*, a Japanese seaweed, is yet another concentrator of nickel.

The nickel-accumulating plants cannot grow normal and healthy in soils lacking nickel and have adapted well to nickel deposited zones. Obviously, therefore, nickel is an essential element for these plants. Identification of nickel compounds present in such plants may be useful in indicating biological role of the element. In *Alyssum bertolonii*, nickel complexing compounds are identified as malonic and malic acids. In the New Caledonian nickel accumulator species, most of the nickel is found as nickel-citrate (citratonic-kelate) complex. This complex is formed in plant tissues metabolically.

To date, nickel has been proved to be essential to jack bean, soybean and a dozen of nickel-accumulator plants. Nickel is an active trace element for nitrogen-fixing microorganisms. It has also been proved to be essential to chickens, rats, swine and probably man. Further researches may throw some more light on the problem.

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Pomfrets and their way of life

POMFRETS are a group of deep bodied marine fishes with a single row fof minute teeth on the jaws and without ventral fins in the adults. They are highly esteemed as table fish. On account of their soft flesh and delicate flavour, they are often called "butter fishes". In Indian seas, pomfrets are represented by three species, viz., silver pomfrets (*Pampus argenteus* Euphrasen), Chinese pomfrets (*Pampus chinensis* Euphrasen) and black pomfrets (*Parastromateus niger* Bloch) (Fig. 1). Of these, silver pomfret is the most common species contributing to more than 90% of the pomfret catch.

Distribution

Distribution of pomfrets is essen-

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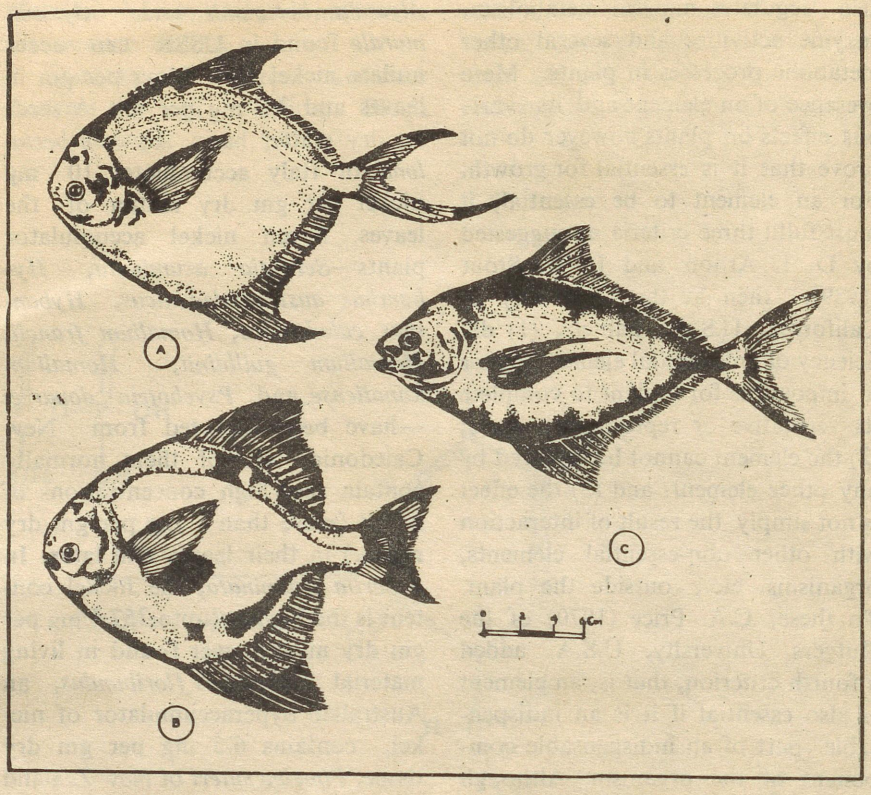
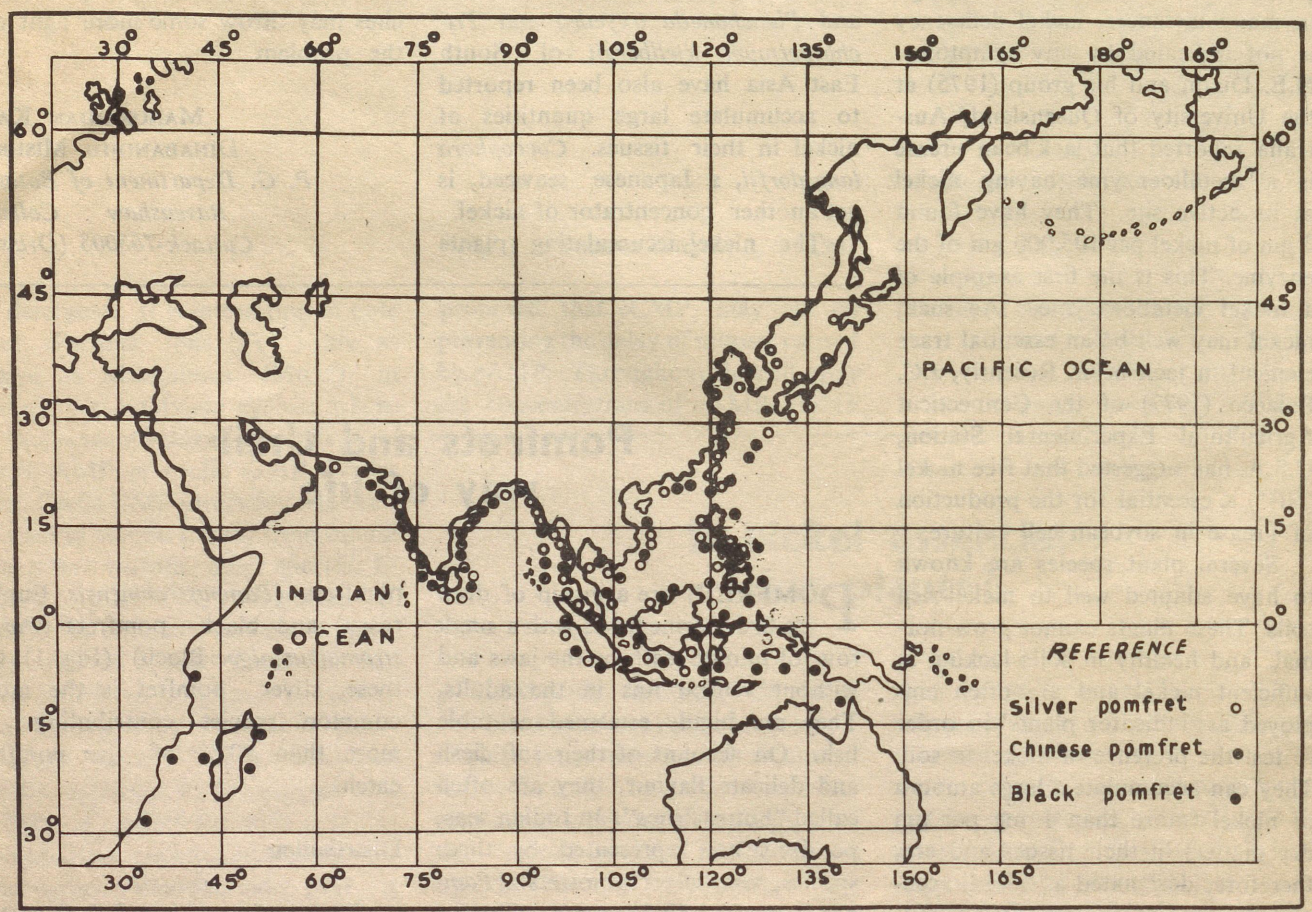


Fig. 1. Adult pomfrets: (A) Silver pomfret; (B) Chinese pomfret; (C) Black pomfret

tially in Indo-West Pacific (Fig. 2). Silver pomfrets occur along the coasts of Japan, Korea, China, Taiwan, Hong Kong, Philippines, Indonesia, Malayasia, Vietnam, Thailand, Singapore, Burma, Bangladesh, India, Ceylon, Pakistan and the Persian Gulf. They inhabit coastal waters of the continental shelf down to a depth of 100 meters. Although black and Chinese pomfrets are similar throughout their distributional range, the silver pomfrets show racial variation in the

Fig. 2. World distribution of pomfrets



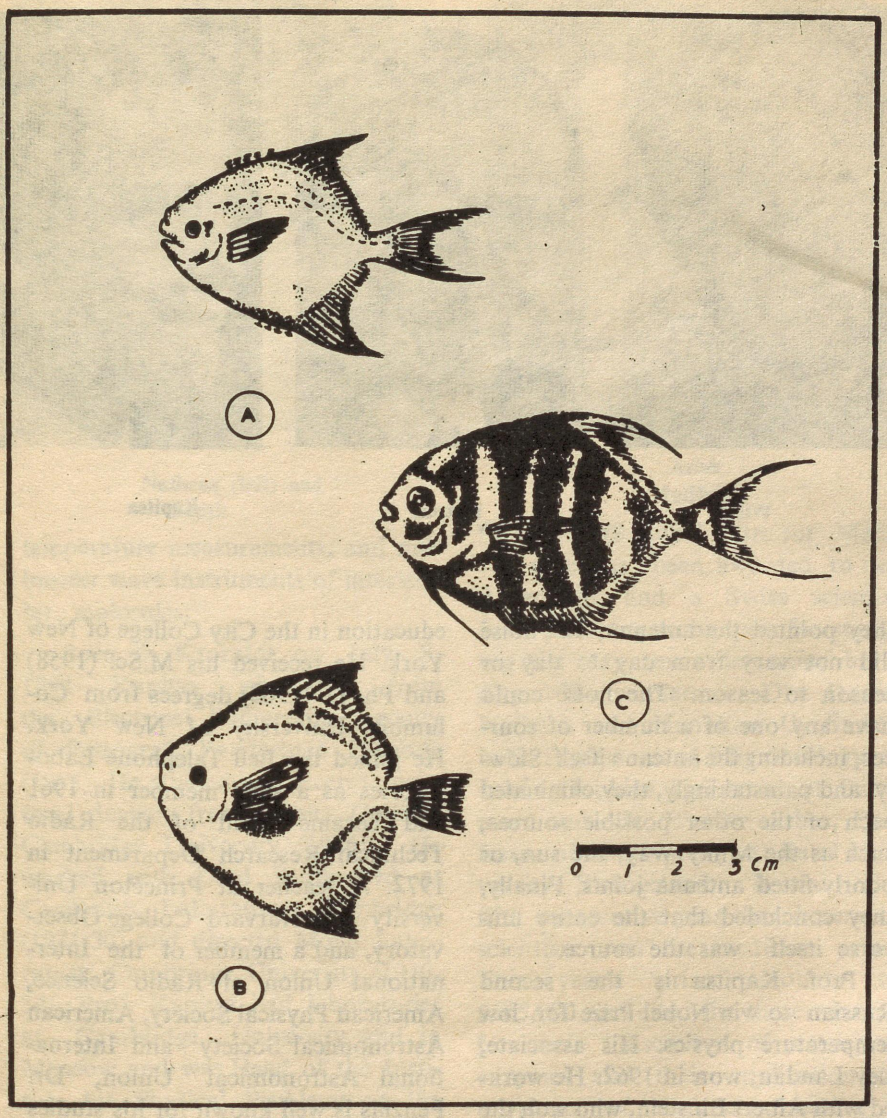


Fig. 3. Young pomfrets: (A) Silver pomfret; (B) Chinese pomfret; (C) Black pomfret

number of their vertebrae. Along the coasts of Japan and Korea, a type of silver pomfret known as butterfly silver pomfret is found. It is regarded as a distinct species.

Food habits

Silver pomfret and Chinese pomfret feed mainly on copepods. Other food items include jelly fish, small crustaceans, polychaetes, fish eggs and larvae, marine insects, molluscan larvae, arrow-worms, algal filaments and diatoms. The diet of black pomfret consists mainly of samller prawns (*Acetes*), copepods, stomatopods and jelly fishes.

The larvae of pomfrets feed mainly on phytoplankton (freely floating microscopic plants). Zooplanktonic organisms such as copepods and smaller jelly fishes are added to the diet only in the later phase of life.

Spawning habits

Pomfrets spawn in the warmer months. They generally prefer broad continental shelf with a rich standing crop of zooplankton during their spawning season. West Bental-Orissa coast along the Bay of Bengal and Gujarat-Maharastra coast of the Arabian Sea fulfil these conditions and therefore constitute the spawning ground of these fishes in the Indian waters. The spawning season extends from late February to early November. This accounts for their stay in the spawning ground for the greater part of the year. Gujarat, Maharashtra, Orissa and West Bengal, are therefore leading pomfret producing regions of India.

The silver pomfret has a prolonged spawning period extending from February to August. The fish spawns twice in a season with peaks in April and August. During the spawning season, a ripe female may lay as many as 90,000 eggs. Chinese pomfret and black pomfret spawn only once a year; the spawning season of the former extends from September to November and that of the latter from March to June.

Life history

Young pomfrets differ markedly from parents (Fig. 3) and undergo remarkable changes during subsequent growth. Juveniles of black pomfrets have dark vertical bands and ventral fins which disappear in adults. The young black pomfret is demersal (living near the bottom) but the adult is strictly pelagic (surface dweller). The Chinese pomfret sticks to its larval pelagic environment throughout its life.

Behaviour and fishery

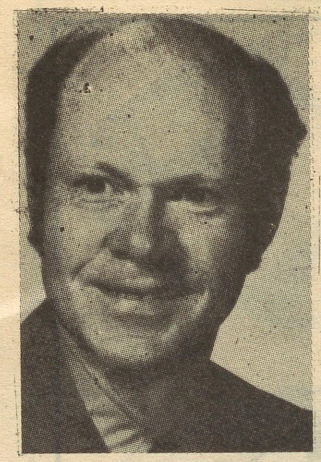
Behaviour of a fish is influenced by various factors. Fishermen take advantage of fish habits for the ex-

(*Continued on page 852*)

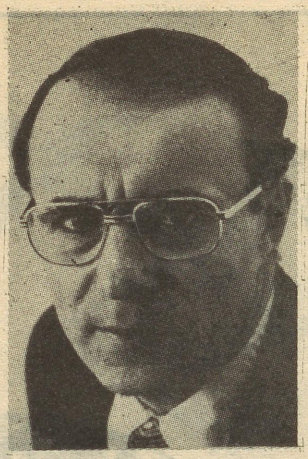


NEWS & NOTES

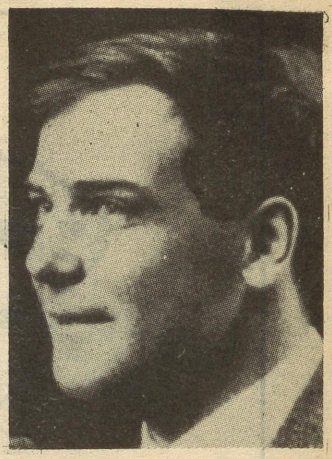
Nobel Prizes 1978



Wilson



Penzias



Kapitsa

Physics

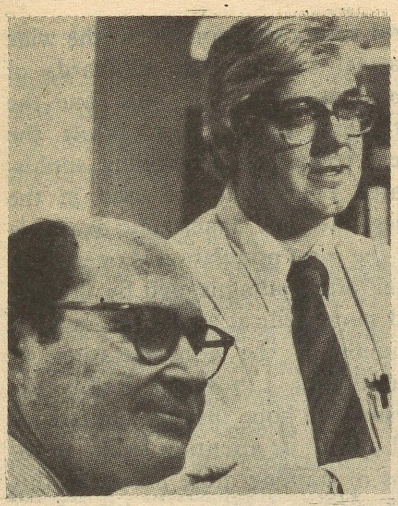
THE 1978 Nobel Prize for Physics has recently been awarded to two American physicists whose work with microwave radiation supported the 'big bang' theory of the creation of the universe, and one Russian physicist whose work with low temperature physics led to liquefaction of helium and oxygen in large scale with major effects on Soviet steel and energy industries. Dr. Arno A. Penzias, 45 years old, and Dr. Robert Woodrow Wilson, 42, both of the Bell Telephone Industries of New Jersey, shared the $ 165,000 physics prize with Professor Pyotr Leontevich Kapitsa, 84, of Moscow.

Drs. Penzias and Wilson discovered in 1965 that the entire universe is bathe in background radiation left over from the birth of the universe some 20 billions years ago. The discovery, described as "the absolutely the most important discovery in cosmology since the expansion of the universe was discovered", provided dramatic evidence that the universe began with the explosion of a primordial fireball of unimaginable force, the 'big bang'. Using an antenna at Bell Laboratories' Cawford Hill Station near Holmdel, N. J., the two physicists found that a faint noise pervaded all space, no matter what direction they pointed the antenna. The noise did not vary from day to day or season to season. The noise could have any one of a number of sources, including the antenna itself. Slowly and painstakingly, they eliminated each of the other possible sources, such as the Milky Way, the sun, or poorly-fitted antenna joints. Finally, they concluded that the entire universe itself was the source.

Prof. Kapitsa is the second Russian to win Nobel Prize for low temperature physics. His associate, Lev Landau, won in 1962. He worked with Albert Einstein, who won the Nobel Prize for physics in 1921 and with Ernest Rutherford of England, who won the Prize in chemistry in 1908. Prof. Kapitsa, a legendary figure in the physics world, has long been mentioned as a Nobel prospect in recognition of his studies of electronic inertia and properties of radioactive radiation, his development of equipment for work with very powerful magnetic fields, high-production hydrogen liquifier, his designing and construction of original apparatus for liquefying large quantities of helium and oxygen and his research on the nature of ball lightning.

Born in Munich, Germany on April 26, 1933 Penzias migrated to the United States and got his education in the City College of New York. He received his M.Sc. (1958) and Ph. D. (1962) degrees from Columbia University of New York. He joined the Bell Telephone Laboratories as a staff member in 1961 and became Head of the Radio Technical Research Department in 1972. A teacher at Princeton University and Harvard College Observatory, and a member of the International Union of Radio Science, American Physical Society, American Astronomical Society and International Astronomical Union, Dr. Penzias is well known for his studies of microwave physics, satellite communication, atmospheric physics, millimeter wave instrumentation, radio astronomy techniques, cosmology, interstellar matter and astronomical uses of television.

Born in Houston, Texas on January 10, 1936, Wilson received his B. Sc. degree from Rice University (1957) and his Ph. D. degree in physics from the California Institute of Technology (1962). After a year of his research at this Institute, Dr. Wilson joined the Bell Telephone Laboratories in 1963. A member of the American Astronomical Society, Dr. Wilson is credited with his investigations of microwave radio astronomy, problems related to the galaxy, absolute flux and background



Nathans (left) and Smith

temperature measurements, and millimeter wave instruments of interstellar molecules.

Born in Kronstdt on July 8, 1894 Kapitsa graduated from the Electrical Engineering Faculty of Petrograd Polytechnic Institute (1918). He studied and received doctoral degrees from Trinity College, Cambridge University (1926). He worked with Lord Rutherford at Cavendish Laboratory, Cambridge (1921-30) and directed Mond Laboratory, Cambridge University (1930-34). Prof. Kapitsa had laboratories at Cambridge University and in Moscow and was Head of the Institute for Physical Problems at the Soviet Academy of Sciences. In 1946 he was put under house arrest by Stalin when he was reluctant to work towards a Soviet arms buildup. He resumed directorsnip of the Institute in 1955 after Khruschev took power, and still holds the post. Since 1955 he is a professor at the Moscow Physico-Tech Institute. He won Order of Lenin, Farady Medal, Niels Bohr Medal, Rutherford Medal and Fellowship of Royal, Society of England. He is a foreign member of the Indian Academy of Sciences.

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Arber

Medicine

THE 1978 Nobel Prize for Medicine has been awarded to two Americans and a Swiss scientist for developing techniques for studying the way genes determine heredity. The winners are Drs. Daniel Nathans and Hamilton O. Smith, both Professors of Microbiology at Johns Hopkins University at Baltimore and Dr. Werner Arber, Professor of Microbiology at Basel University, Switzerland. It was the fifth consecutive year that American scientists won the medicine prize. This year's prize amounts to $165,000 and cited the three winners for their "discovery of restriction enzymes and their application to problems of molecular biology." The restriction enzymes provide the 'chemical knives' that split chromosomes into their component genes. Dr. Arber was honored for discovering the restriction enzymes; Dr. Smith proved Dr. Arber's hypothesis, and Dr. Nathans pioneered the application of the restriction enzymes to genetics. Restriction enzymes can help explore the processes that convert normal cells into cancerous ones, make possible the determination of the health of an ovum-removed from a mother prior to fertilization and re-implanting in test tube births and can help crack the biochemical code of life, which aids to find the cause of many birth defects.

Dr. Arber, 49 years old, was appointed Professor of Microbiology at the University of Basel in 1971, where he also works at the Biozentrum, which is financed by the Swiss government and Switzerland's large pharmaceutical industries. He was a research associate at the University of Southern California Medical School from 1958 to 1959 and was a visiting investigator at the Molecular Biology Department of the University of California in Berkeley from 1970 to 1971.

Born on October 30, 1928 in Wilmington, Delaware, Nathans was educated at the University of Delaware. He obtained his medical degree from Washington University (1954). He served in various capacities in research and teaching at Rockefeller University (1959-62), Columbia Presbyterian Medical Centre (1957-59). Since 1962 he is with Johns Hopkins University, becoming its Professor of Microbiology in 1967 and Director of the Department of Micorbiology in 1972.

Born on August 23, 1931 in New York City, Hamilton Smith was educated at the University of California in Berkeley. He received his medical degree at Johns Hopkins University (1956). Having served as the U.S. Public Health Service fellow at Michigan University Dr. Smith joined the Johns Hopkins University in 1964.

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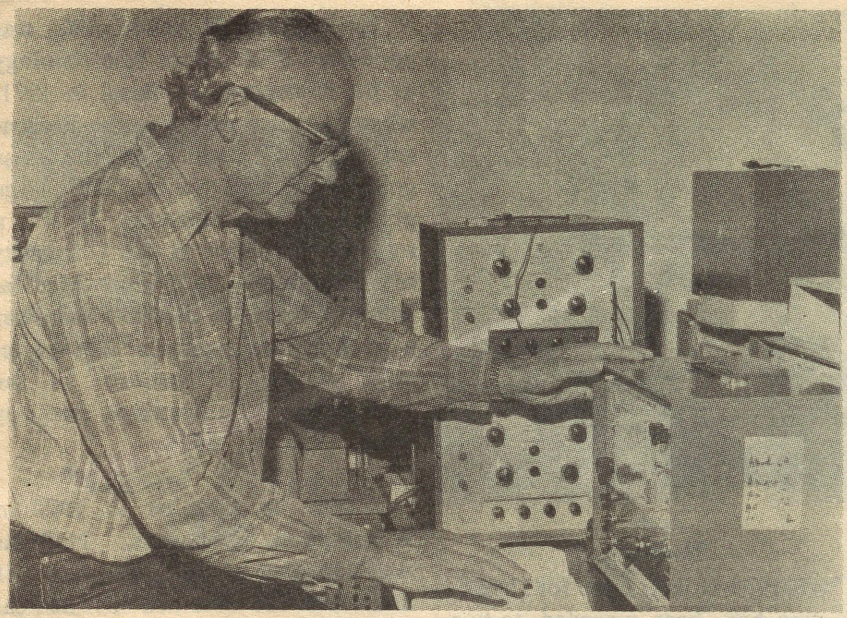
Chemistry

The 1978 Nobel Prize for Chemistry has been awarded to Professor Peter Dennis Mitchell, 58 years old, of Bodmin, Cornwall England, for his work in bioenergetics which concerns the chemical processes responsible for the energy supply in living cells. The prize this year amounts to $ 165,000.



Mitchell

Born on September 29, 1920 young Mitchell was educated in Queen's College, Taunton, and Jesus College, Cambridge University. He obtained his Ph. D. degree from that university in 1950. He served the Department of Biochemistry of the University of Cambridge from 1943 to 1955 and the University of Edinburgh from 1955 to 1963. Recepient of honorary degrees from Berlin Technical University and Exeter University Dr. Mitchell received several awards for his contributions in bioenergetics. The CIBA Medal and Prize (of the British Biochemical Society), (1973). Freedman Foundation Award (New York Academy of Sciences), (1974), Feldberg Foundation Award, (1976) and Rosenstiel Award (Brandies University) (1977) are few to name. He was made a Fellow of the British Royal Society in 1974. He authored books entitled *Chemiosmotic Coupling in Oxydative and Photosynthetic Phosphorylation* (1966) and *Chemiosmotic Coupling and Energy Transduction* (1968). Since 1964 Dr. Mitchell is Professor and Director of Research of Glynn Research Laboratories.

R.K. DATTA

Vth Asian and Australasian Anaesthesiology Congress

FOR the first time, India hosted an international congress of anaesthesiologists at the All India Institute of Medical Sciences, New Delhi. The five-day Asian and Australasian Congress of Anaesthesiology aimed at exchange of medical knowhow on safe anesthesia and pain relief during surgery. Over 1200 delegates from 14 countries attended the Congress. This was the fifth congress in this speciality, the first was held in Manila (Philippines) in 1962.

The Congress was inaugurated on 23rd September by President Neelam Sanjiva Reddy. He drew the attention of anaesthesiologists to rural areas, and pointed to the wide contrast between the standards of anaesthesia in major cities and the peripheral rural areas. While the latest techniques employing sophisticated equipment are used in the cities, the only anaesthetic available for the rural population is open drop ether often administered by doctors and para-medical staff who have no training in the administration of anaesthetics. President Reddy expressed the hope that the conference will devote its attention to the problems of training more people in this speciality, providing simple and inexpensive anaesthetic to rural patients and other related problems.

Professor Quintin J. Gomez, President of the World Federation of Societies of Anaesthesiologists, in his address emphasised the need for greater cooperation and exchange of medical knowledge in this field among the countries of this region.

Dr. Pritam Singh, who was elected President of the Congress for the coming four years, said a large num- of training centres will be opened in the region in the coming years, to meet the shortage of anaesthetists.

Over 200 papers were presented at the technical sessions on various problems and sub-specialisations of anaesthesiology. They brought out a wealth of research information and experience. Highly developed techniques of providing anaesthesia for brain, heart and other major surgical operations; newer and yet to be established techniques of acupuncture anaesthesia, were among the topics discussed. A few papers were on intractable pains and their relief.

Prof. G. R. Gode, of A.I.I.M.S., spoke of his studies on keeping a rabies patient alive in intensive care unit for 21 days. This, according to him, is the longest survival of any rabies patient in the world. Dr. Gode studied for the first time the physiological changes and the action of potent drugs on rabies patients

under prolonged survival. He said a cure for rabies may be within sight if a still longer survival of the patient, say, a month, is achieved.

In the guest lecture, Prof. J. P. Payne of Royal College of Surgeons, London, warned that many of the present achievements in this field are in danger of erosion. According to him, little anaesthesiology is taught in undergraduate courses these days and post graduate programmes are becoming increasingly rigid and less accommodating to individual doctors.

Today, the role of anaesthesiologists has become very important in the safe development of surgery and critical medicine. This is reflected by the fact that it has become the largest single speciality in most of the western countries.

The next Congress of Anaesthesiologists will be held in 1982, in Auckland (New Zealand).

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Science Cell
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Interview

Prof. S. K. Trehan

"INDIAN scientists are certainly doing their best within the available facilities," says Prof. Surinder Kumar Trehan, Professor of Mathematics at Punjab University, who won the 1977 S.S. Bhatnagar Award in mathematics. "However," he adds, "they could certainly do more even within the present facilities if the red-tape and bureaucratic procedures were much less." In his opinion most of these hindrances can be cut down if full confidence is deposed in the judgement of the person holding a responsible position.

Prof. Trehan is well known among astrophysicists for his recent contributions to the understanding of the internal structure of stars. He has forwarded a consistent mathematical treatment for solving some problems of stellar structure in presence of magnetic field. A result of sustained study for about a decade, this work is, according to him, "a breakthrough in the subject since the pioneering efforts of Prof. S. Chandrasekhar and others." Besides he has made some fundamental butions to theoretical Magnetohydrodynamics.

Born on April 4, 1931, to a mathematics school teacher, Prof. Trehan has a throughout first class career. He is also the recipient of many scholarships during his graduation and post-graduation at the University of Delhi. It was on the William Rainey Harper fellowship of the University of Chicago, that he went to the U.S.A. to do his Ph. D. under the guidance of Prof. Chandrasekhar. "I have received enormous encouragement from Prof. Chandrasekhar, "he says with reverance, "His teaching and method of guiding research have always inspired me. His objectivity in science has helped me immensely in my research career." Today, Prof. Trehan's review articles and lecture notes on various topics in plasma physics have received wide circulation and appreciation.

Prof. Trehan has been abroad on several occasions. He cautions that one should be careful when one refers to the teaching procedures adopted there. "Merely the fact that a certain procedure is adopted in the U.S.A. and U.K. does not necessarily make it superior to the ones adopted here."

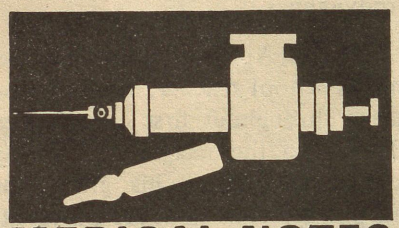
DILIP M SALWI



Prof. Trehan

Plasma physics and MHD symposium

THE Department of Atomic Energy plans to hold the third National Symposium on Plasma Physics and Magnetohydrodynamics, at Trombay, Bombay during January /February 1979. The exact date will be announced later. The 2-3 days symposium will discuss various aspects of plasma physics and MHD grouped under seven heads. For further information, write to Shri V. K. Rohatgi, Convener, Symposium Committee, Plasma Physics Section, Bhabha Atomic Research Centre, Trombay, Bombay-400085.



MEDICAL NOTES

Banana and peptic ulcer

PEPTIC ulcer is a common term for all types of ulcers—specific names are ascribed according to the site of ulceration, viz., when the ulcer is located at stomach, it is known as gastric ulcer; when at duodenum, duodenal ulcer, etc. Likewise corneal ulcer, jejunal ulcer, uterine ulcer and esophegus ulcer have been named after the site of ulcers, i.e., cornea, jejunum, uterus and oesophegus respectively.

The aetiology of peptic ulcer, inspite of extensive research, is still contradictory. Different groups of workers have suggested different causes of the disease. They are : (1)Increased secretion of gastric juice associated with a high amount of hydrochloric acid and proteolytic enzyme; (2) Alterated and decreased secretion of protective mucus present in the gastric juice; (3) Bile reflux; (4) Genetic factors; and (5)Disorder in the energy metabolism, etc.

Due to scant and contradictory knowledge about the cause of peptic ulcer, its treatment is still unspecific. Apart from the successful intervention by surgical means, drugs most frequently used are either antacids or anticholinergics or the pro-mucus secreting drugs, depending on the type and sign-symptoms of ulcers.

Treatment of peptic ulcer with Indian medicinal plants is now claiming interest of research workers in India. Among the antiulcerogenic plants and fruits, vegetable banana may prove useful in view of the systematic research conducted by A.K. Sanyal and his associates at the Department of Pharmacology, Medical College, Agra, in 1964 (Sanyal, A.K.; Gupta, K.K. and Chowdhury, N.K. : Studies on peptic ulceration, Part I, *Arch. Int. Pharmacodyn. Ther.*, Vol. 149, No. 3-4, Pp. 393-400, 1964) and by the same workers at the Department of Pharmacology, College (Institute) of Medical Sciences, Banaras Hindu University, Varanasi 1965 and 1977 (Sanyal , A.K. ; Banerjea, C. R. and Das, P. K. ; Studies on peptic ulceration, Part II *Arch. Int. Pharmacodyn. Ther.*, Vol. 155, Pp. 243-248, 1965; Sanyal, A. K. and Mitra, P.K.: The effect of stress on gastric mucin in albino rats, International Seminar on Stress in Health and Disease, *Abstract*, Institute of Medical Sciences, Banaras Hindu University, Varanasi, February 28-March 4, 1977). These researches established not only the prophylactic action of unripe vegetable banana but also its curative value in different types of ulcers in experimental animals. Results were encouraging in clinical trials. The mode of action of banana in ulceric condition, as suggested by these workers, is as follows :

(i) Banana porbably has got some beneficial effects on the secretion of acid, proteolytic enzyme and mucosubstances in gastric juice which, in turn, help the healing procedure of ulcers; and

(ii) Due to a large amount of 5-hydroxy tryptamine content in unripe banana, unlike ripe banana, it perhaps decreases gastric secretion.

One can be optimistic about the possible therapeutic use of a special preparation of unripe vegetable banana or its active component(s) in peptic ulcer in near future.

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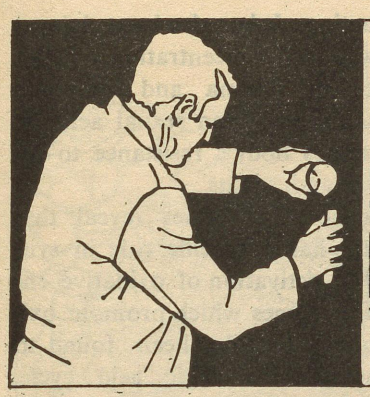
Blind diabetics can test their urine sugar

DIABETES mellitus is a hereditary disorder in which amount of blood glucose is increased (hyperglycemia) and it is passed in the urine. Management of diabetes requires routine urine test for glucose because it helps in calculating the dose of oral drugs (rastinon, diabenese, euglucon, daonil and DBI) or insulin. However, until recently there was no technique which could be used by a blind person for testing his urine glucose.

In 1976, J. May, S. Inman, D. E. Wilcox and R. S. Backett of Hartford Hospital, Connecticut, U.S.A. developed an audio-urine glucose analyser which even a blind diabetic can use to test urine glucose. The technique involves use of specially made plastic strips (diastix), potassium iodide, a blue background dye and two enzymes, glucose oxidase and peroxidase. The two enzymes, potassium iodide and blue background dye are impregnated on one end of the diastix. Once the diastix is dipped in urine, reactions occur in a sequential, nondiffusible manner. Glucose oxidase catalyzes oxidation of glucose to gluconic acid and hydrogen peroxide. Then, peroxidase catalyzes oxidation of potassium iodide with hydrogen peroxide to form free iodine. Free iodine reacts with blue background dye to give shades of green, green brown and brown depending upon the con-

(Continued on page 809)



SCIENCE FOR THE YOUNG

Metals and coins

ONE of the important landmarks in the progress of human civilization is the use of coins. In the beginning of civilization barter, that is, exchange of goods, was in vogue. For example, a person who had corn and required a piece of cloth would give corn to another person in exchange for cloth. In the barter system the difficulty arose when the respective needs of the parties did not coincide. To overcome this shortcoming of the barter system, some objects were used as medium of exchange. Cowrie shells were one of the media of exchange. This system too did not work out well.

Soon metals replaced other materials for making coins. Metals have certain advantages over others for coinage. They are permanent, lasting, divisible and portable. Gold, silver, copper and lead were the principal metals used in coinage.

The earliest coins in India are known as punch-marked coins or Puranas. These coins are called punch-marked because some symbols are punched on one side or both sides of the coins. They were in circulation in India from about the 5th Century B.C. to about the 1st or 2nd Century A.D. Punch-marked coins are usually of silver but are also available in copper. They are of different shapes. Some are rectangular, some round, while others are of no particular shape.

The Indo-Greeks issued a considerable quantity of coins of gold and silver. They issued gold coins for the first time. Gold coins were minted on a large scale by the Kushans. What could have been the possible source of gold for Kushans? The possibility of Kushans obtaining their gold from central Asia lacks archaeological evidence. Some gold coins were minted from gold obtained from India. The Kolar gold fields were outside the Kushan empire. Some scholars have suggested that Kushans converted Roman gold coins into their own gold coins. The study of coins offers a wide scope to know about metals, their mining and also metallurgy.

The Guptas issued a large quantity of gold coins. What was their source of gold? According to some scholars, they procured gold from the eastern part of the Roman empire through trade and also from South East Asia and China.

The use of gold currency cannot be taken as an index of golden age of a particular country. Gold coins were issued probably to meet the demand of higher denominations. According to L. K. Tripathi, the choice of a metal was dictated by economic need and opportunities. According to S. K. Maity, the ruling dynasties of ancient as well as medieval India had almost invariably failed to maintain the purity and percentage of yellow metal that characterised their currency. It is also interesting to note how during the Vijayanagar rule (14th century A.D.) the coin of one metal was linked with the other . The silver coin *Tar* was 1/6 of a gold coin called Fanam.

The Satavahanas (3rd Century B.C. to 3rd Century A.D.) issued coins in lead, copper and silver. It is significant to note that the Satavahanas issued a large number of coins of lead. The Cholas (9th Century A.D. to 12th Century A.D.) issued coins in four metals. The gold coins, called *Madais* which were issued by the Cholas varied considerably in purity. The earliest were almost pure gold but the later coins were considerably alloyed with silver until in some of the later issues they were of silver, merely gold washed or plated.

Apart from the coins themselves, literature and epigraphs throw a flood of light on coinage, the purity of the yellow metal, etc. In a learned article in the *Journal of Numismatic Society of India*, Vol. XX, Part I, pp. 9-14, K. G. Krishnan gives an interesting account of coinage as gleaned from inscriptions in the following words. "The gold metal ingot, which is to be used for minting, is first burnt well. Then it is cut perhaps into pieces, melted and cooled. These handy pieces of different sizes and weights are then released for use. The quality of the gold obtained in these pieces is often referred to in Tamil inscriptions as *Tippakku Sempon*.....Whenever gold currency was offered as a gift in temples, it is referred to as *Tulai nirai Sempon*, wanting neither in purity nor in weight. *Tulai* evidently refers to the punch or marks or impressions on the obverse of the coin, *nirai* to the wright of the coins, and *Sempon* to the purity of gold content. Thus, it would mean pure gold coins having proper weight and marks of impressions."

For the study of metals, coins

afford ample opportunity. By a systematic and scientific study of coins of ancient and medieval periods, we not only have a glimpse of the economic condition prevailing at the time, but also get an idea of the development of metallurgy.

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Thyroid gland

THE endocrine glands, which directly pour their secretions into the blood, have an important role in growth regulations, sexual development and metabolism. There are seven important endocrine glands: the pituitary, thyroid, parathyroid, thymus, the pancreas, adrenals and gonads. Their secretions are called hormones which are generally excitatory and specific in action.

Thyroid is present in all vertebrates, but it varies in size, shape and anatomical position in different species. During foetal development, thyroid arises as an outgrowth from the floor of pharynx and is richly supplied with blood vessels. The human thyroid is a soft, yellowish red, bilobed structure. Each lobe lies on one side of the trachea at the base of the vocal cord (Fig. 1). The normal thyroid of an adult weighs 25 gm to 40 gm.

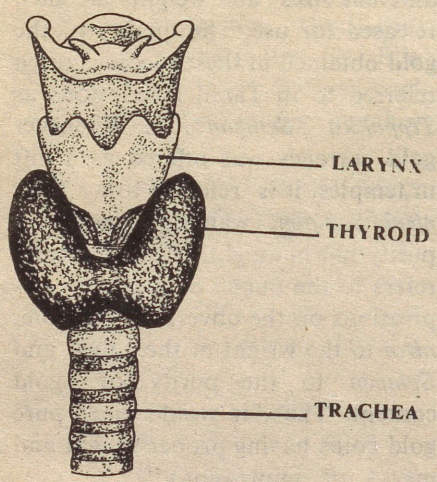

Fig. 1. Location of human thyroid

The gland consists of millions of microscopic spherical units called thyroid follicles or acini of varying sizes. The follicles are lined with a single layer of cuboidal cells (Fig. 2) which can concentrate a large amount of iodine or iodide from blood (mostly in the form of sodium iodide), oxidise it and incorporate it in a protein, thyroglobulin (Fig. 3). Concentration of iodine within the gland may be fifty to several hundred times than that of blood-plasma. Thyroglobulin is stored inside follicles and then split by certain proteolytic (protein breaking) enzymes to form the actual hormone known as thryoxine. Thyroxine was first isolated by E.C. Kendall of he University of Minnesota, U. S. A. in 1914, and its chemical nature was recognized by C. R. Harrington of Oxford University in 1937. Thyroxine is actually an amino acid $C_{15}H_{11}N_4$ and can be prepared synthetically. Release of thyroxine is regulated by the anterior pituitary.

Thyroid hormone regulates rate of energy production and oxygen consumption of most of the normal tissues of the body. It stimulates growth in general and influences calcium, phosphate, iodine and carbohydrate metabolism. Because thyroxine speeds up the oxidation of sugar in body tissues, the rate of absorption of sugar is also increased and glycogen content of liver is gradually decreased. Thyroxine in excess impairs efficiency of muscular contraction. It has also been claimed to lower the concentration of cholesterol in plasma and stimulate spermatogenesis and sexual activity. It increases body's resistance to infections and toxins.

Biochemical studies reveal that thyroxin has a specific role in synthesis or activation of oxidative enzymes (enzymes which promote oxidation). It has also been found to be involved in citric acid cycle, because enzymes involved in this cycle are localised in mitochondria—the respiratory centres of cells. Thyroxine may act by altering permeability of cell membrane and membrane system of mitochondria.

Rate of oxidative process may increase or decrease in accordance with the secretion of thyroxine. Recent observations have also shown that small amounts of the hormone cause an early substantial increase in the rate of protein synthesis. Thyroid thus acts as an accelerator speeding up or slowing down the body activities.

When secretion of thyroxine is inadequate, body consumes less oxygen and produces less metabolic wastes. The individual becomes fat, sluggish in mental reactions and even feeble-minded. The skin becomes thick and puffy and the face becomes expressionless. Such a condition in adults is called myxoedema or Gull's disease. In children, severe deficiency of thyroxine leads to cretinism. A cretin has an idiotic look with large protruding tongue and dribbling saliva. There is evidence that thyroid deficiency may make ovary particularly susceptible to cyst formation, a disorder frequently associated with infertility in women.

If diet lacks sufficient iodine needed by the thyroid, the latter tries to compensate for it by the formation of new gland tissue causing enlargement of thyroid or goitre. Goitre is unknown in Japan where people eat large quantities of fish and a variety of seaweeds rich in

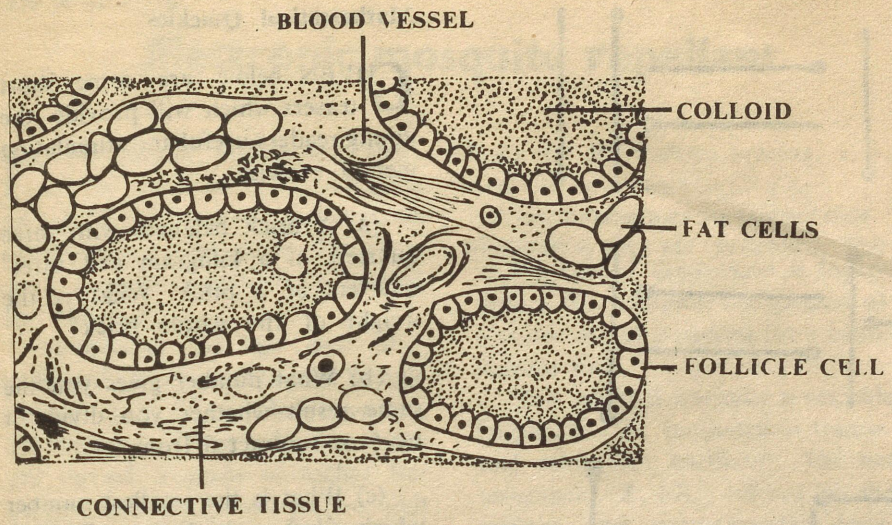

Fig. 2 Histological features of normal thyroid gland.

iodine. In the Great Lakes region and the North Western States of America and the mountain regions of Europe, where iodine leached off the soil by the action of glaciers, thyroid disturbances are common. Advanced cases of goitre require surgical treatment.

Increased secretion of thyroid hormone speeds up basal metabolism (the minimum energy required to maintain normal life activities in an animal) and increases heat and heart beat causing a condition known as exophthalmic goitre or Grave's disease. This is relieved by removing a portion of the gland surgically. X-rays and radium may also be used to destroy some of the thyroid tissue. Recently, certain drugs such as sulphonamide and thiourea which inhibit synthesis of thyroxine have shown promising results. Complete removal of the gland is not advised because it would arrest skeletal growth and sexual maturity.

In cold blooded vertebrates, the role of thyroid seems to be somewhat different. In amphibians such as frogs, thyroid induces metamorphosis. Frederick G. Gudernatsch of the University of Munich (1912) found that frog tadpoles fed with dried thyroids matured much earlier. They soon developed legs, lost their tail and became tiny frogs. Bennett M. Allen of the University of California at Los Angeles removed the thyroid of a frog tadpole and found that it always remained a tadpole, though becoming abnormally large. When fed with thyroxin, it changed into a frog.

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Science quiz

1. A.C. is converted into D.C. by using:
(a) a transformer,
(b) a triode valve,
(c) an electric motor,
(d) a dynamo.

2. The atom comprises of:
(a) electrons and protons,
(b) protons, neutrons and electrons,
(c) neutrons and protons,
(d) a nucleus of hydrogen atom.

3. The magnetic effect of electric current was discovered by :
(a) Andre M. Ampere,
(b) Hans Christian Oersted,
(c) Michael Faraday,
(d) Alexander Fleming.

4. Which of the following alloys does not contain zinc?
(a) Bronze,
(b) German silver,
(c) Brass.

5. Which reacts with water to liberate hydrogen?
(a) Potassium,
(b) Lithium,
(c) Caesium.

6. Sunlight reaches earth in about:
(a) 5 sec.
(b) 100 sec.
(c) 8 sec.
(d) 60 sec.

7. The speed of light was first determined by:
(a) Galileo Galilei,
(b) Isaac Newton,
(c) Olaus Romer,
(d) H. L. Fizeau.

8. Electron was discovered by:
(a) Robert Boyle,
(b) Vant Hoff,
(c) J. J. Thomson,
(d) Madam Curie.

9. Liquid and solid oxygen are:
(a) attracted by magnet,
(b) repelled by magnet,
(c) not paramagnetic.

10. The first man-made element is
(a) Radium,
(b) Polonium,
(c) Uranium,
(d) Plutonium.

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(Answers on page 849)

Brain teasers

A shopkeeper has in his possession four weights for use in the pans of his scale. He is able, by proper selection of these weights, to measure any load from 1 to 40 kg. Of course, for this, he has sometimes

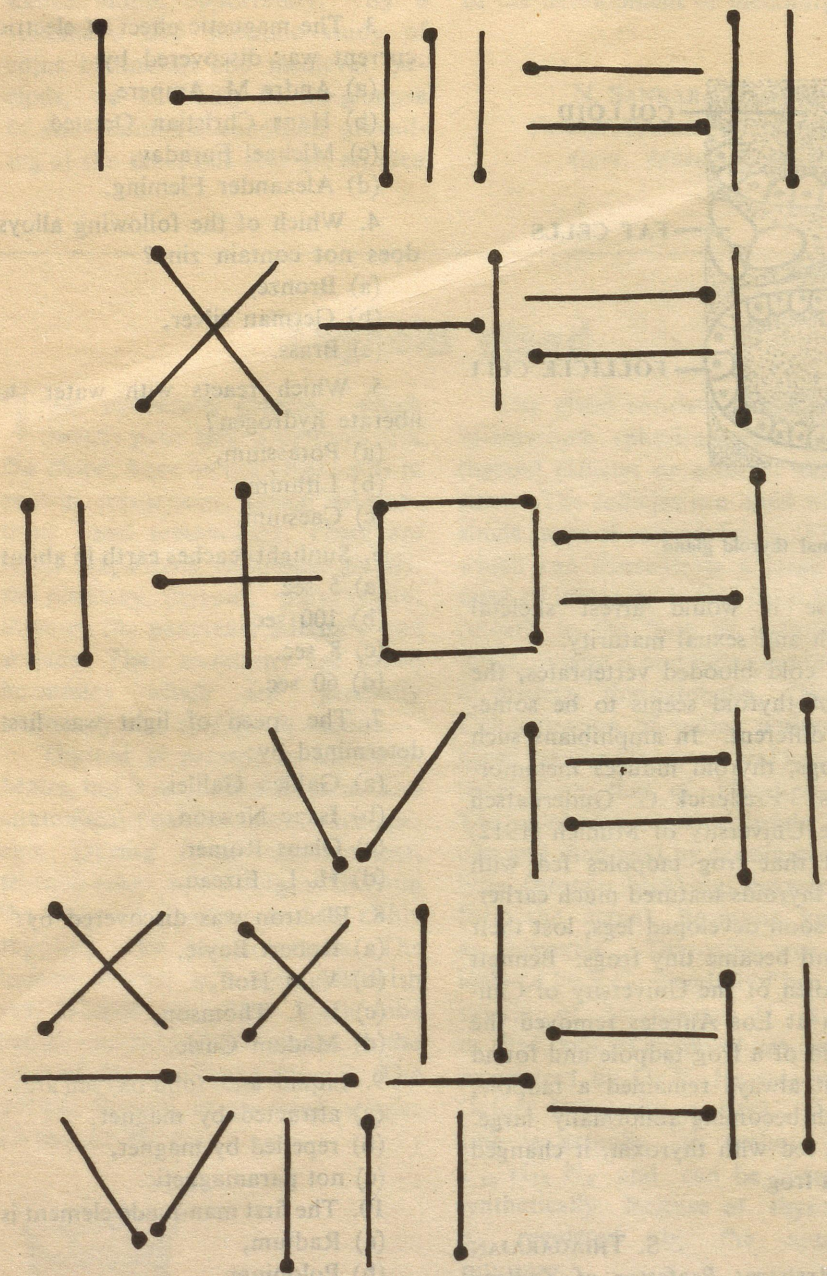

Fig. 1

also to put weights in the same pan as the load he is weighing out. What are the four weights that the shopkeeper possesses ?

Recreation with match sticks

Fig. 1 illustrates a set of mathematical equations involving Roman numerals formed by using match sticks. The square in the third equation is intended to represent zero, a single horizontal match represents a minus sign, while two parallel horizontal sticks stand for the equality sign. Two crossed matches, one horizontal and the other vertical, represent the plus sign. All these equations, as they stand, are false but they can be changed into a true equation by altering the position of a single match stick. Try your hand and obtain the solutions.

Mathematical Quickies

GIVEN below are some short teasers which will provide the young readers useful and stimulating mental exercise.

(a) A brick balances with three quarters of a kilogram and three-quarters of a brick. What is the weight of the whole brick?

(b) What number gives you the same result whether you divide it by 5 or subtract 5 from it?

(c) What is the smallest number which when multiplied by 7, gives an answer, consisting entirely of 9s?

(d) If, in a race, the man who came two places in front of the last man finished one place ahead of the man who came fifth, how many men finished the race?

(e) What is so peculiar about the following fractions?

19/95, 26/65, 16/64

(f) Using the digits 1 to 9, with just one mathematical sign make an expression exactly equal to 100.

(g) What mathematical symbol can be placed between 2 and 3 to make a number greater than 2 but less than 3?

(h) 78 players enter a table-tennis tournament for a singles championship. How many matches have to be played to determine the winner?

(i) 10 pairs of blue and 16 pairs of grey socks are kept in a drawer. If you reach the drawer in dark, how many socks must you take out of the drawer to be sure of getting a pair of socks of the same colour?

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(*Answers on page 848*)

Do it at home

Electronic mosquito repellant

IN this age of electronics, there is no need to use mosquito creams, mosquito coils and curtains to keep mosquitoes at bay. The ultrasonic mosquito repellent can be used for the purpose.

Depending on age and physiological condition, a human being's average range of audible frequencies lies between 20 and 20,000 cycles per second. Sounds of higher frequency than these will be too high to be audible to man. Such an inaudible sound is called 'ultrasonic'.

High frequency sounds, though of no use for human hearing, are found to have wonderful uses.

When mosquitoes are treated with ultrasonics, they are destroyed. But as the rate of destruction is logarithmic, for complete destruction ultrasonic sound is needed for a considerable time.

The device is basically a variable frequency UJT (unijunction transistor) relaxation oscillator. The net resistance (R_1+R_2) offered by the resistor and potentiometer determines the charging rate of the capacitor and therefore the frequency of oscillation.

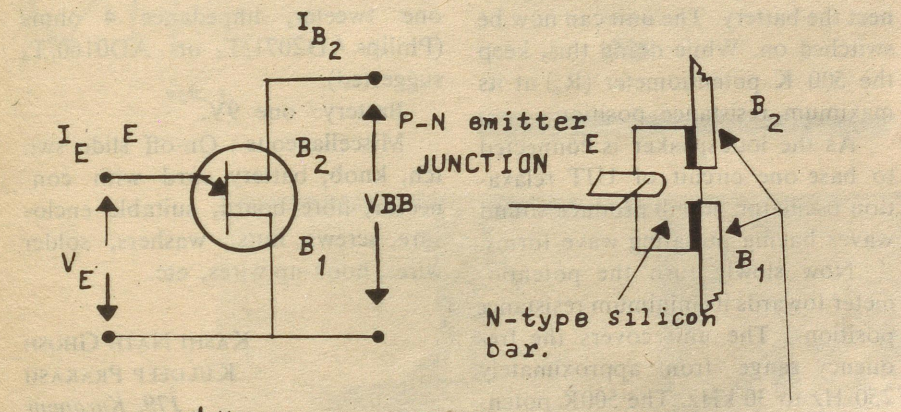

Fig. 1.

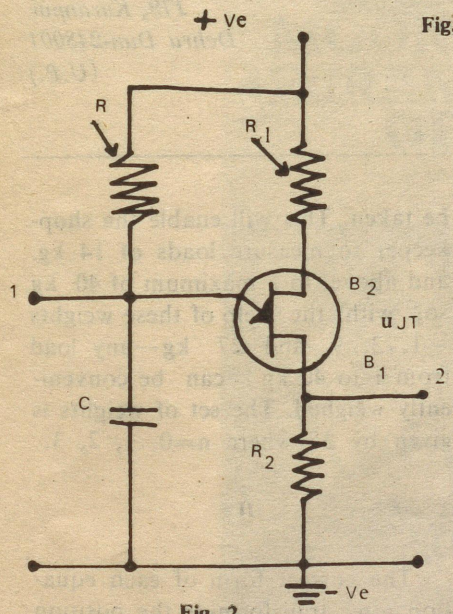

Fig. 2.

The approximate frequency of oscillations F is equal to 1/RC Hertz (cycles per second), where F=frequency in Hz, R=resistance in ohms, and C=capacitance in farads. From this formula it is apparent that the larger the value of R, the lower will be the frequency of oscillations, and vice versa.

FORMULA

The heart of the ultrasonic mosquito repellent (Fig. 1) is a unijunction transistor. The unijunction transistor is a three terminal semiconductor device which has electrical characteristics quite different from those of the conventional two junction transistors. Its most important feature is its highly stable negative resistance characteristic. Two ohmic contacts, called base one (B_1) and base two (B_2) are made at opposite ends but on the same side of a small bar of n-type silicon. A rectifying contact, called the emitter (E), is made on the opposite side of the bar close to base two. An interbase resistance, RBB, between 5K and 10K, exists between base one and base two. In normal circuit operation, base one is grounded and a positive bias voltage VBB is applied at base two. With no emitter current flowing, the silicon bar acts like a simple voltage divider and a certain faction n of VBB will appear at the emitter. If the emitter voltage VE

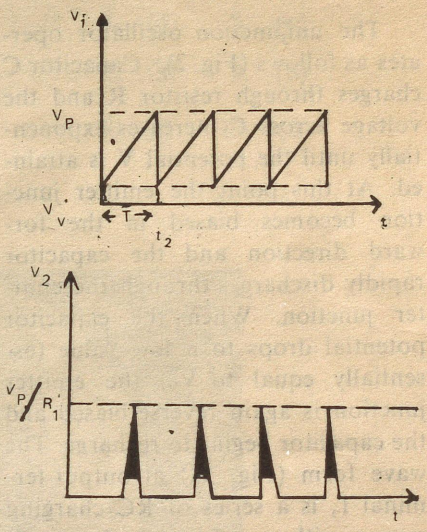

Fig. 3(a) Top; 3(b) bottom

is less than nVBB, the emitter will be reverse biased and only a small emitter leakage current will flow. If VE becomes greater than nVBB, the emitter will be forward biased and emitter current will flow. The emitter current consists primarily of holes injected into the silicon bar. These holes move down the bar from the emitter to base one and result is an equal increase in the number of electrons in the emitter to base one region. The net result is a decrease in the resistance between the emitter and the base one, so that as the emitter current increases, the emitter voltage decreases and negative resistance characteristic is obtained.

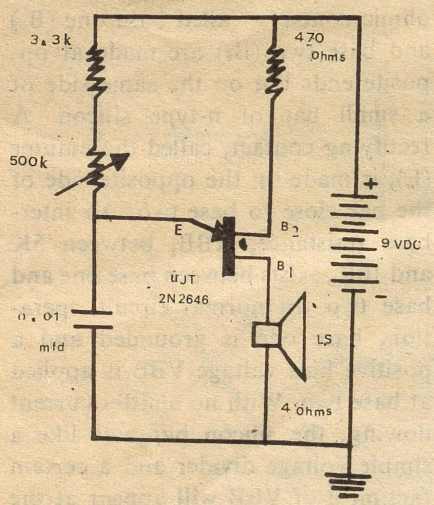

Fig. 4. Ultrasonic mosquito repellant

The unijunction oscillator operates as follows (Fig. 2): Capacitor C charges through resistor R and the voltage across C increases exponentially until the potential V is attained. At this point the emitter junction becomes biased in the forward direction and the capacitor rapidly discharges through the emitter junction. When the capacitor potential drops to a low value (essentially equal to V_v) the emitter junction is again reverse-biased and the capacitor begins to recharge. The wave form (Fig. 3a) at output terminal 1, is a series of RC charging curves with a peak-to-peak amplitude equal to $Vp—V_v$. Note that following every charging period the circuit "relaxes" back to the starting point. This is the origin of the terminology for this type of oscillator. The output wave form at terminal 2 is a series of sharp positive pulses (Fig. 3b).

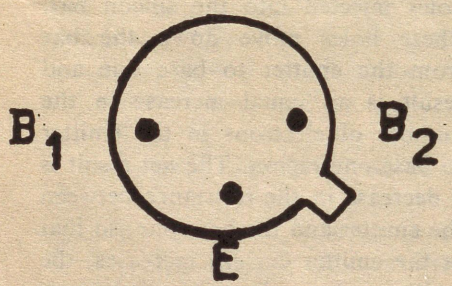

Fig. 5. Bottom view

Construction tips

The construction does not need much time or effort. First make a mini-box. Take a fibre board piece and drill holes in it with a 0.2 cm drill bit. The components (Fig. 4) should be mounted on the fibre board piece and all the connections should be soldered as short as possible. A series of small holes should be drilled in the enclosure for the loudspeaker. The potentiometer should be mounted directly on the enclosure.

Operation

After the construction of the unit, check thoroughly the circuit and connect the battery. The unit can now be switched on. While doing this, keep the 500 K potentiometer (R_2) at its maximum resistance position.

As the loudspeaker is connected to base one circuit of UJT relaxation oscillator, it will produce sound waves having pulsating wave forms.

Now slowly turn the potentiometer towards its minimum resistance position. The unit covers the frequency range from approximately 250 Hz to 30 kHz. The 500K potentiometer provides continuous adjustment of the frequency within the range. So, if the frequency of oscillation is increased by turning the potentiometer towards its minimum resistance position, there will be a change in pitch which becomes increasingly shrill. Beyond a certain point, the frequency of oscillation crosses the audible range and reaches the ultrasonic. Now no sound will be heard, but mosquitoes will however be able to hear the ultrasonic sound and react to it strongly.

You will need

One semiconductor : 2N2646 (UJT); Capacitor (C) one 0.01 mfd polyester or ceramic; Resistors: one 470 ohms-1/2 watt, one 3.3K ohms-1/2 watt; Potentiometer: one 500K ohms carbon linear; Loudspeaker: one tweeter, impedance 4 ohms (Philips AD2071/T_4 or AD0160/T_4 suggested).

Battery: one 9V.

Miscellaneous : On-off slide switch, knob, battery cord with connector, fibre board, suitable enclosure, screws, nuts, washers, solder wires, hook-up wires, etc.

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Solutions

to Quickies

I

The shopkeeper has essentially to start with a weight of 1 kg. To measure 2 kg, it is most economical to add a 3 kg weight, for he can then get 2 kg. by subtraction as well as measure 3 kg and 4 kg To measure 5 kg. and above, a 9kg weight can be added. This, by proper subtraction and addition of weights, will facilitate weighing upto 13 kg. Next, a 27 kg weight can be taken. This will enable the shopkeeper to measure loads of 14 kg. and above, to a maximum of 40 kg so, with the help of these weights —1, 3, 9, and 27 kg—any load from 1 to 40 kg can be conveniently weighed. The set of weights is given by 3^n where n=0, 1, 2, 3.

II

The correct form of each equation after transforming the position of one match is illustrated in Fig. 2. Here, in the second equation, Roman

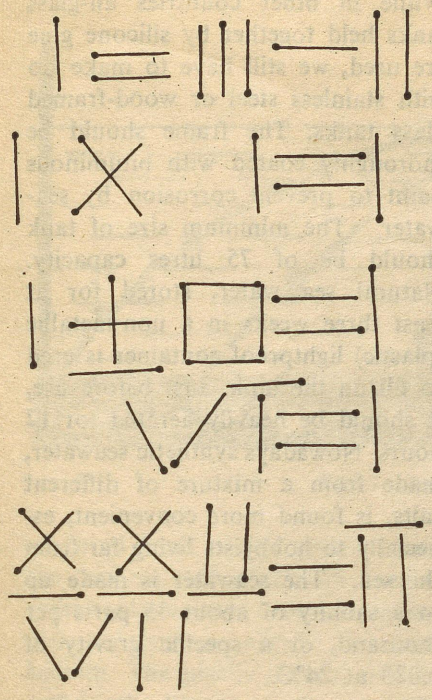


FIG. 2

10 is converted into a multiplication sign. In the third equation, the added match makes the mathematical sign read "plus or minus" while in the fourth equation the match moved is used to transform the Roman 5 into the radical sign. In the last equation, the extra match changes Roman 2 into the familiar Greek symbol π with value of 22/7.

(a) 3 kg

(b) 6.25

(c) 142, 857

(d) Six

(e) Each fraction can be reduced to its simplest form merely by cancelling the number which is common to both numerator and denominator.

(f) 94+1578

263

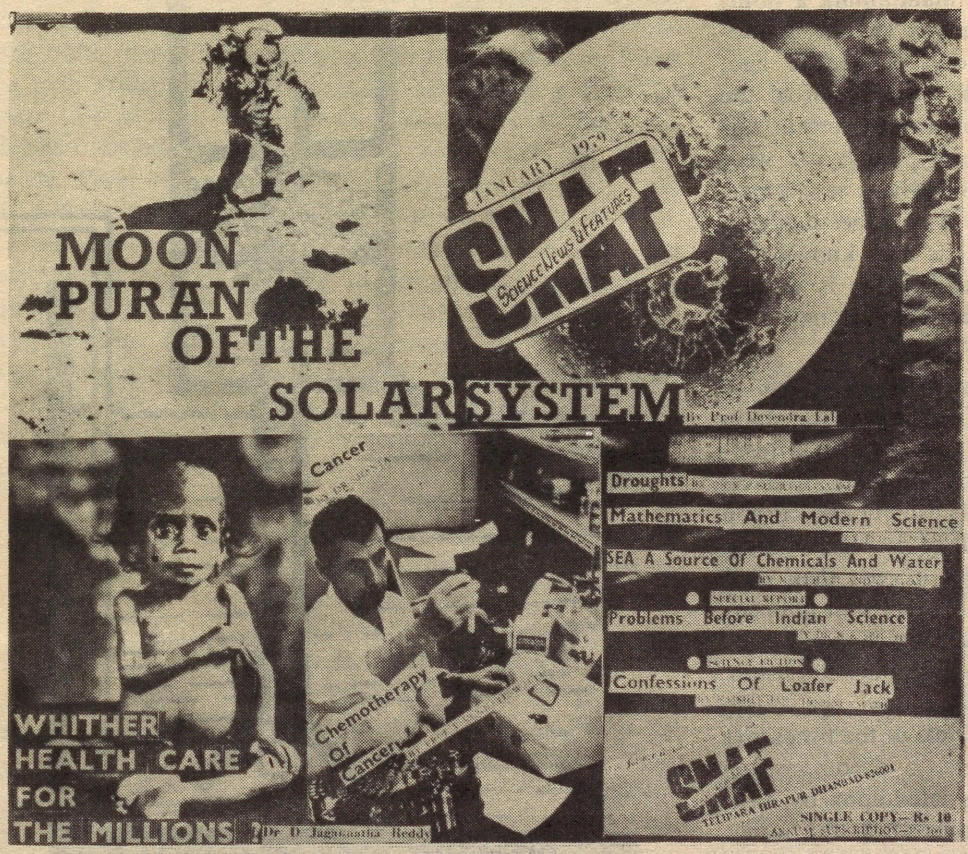
(g) A decimal point

(h) 77 of the entrants are to be eliminated. So, 77 matches are required.

(i) It is enough to take three socks, for two of them will always be of the same colour.

Solution to Science quiz

1.	(c)	6.	(b)
2.	(c)	7.	(d)
3.	(d)	8.	(c)
4.	(a)	9.	(b)
5.	(c)	10.	(d)





FOR HER

An aquarium for your drawing room

IT is generally thought, even by experienced people who have kept freshwater fish as pets at home for years, that maintaining a home marine aquarium is next to impossible. Albeit, only a decade ago, when much less was known of the factors necessary for success in this field of the hobby, hobbyists were at their wit's end when, say, a perfectly healthy set of fishes suddenly died at once. It is now known that while freshwater keeping is an art, marine aquarium maintenance is a science.

This difference is simply due to the inability of keeping seaweeds in a home marine aquarium. In a freshwater aquarium, the waste products of fishes, such as excreta and carbon dioxide, are utilised by plants which, in turn, give out oxygen then used by the fish. Let us see what happens in a marine aquarium. Organic matter such as uneaten food, dead fishes, etc., decays; these and the waste (excretory) products of the fishes give rise to ammonia, a decomposition product. This is acted upon by nitrifying bacteria present in the water. The *Nitrosomonas* group of bacteria convert ammonia to nitrites (NO_2^-) which, in turn, are converted by *Nitrobacter* group to nitrates (NO^-_3). In the next step, nitrates are converted by denitrifying bacteria to nitrous oxide (N_2O) and nitrogen (N_2).

In a new aquarium, it takes time for all these different bacteria to get established. During the first week, therefore, the ammonium (NH^+_4) level rises sharply. On reaching a peak of about 6 parts per million (ppm) in a week, the *Nitrosomonas* take over, with the result that the ammonium level rapidly falls to 0.25 ppm. The nitrites increase in a fortnight to a peak of about 9 ppm and then their level decreases to 0.1 ppm, as *Nitrobacter* start proliferating. The nitrate level builds up more gradually and levels out in a month at approximately 20 ppm.

To start a marine aquarium, the first requisite is to have a tank. While in other countries all-glass tanks held together by silicone glue are used, we still have to make do with stainless steel or wood-framed glass tanks. The frame should be thoroughly coated with bituminous paint to prevent corrosion by seawater. The minimum size of tank should be of 75 litres capacity. Natural sea water, stored for at least three weeks in a non-metallic (plastic) lightproof container is used to fill up the tank. Just before use, it should be heavily aerated for 12 hours. Nowadays synthetic seawater, made from a mixture of different salts, is found more convenient, especially to hobbyists living far from the sea. The seawater is made up to a salinity of about 35 parts per thousand, or a specific gravity of 1.023 at 24°C.

After the tank is filled up with seawater, an under-gravel filter is placed on the bottom. This can be

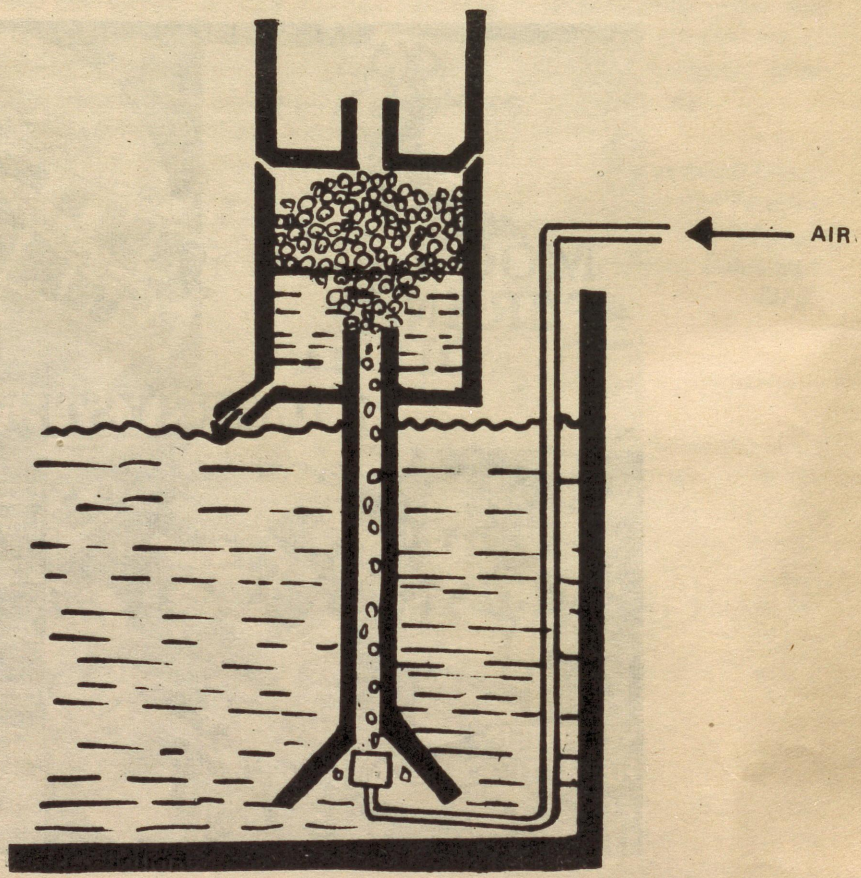


Fig. 1. Protein skimmer

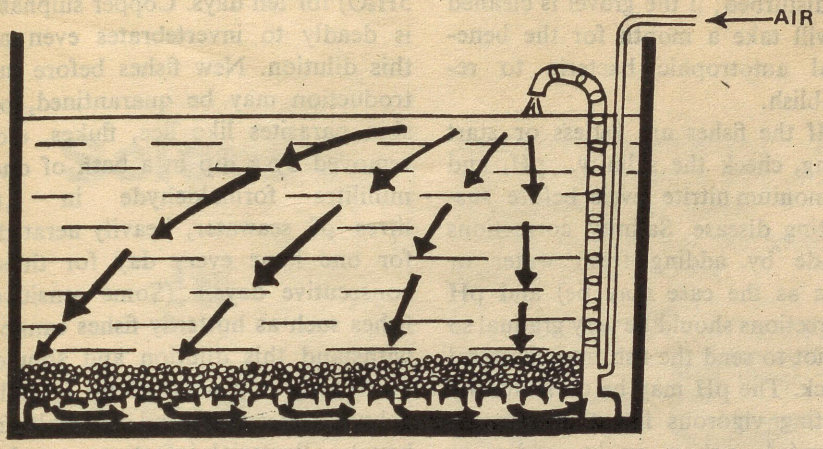


Fig. 2. Biological filteration

prepared from a stiff plastic sheet, the two ends of which are bent at right angles so that it remains about two centimetres above the tank bottom. The plastic plate should be sufficiently big to cover the tank bottom; to prevent sagging, a plastic "leg" may be fixed on the middle of the lower side. Slots or holes are cut into the plastic sheet and a $1\frac{1}{4}$ centimeter stiff plastic tube fixed by epoxy glue into a hole drilled in a corner of the plate. To a hole 3 millimetre in diameter drilled two centimetres above the lower end of the tube is stuck a flexible plastic tube leading to a vibrator-type air pump. Over the plate is laid the filter bed— a five centimetre thick layer of dolomite gravel, crushed oyster shell (available as poultry grit), oolite or limestone of 2 to 5 millimetre particle size. The first ($CaMgCO_3$) is the best of the three as it contains calcium as well as magnesium carbonates, whereas limestone contains only calcium carbonate. The gravel should be calcareous as it keeps the pH of the water upto 8.3. A layer of five centimetres depth is essential to act as a substratum for bacteria to settle on.

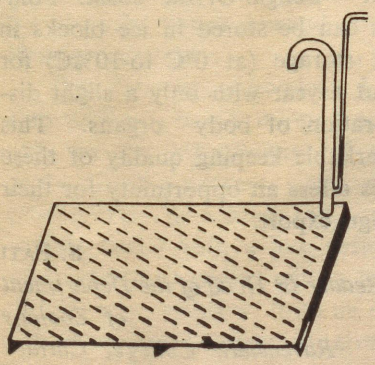


Fig. 3. An under-gravel filter

When air is pumped in, it rises from the bottom of the larger tube (called an airlift) and lifts up water from below the plastic plate. This water is thrown back into the aquarium at the top open end. Water from the aquarium passes down through the gravel layer to the tank bottom, thus aerating the gravel. To condition the gravel, i.e., to have a luxuriant growth of the desirable kinds of bacteria, the gravel may be seeded by adding gravel from an established marine tank. Or else, a few inexpensive hardy fishes such as groupers (*Epinephalus*) which are tolerant of fairly high ammonia levels, may be kept in the aquarium for a fortnight, and then replaced by the more delicate exhibits. The best way is to start by keeping only one fish, gradually adding one or two more fish every week. This gives the filter bed ample time to adjust to each new increase in ammonia level. Of course the bacteria in an aquarium can cope up with a certain maximum load of fishes, beyond which the ammonia level will rise and give rise to wholesale mortality.

An adjunct to the system logical filtration (using bacte the use of an under-gravel fi chemical filtration. This is the r val of dissolved organic waste terial. Activated carbon (charcoal) is one of the best adsor ing agents, as it can adsorb 55% of its own weight of these toxic materials as they are produced and before they can accumulate in the water leading to a chemical oxygen demand. Activated carbon also adsorbs carbon dioxide, and thus prevents the lowering of pH, although here it is also aided by the buffering action of the gravel. It also catalyzes a shift of harmful free (dissolved) chlorine to harmless chloride, removes copper and coloured dyes. An increase in the amount of dissolved organic matter gives rise to a yellow coloration of the seawater. As activated carbon removes this colour, it can be made out when the carbon has been "spent"; as soon as the water turns yellow, the activated carbon needs to be replaced. Normally, half of the quantity of carbon should be replaced every fortnight. The activated carbon is laid as one of the layers in an outside filter.

Large protein molecules and other surface-active degradation products are removed by air-stripping (protein skimming). Here air is injected into a vertical column of water. Due to agitation of the water, foam is formed which is collected in a dry chamber above the water level. Surface-active agents, because of their electric polarity, are attracted to the surfaces of the air bubbles and held there by a static electric charge on the bubble. The foam is removed from time to time. When an air-stripper is used together with activated carbon, foam will not be produced until the surface-active agents build up to a level over one ppm (the minimum level for foam formation to occur).

Mechanical filtration is achi-

by the use of an outside box with an airlift device and a siphon. The filter bed may be gravel, nylon (not glass) wool if preferred, activated carbon. Once a tank has been set up, ly routine maintenance is required. ll uneaten food and dead animals should, of course, be removed daily. Evaporated water should be replaced only with tap water and not with salt water (during evaporation only fresh water goes away as water vapour and the salts remain behind). About 10% of water should be removed every week and replaced by new salt water. This lowers the nitrate level and replenishes trace elements. Algae may be scraped off the front glass but should be allowed to grow on the back and side glasses and on the stone and coral decorations in the tank; algae help to "clean" the water by converting nitrates and also serve as food for many fishes and invertebrates. The outside filter should be cleaned once a fortnight and activated carbon replaced if necessary. The under-gravel filter should not, however, be disturbed; if the gravel is cleaned it will take a month for the beneficial autotrophic bacteria to re-establish.

If the fishes are listless or start dying, check the salinity, pH, and ammonium nitrite levels before suspecting disease. Salinity corrections (made by adding fresh water or salts as the case may be) and pH corrections should be very gradual so as not to send the fish into chemical shock. The pH may be corrected by starting vigorous filtration through activated carbon or by adding a solution of one pinch of soda bicarb in a tumbler of water drop by drop into the aquarium. Fishes suffering from disease should not be treated in the display tank as most of the remedies used kill the beneficial bacteria and algae. The commonest infections are due to the dino-flagellate *Oodinium* or the ciliate *Cryptocaryon* (saltwater Ich or white-spot). Both can be eradicated by using 0.4 ppm copper sulphate solution (*i.e.*, 0.1 ppm of Cu ion, made by adding on drop per 3.8 litres of a 4% solution of $CuSO_4$, $5H_2O$) for ten days. Copper sulphate is deadly to invertebrates even at this dilution. New fishes before introduction may be quarantined, or skin parasites like lice, flukes, etc. removed by a dip in a bath of one millilitre formaldehyde in 3.8 litres of seawater, heavily aerated, for one hour every day for three consecutive days. (Some sensitive fishes such as butterfly fishes cannot withstand this dilution and should be treated only with 0.5 ml formaldehyde instead of 1 ml, for half an hour). Bacterial infections can be cured by adding two drops of a 0.75% solution of malachite green in 3.8 litres of seawater, or by using a broad-spectrum antibiotic such as tetracycline or ampicillin. Superficial wounds and skin injuries may be swabbed with mercurochrome solution.

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SCIENCE SPECTRUM (*Continued from page 837*)

ploitation of a fish stock. As a rule, silver pomfrets remain near sea surface in night and sink to bottom in day in search of their favourite food, copepods, which also exhibit a similar diurnal vertical migration. The silver pomfret is vulnerable to capture by trawl-nets during day, whereas drift gill-nets are effective for its catch in night. In winter these fishes migrate to the deep seas. Therefore, deeper waters are the place to look for pomfret-fishing in colder months. With the approach of spring, they migrate towards their spawning ground in the north where a rich crop of copepods develops during South-West monsoon.

Resources

The annual production of marine fish from the seas around India exceeds one million tons. Pomfrets contribute about 2.5% to 3.0% of the total catch. The conventional gears used for the capture of these fishes vary from place to place. The most common gears are shore seines, boat seines, purse seines, gillnets and bottom trawls. The estimated landing of pomfrets from our seas for the year 1976 was 38,000 tons, of which Maharashtra alone landed 18,000 tons, and Orissa harvested 10,700 tons. Investigations have indicated the existence of a vast unexploited resource of pomfrets along the West Bengal-Orissa coast. Pomfrets can be stored in ice blocks in cold storage (at 0°C to 10%C) for about a year with only a slight discoloration of body organs. This remarkable keeping quality of these fishes offers an opportunity for their foreign export.

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Science in Industry

Silver paste for mica capacitor electrodes

SILVER paste is used in the production of mica capacitor electrodes. Mica capacitors are being produced in the country for use both in entertainment equipment such as radio and television receivers and amplifiers and professional equipment such as communication systems. The electrode material in the form of paste facilitates the application of screen-printing techniques which are being employed presently by capacitor manufacturers. The glass in the paste forms a matrix for conducting metal particles and this facilitates firm binding with mica substrate. The demand for the product in the country is not known precisely. These pastes are not being manufactured in the country and the entire demand is met through imports.

The National Chemical Laboratory, Pune, has developed a process for the manufacture of silver paste. In this process, silver, precipitated from its soluble salt, is intimately mixed with a low softening glass and is processed with a highly viscous mass prepared from an organic filler and solvents to give the paste. It is paint-like in consistency. The yields are quantitative. The laboratory investigations have been carried out on a scale of 1 kg of silver paste per batch.

The product has the specifications as given in Table 1.

Table 1

Drying time	10-15 min. at 150°C
Firing temp.	600°C (peak)
Time at peak temp.	6 min.
Conductivity	0.02-0.06 ohms/sq cm
Rheology	Thixotropic
Thinner	Butyl cellosolve
Adhesion	Good on mica

Tested by a firm in Bihar, the product was found suitable for screen-printing.

The raw materials required for the manufacture of silver paste are silver nitrate, acetone, sodium hydroxide, an organic filler, a reducing agent, glass, and a pine oil component. All these chemicals are of CP grade and are indigenously available.

Stainless steel vessel jacketed 60-litre glass beakers, a plastic vessel, a porcelain Buchner funnel, porcelain ball mills (3 to 5), a drying oven, and a paint mill are the major items of plant and equipment. All these are available indigenously.

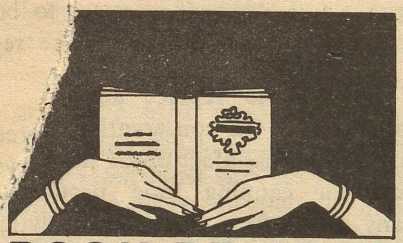
According to the laboratory, the minimum economic capacity of a plant would be 1 tonne/annum. The total capital outlay for a plant of this size has been estimated at Rs. 6.27 lakhs (Rs. 1.10 lakh for land, building, and plant and equipment; and Rs. 5.17 lakh as working capital). The cost of production comes to about Rs. 1670/kg as against the present market price of about Rs. 2000/kg.

Differential tinplate for canning food products

THE electrolytic tinplate was developed during the Second World War to replace hot-dip tinplate as a tin conservation measure in the manufacture of the cans used for canning food products. Cans made from these electrolytic tinplates carried the same thickness of tin on the inner and the outer sides of the container. Later, 'differential tinplates', i.e., electrolytic tinplates having different thicknesses of tin coating on the inner and the outer sides, were developed and these found wide use in the developed countries. Presently, in India, an electrolytic tinplate with a tin coating of 1 lb per base box (one base box 112 sheets of 50 cm × 35 cm) equally coated on both sides is being used for canning food products. If the differential tinplate with reduced thickness of tin coating on the external surface of the can is introduced in the canning industry, it would be possible to save about Rs. 25 lakh in foreign exchange annually.

Experiments undertaken at the Central Food Technological Research Institute, Mysore, to find the optimum thickness of tin coating required on the external surface under Indian atmospheric conditions indicated that cans fabricated from the electrolytic tinplate with a tin coating of 0.25 lb per base box were not suitable under humid conditions like those in Bombay. However, cans with a tin coating of 0.5 lb per base box with lacquer or lithograph, and plain cans with a tin coating of 1 lb per base box showed satisfactory results.

At present differential tinplates are being imported from other countries. In India, facilities for the manufacture of differential tin plates are available at the Rourkela Steel Plant.



BOOK REVIEWS

PLANT AND PLANET *by* A. Huxley, *Penguins* (Available at *Penguin Overseas Ltd.*, 706 Eros Apt, 56, Nehru Place, New Delhi-110024), Second Ed., 1978, Pp. 464, £1.25.

PLANTS are the prime source of food, clothing, shelter and oxygen. Not only are they the first to appear on this planet but they also exhibit tremendous diversity both in form and habitat. Their exploitation by man, rather extravagantly and injudiciously, endangers both the very existence of plants as well as life in general on this planet. It is in this background that the author of the book under review has tried to educate the masses about group of living beings. Author's main aim while writing this book has been to awaken interest, create wonder and stimulate interest about the plants, which are taken too much for granted. He is more than successful in his attempt.

In thirty chapters, each provided with a lovely and apt heading, good quotations and phrases, author has narrated, discussed and projected the subject in a simple and lucid manner. Elementary details of almost every aspect of plant life, viz, origin, evolution, form and structure, structure and function, reproduction, social behaviour, etc., have been provided. The author has emphasized and tried to convey that plants display sophisticated techniques of aerodynamics, hydrodynamics, structural engineering, insulation, plumbing and internal communication system, some of which even man has not yet mastered.

The chapters entitled, "Nature the Engineer," "Do Plants Feel", "Society" are extremely interesting. A variety of classical and the so-called abnormal examples are provided in the chapter, "Eccentric and Bizarre." It includes among others the most bizarre, the most wonderful as well the ugliest of the plants, the *Welwetschia bianesii* (also known as a giant turnip or the octopus of desert).

The chapter, "An Incestuous Relationship" deals with plants and the mother earth. It emphasizes how the people, so concerned with preservation of rare animals and birds, do not realize that these creatures, including the man, can only be preserved if their environment, which is basically plants, remains unaltered. In the chapter, "Man the Manipulator" how man has modified, altered, destroyed, or improved the existing plants and environment for his own benefit is discussed. On the other hand, in the chapter, "War of the World" the author tells how the nature, the plants, the insects, etc. strike back and dominate man and his intelligence. The last chapter is an eye-opener about the "Things to come."

On the minus side one feels that the book should have been illustrated. The restriction of Latin names of plants to the index only irritates the reader when he has to refer it every now and then while reading. Inclusion of a chapter on "Biochemistry of Plants" and "Molecular Biology" would not have been out of place. In fact, the chapters would have helped to stress how little plants differ from animals.

The price of the book is, however, on the higher side.

A. K. KAVATHEKAR JR.

THE GENETIC CODE *by* Brian F.C. Clark, *Edward Arnold* 25 Hill Street, London WIX8LL, U.K. (1977) Pp. 74 £ 1.74.

THE genetic code remains at the very foundations of molecular biology and genetics and ever since Hargobind Khorana's breath-taking exercise in synthesis of individual 64 codons, the subject has been gaining momentum. This small and handy book on the subject by Professor Clark is an excellent summary drawn from an exceedingly vast subject. Dr. Clarke, who has been closely associated with the Nobel Laureate Marshell Nirenberg, and is an authority on genetic code, has presented the matter in an interesting way giving the main events in individual experiments. The book contains four chapters including "Cellular Macromolecules, Elucidation of the Genetic Code, Components of Protein Biosynthesis and Punctuation." The chapter on "Elucidation of the Genetic Code" forms the core of the book. It emphasizes the use of synthetic polyribonucleotides and triplet binding assay. Besides, there is comprehensive information on the collinearity, polarity of reading the genetic message and accuracy in translation of the genetic code.

In the opening chapter on macromolecule the major discoveries preceding the genetic code have been well summarised in a table and reader gets a complete picture of the history and major workers in the area. The book offers latest information on the macromolecular components and protein synthesis. Tertiary structure of transfer RNA has been discussed particularly in relation to the decoding mechanisms. An appreciable feature of the book is the information on methodology and brief experimental procedure pertaining to the discoveries.

The book is primarily useful to the post-graduate curriculum in universities.

KESHAV TREHAN

COLLOID AND SURFACE SCIENCE, Ed. E. Wolfram, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, U.K., Pp. 387-494, $ 22.00.

IN recent years there has been a growing tendency to publish proceedings of short courses, symposia, conferences, etc., in book form. This practice can be justified only if the information offered is new, or is not readily available elsewhere. On the basis of this criterion, publishing of papers presented at the International Conference on Colloid and Surface Science held in Budapest, Hungary, 15-20 September 1975, in the form of this book is justified.

The present volume contains fourteen articles and all authors are well-known scientists in the field of colloid and surface science. Kinetics, thermodynamics, coagulation, aerosols, liquid crystals, adsorption and adhesion of various materials and other aspects of colloidal systems are discussed in this volume. In the first paper B. V. Derjaguin discussed the role of interparticular attraction forces in the stability of colloidal systems. G. Schay and R. J. Good dealt with the thermodynamics of adsorption. Some interesting photographs accompany the article. G. D. Parfitt reviewed the application of I. R. Spectroscopy and electrochemical techniques in the chemical characterisation of oxide surfaces because these techniques help in the manufacture and application of oxide powders. He has made a special note of alumina, silica and titania, the important oxides used in pigment and catalyst industry. In one of the papers an explanation for the colloid stability in mixed solvents has been given. Stability and instability of aerosols has also been attempted. Some of the papers deal with the conformation and interaction of polymers at interfaces.

Each contribution is authoritative and can be read and understood by both laymen and scientists alike. Most of the topics are discussed in much detail, which illustrates the author's extensive knowledge and mastery of the subject. Each chapter is provided with an impressive list of additional references useful for research workers.

However, the publication suffers from one serious defect in that the discussion (following the presentation of the various papers) by scientists who attended the conference has not been included. Such discussions usually reveal the response of other scientists to new information, as well as highlight other aspects and implications of the papers.

P. BAHADUR
ASHOK K. GOSWAMI

CARBOHYDRATE CHEMISTRY-8 (Kyoto, 1976) Ed. K. Onodera, *Pergamon Press*. Headington Hill Hall, Oxford OX 30 BW, England $ 27.

THIS publication brings in one volume the eleven plenary lectures presented at the Eighth International Symposium on Carbohydrate Chemistry at Kyoto, Japan, 16-20 August, 1976. These lectures also appeared in *Pure and Applied Chemistry*, Vol. 49, No. 8, Pp. 1069-1240.

Except for the paper by Prof. I. G. Goldstein *et al* on "Lectins as carbohydrate binding proteins" all the other papers are directly concerned with carbohydrates or compounds with carbohydrate components. Molecular architecture and structural studies account for four of the papers. Prof. B. Lindberg uses biosynthetic methods as an aid in his structural studies of bacte polysaccharides which also exem some new methods in structural saccharide chemistry. The t of Prof. L. Szabo's paper is work regarding the structure of endotoxin of *Bordetella pertusis*, th bacteria causing whooping cough, which has indicated that the two polysaccharides are bound to the lipidic region of the endotoxin and it has a structure distinct from that proposed for the lipopolysaccharides of *Enterobacteria*. The paper by Prof. Atkins reviews briefly the various polyuronides and the conformations derived from X-ray diffraction studies. Bruce Cascon reviews some 15 N labelled amino sugars in his paper 'Synthesis and n.m.r. spectroscopy."

Two papers discuss the closely related field of analytical and investigative chemistry. Prof. G.O. Aspinall reviews methods for selective degradation of polysaccharides and glucoproteins, the emphasis being on sugar sequences and nature of linkages undergoing modification. Prof. S. I. Hakomon *et al* describe the separation of four sets of glycolipid variants of human A and O erythrocites, determination of their structures, the status of these blood group carbohydrate chains and their changes during onto-and oncogenesis.

Three papers are devoted to chemical manipulation of carbohydrates for obtaining newer products of interest. Prof. L. Hough and A.C. Richardson deal with the stereoselective chemical manipulation of readily available disaccharides with a view to their economic conversion into compounds having desired chemical and biological activity. Amongst the compounds mentioned is a tetrachloride derivative of sucrose with an intensely sweet taste comparable to saccharine but with a pleasant aftertaste. In his paper, Prof. H. Paulsen starts wi h

opments in the preparation of hed chain monosaccharides, n to the oligosaccharide syn- of ∝-glycosdically linked bran- chain sugars and concludes an extended discussion on the hesis of ∝- glycosides in amino gar oligosaccharides. Prof. S. anessian describes the development of a synthetic route to carbohydrate-derived intermediates which constitute fully chiral and functionalised segments of Erythronolide A, the aglycon portion of Erythromycin A. The paper by Prof. R. L. Whistler maps the future fields of research by identifying areas where extensive research is expected to occur, such as applications of new organic reactions, production of nucleosides and new antibiotic and antitumour agents, the organization of polysaccharides, glycorproteins and proteo glycans in cell walls, and production o new polysaccharide structures to serve specific applications.

This volume is o. value ot those interested in carbohydrates and particularly in their antibiotic, antitumour and other biomedical applications.

M. G. KRISHNA RAO

MATHEMATICAL CARNIVAL by Martin Gardner, *Penguin Books* (Available at *Penguin Overseas*, 706, Eros Apartments, 56 Nehru Place, New Delhi-110024), Pp. 274, 95 p.

HOW can mathematics be made stimulating, educative and enjoyable? The book under review illustrates this : Tell the background of mathematical discoveries and discoverers, givean account of other mat hematicians, resPonse, comment on them, sum up a discussion by posing a tricky problem to the reader. By only gancing throug such a material an intelligent layman could grasp most of the mathematlcal insights. Then top it all by presenting the intended problem in all its grandeur, with lively results. No one needs to be told that this is the manner in which that grandmaster of recreaticnal mathematics Martin Gardner handles his "material,, and thus keep the readers spell bourd. Our mathematicians and teachers should emulate his sytle and presentation to keep their students awake in classrooms and mkae their books thoroughly interesting.

The book is a Penguin edition of the one first published in 1965 and is, like the author's other books, a compilation of articles that appeared in *Scientific American* with some changes and addenda. It relates how much mathematics has pervaded the paintings of some artists like M.S. Escher and town planning designs like Piet Hein's Supepellipse. Interspersed are chapterson tricky physics problems, the art of mathematical prodigies and numerology, which are intended to remove, in the opinion of the reviewer, any monotony that might appear. The problems given in the book will doubtlessly keep a calculating mind busy for hours on end, though answers and hints to the problems are given for almost every problem.

The book would be of interest to an intelligent layman. But, then, he should also have a good grasp of the fundamentals of mathematics to appreciate the book in its true sense.

DILIP M SALWI

BOOKS RECEIVED

1. **INDIAN SCIENCE INDEX** 1976 Ed. by Satyaprakash *Indian Documentation Service* (2, Ansari Road, Daryaganj, New Delhi, 110002), Pp. 428, Rs. 150.

2. **HEAT AND THERMODYNAMICS** by D. S. Mathur, *Sultan Chand & Sons*, 4772/23, Daryaganj, New Delhi-110002, 647 Pp., Rs. 20.00.

3. **REPORT ON REGIONAL CONFERENCE ON DEVELOPMENT INTEGRATED CURRICULUM IN MATHEMATICS FOR DEVELOPING COUNTRIES OF ASIA,** *INSA*, (Bahadur Shah Zafar Marg, N. Delhi-110002), Pp. 208, Rs. 40.

4. **GENERAL RELATIVITY AND COSMOLOGY,** by J. V. Narlikar, *Macmillan Co. of India*, 2/10, Ansari Road, Daryaganj, New Delhi-110002, Pp. 279, Rs. 65.00

5. **THE EARTH'S CHANGING SURFACE,** by M. J. Bradshaw, A. J. Abbott, & A.P. Gelsthorpe, *Hodder and Stoughton*, (*B. I. Publication*, 359, Dr. D. N. Road, Bombay-400023), Pp. 336, Rs. 97.40.

6. **THE STUDY OF MAN** by E. J. Clegg, *Hodder and Stoughton B. I. Publication*, address as above), Pp. 330, Rs. 52.65.

7. **ORGANIC GEOCHEMISTRY** Ed. by Irving A. Breger, *Pergamon Press*, Headington Hill Hall, Oxford OX 3 OBW, England, Pp. 62, Annual subscription £ 60.

8. **IMPACT OF COMPUTERS ON EMPLOYMENT** by K. Prasad and P. Verma *Macmillan Co. of India Ltd.* (2/10, Ansari Road, Daryaganj, N. Delhi-110002), Pp. 184, Rs. 25.00.



Where the Pioneers have left

The key nature of alchemists role in laying the foundations of modern science, may be judged from only a partial list of basic scientific tools, associated with their names.

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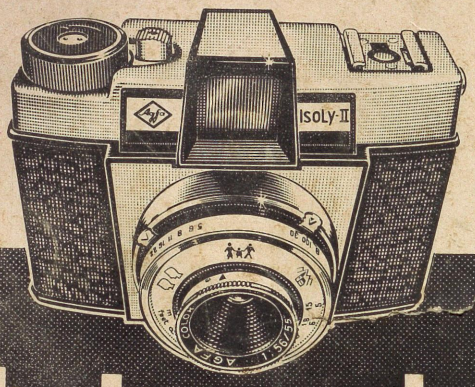

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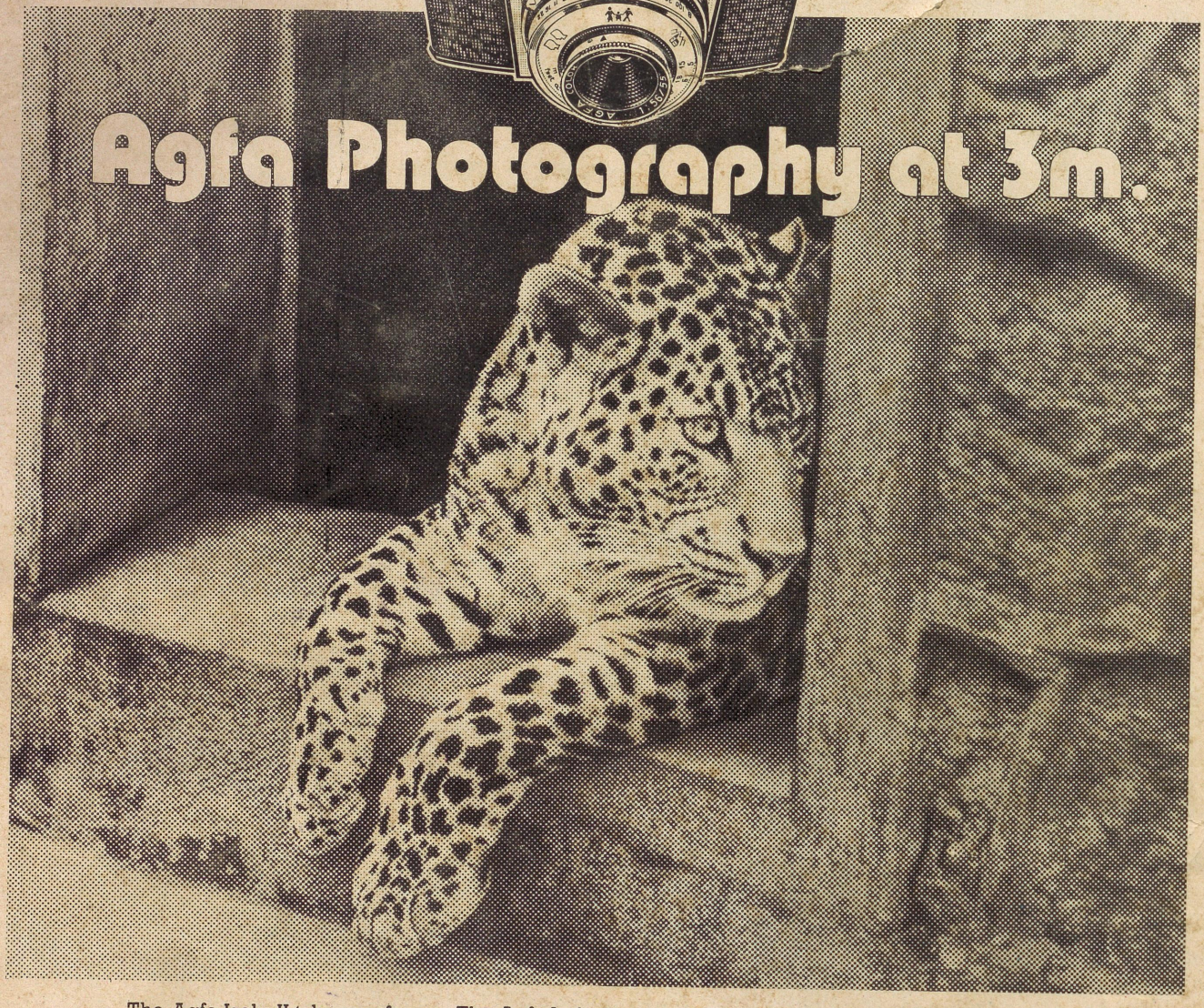

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