SCIENCE REPORTER

DECEMBER 1977

NAUTILUS - GEOMETRY IN NATURE

INTELLECTUAL MACHINE - IS IT FEASIBLE ?

WHY EARTHQUAKES ELUDE PREDICTION

THE ATMOSPHERE OF MARS

TISSUE CULTURE, BREAKTHROUGH IN PLANT PROPAGATION

THE MERMAID MYSTERY

Re. 1.00

COUNCIL OF SCIENTIFIC
& INDUSTRIAL RESEARCH
NEW DELHI-110001

MINISTRY OF HOME AFFAIRS

Department of Personnel and Administrative Reforms

Assignment of Indian Experts Abroad

The Department of Personnel and Administrative Reforms registers experts with educational qualifications of the graduate level and above desiring to take up assignments in the developing countries of Asia, Africa and Latin America, for a period of two to three years. Candidates who are so registered are sponsored as and when demands suiting their qualifications and experience are received from foreign governments.

2. Applications for registration are invited from :—

(1) Medical personnel holding at least the qualification of M.B.B.S. or equivalent.

(2) Engineering and other technical personnel holding at least bachelor's degree or equivalent.

(3) Teachers in different subjects holding B. Ed. or equivalent.

(4) College/University Lecturers and other academic personnel holding post-graduate qualifications.

(5) Chartered Accountants, Statisticians, Economists and others possessing qualifications equivalent at least to a bachelor's degree and experience of a specialised nature.

3. Persons with less than three years' professional experience after obtaining the requisite qualifications need not apply.

4. Experts wishing to be enrolled in the Foreign Assignment Panel may obtain the necessary forms from the Foreign Assignment Section, Department of Personnel and Administrative Reforms, New Delhi-110001, by sending a self-addressed, stamped (60 paise) envelope size 10×22 cms. Applications from persons employed by the Central or State Governments, Public Sector Undertakings and Quasi-Government Organisations should be supported by a certificate from the employer that the applicant will be released for service abroad on foreign service terms in public interest (i.e., retaining the applicant's lien and protecting his seniority) within thirty days of selection, if need be, and also stating the total period for which the applicant could be released for service abroad. This consent of the employer to the release of the expert shall be valid for a period of one year. Registration of candidates made prior to 1st September, 1974 is no longer valid and they may apply afresh.

5. Persons registered after 1st September, 1974 need not apply afresh until the expiry of three years from the date of registration, when their registration will lapse.

6. These registrations will be valid for a period of three years subject to annual renewal of the certificate described above in the case of employees of Governments of parastatal organisations, etc.

7. Persons who have attained the age of 60 years need not apply. Application of persons registered earlier will also not be considered after they attain the age of 60 years.

(davp 56(EN-25)/77)

ADVERTISEMENT TARIFF

FOR

SCIENCE REPORTER

ORDINARY POSITION

SIZE	CASUAL	CONTRACT SIX INSERTIONS	CONTRACT TWELVE INSERTIONS & ABOVE
FULL PAGE	Rs. 800.00	Rs. 4200.00	Rs. 8000.00
HALF PAGE	Rs. 450.00	Rs. 2550.00	Rs. 5000.00
QUARTER PAGE	Rs. 250.00	Rs. 1250.00	Rs. 2500.00

SPECIAL POSITION

SECOND, THIRD, BACK COVER PAGE OR PAGE FACING SECOND COVER PAGE

SIZE	CASUAL	CONTRACT SIX INSERTIONS	CONTRACT TWELVE INSERTIONS & ABOVE
FULL PAGE	Rs. 1000.00	Rs. 5500.00	Rs. 10,000.00

COLOUR : Rs. 250.00 for each additional colour.

MATERIAL : Mounted original Zinc Blocks and Layout.

TERMS

1. Matter is accepted upto 15th of each month for the next issue.
2. Additions and cancellations, if any, must reach on or before 20th.

to our contributors

- **SCIENCE REPORTER** welcomes articles of absorbing interest on science and technology. Contributions published in the Journal will be paid for.
- Articles should be sent to the Editor, **SCIENCE REPORTER, CSIR,** Rafi Marg, New Delhi-110001.
- The form and manner of presentation of the subject should be easily understandable to the undergraduate level.
- The length of the article, written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.
- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper.
- While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. **All weights and measures should be given in Metric Units.**
- A short note about the contributor should also accompany the article. The note should contain age, academic accomplishments, important assignments held, fields of research and hobbies.
- Articles or illustrations published in the Journal can be reproduced with permission of the Editor.
- The Editor reserves the right to reject even invited articles without assigning any reason.

SUBSCRIPTION FORM

To

The Editor
SCIENCE REPORTER
C.S.I.R., New Delhi–110001

Please enter/renew my subscription to SCIENCE REPORTER for one year. I am sending Rs. 10.00 by M.O/P.O. No. . . . . dated . . . . . marked payable to CHIEF (ADMN.), CSIR, NEW DELHI-110001.

Name _____

Full Address _____

(in capitals) _____

_____

PIN

(Old Subscription No. . . . .) Signature

NOTE: Please mention old Subscription No in M.O. coupon also.

SCIENCE REPORTER

VOL. 14 DECEMBER 1977 NO. 12

Cover : Shell of nautilus sawn to show the many chambers. There are about 35 chambers in an adult shell

Annual Subscription

Inland : Rs. 10.00

Foreign : $ 5.00

Editor : S.P. Ambasta Asstt. Editors : C.B. Sharma, Zaka Imam, Biman Basu

Editorial Staff : Dilip M. Salwi, Nisha Misra Sales & Advt. : G.N. Jaswal, G.E. Salpekar

Production : V.S. Chaturvedi, Suresh Kumar

New gel-filtration medium for macromolecules

Sir, We have been working on the development and utilisation of new products from guar seeds. Two successful, yet unconventional, uses of guar gum have been made (see *S.R.*, September 1977). Both these applications are based on the preparation of cross-linked, insoluble resins from guar gum. Such a resin, because of the presence of selective boron binding *cis*-glycol group in its molecule, has been used for separation, concentration and determination of boron in natural sources.

The other important application of the guar resin is as a gel filtration medium for macromolecules such as proteins, nucleic acids and polysaccharides. Gel filtration of macromolecules is based on the sieve action of the porous beads. The flow of the molecules which enter the pores of gel particles is retarded. The effectiveness of the gels is increased by introducing ionic groups. The results indicate that these resins behave just like Sephadex gels, and may prove cheap and indigenous substitutes for them. Currently Sephadex gels of different grades are available in India at Rs. 250 to Rs 450/100 g and their total import is worth a few lacs of rupees.

We have also synthesised ion-exchangers (similar to Sephadex ion-exchangers) based on guar resins. Persons working in the field of macromolecules may try these resins and compare them with the corresponding Sephadex products. 20 g-25 g samples of these resins can be obtained from us on request. We shall be glad to know the efficiency and limitations of the resins so that improvements can be made. The resins may also find application in immobilization of enzymes, and for making affinity chromatographic material.

Utilisation of guar gum protein for human food is also engaging our attention. Guar gum analysis for amino acids has indicated that the germ protein is a rich source of lysine, and the general amino acid composition of the protein is comparable to soyabean protein. We are working on the preparation of texturised protein food from guar gum and welcome any correspondence relating to this subject.

This work is being done under joint collaboration of the departments of chemistry and botany and the Centre for Desert Studies, University of Jodhpur, Jodhpur (Raj).

K. C. GUPTA
N. K. MATHUR
Department of Chemistry
University of Jodhpur
Jodhpur-342001

Extraterrestrial life

Sir, In the article **The search for extraterrestrial life** (*S.R.*, August 1977), the authors have laid stress on the biological analysis of soil samples for detection of life. In this connection, it may be mentioned that by intercepting radio signals from outer space also we can infer the existence of extraterrestrial life.

In 1960 a project called Ozma, for detection of extraterrestrial civilisation, was conducted in the U.S.A. The 27-metre radio telescope at National Radio Astronomy Observatory was focussed on the stars Tau Ceti and Epsilon Eridani. These stars are strong contenders for possessing planetary systems. However, no signals of an artificial character could be received. According to Prof. Carl Sagan of NASA, there are as many as one million advanced civilisations in the Galaxy. Such a contact is expected to help us to understand our place in the universe.

S. K. GURTU
Defence Science Laboratory
Metcalfe House
Delhi-54

X-rays

Sir, In **X-rays : Discovery and application** (*S.R.*, July 1977), the author says that "a high vacuum is created inside the tube so that the pressure is about $1/10^{-9}$ the atmospheric pressure. The cathode is electrically heated and when very high energy cathode rays (electrons) strike the anode at great velocities, the anode starts emitting X-rays."

In almost all text books of physics, it is mentioned that X-rays are produced when cathode rays fall on a metal plate called anti-cathode, and not on anode, as the author states.

Would you enlighten us on this apparent or real contradiction ?

S. S. DHAKTODE
10/129, D. N. Nagar II
Andheri West, Bombay-50

Essentially, X-rays are produced when fast electrons fall on any metal, whether it is an anode or not. The simple figure of an X-ray tube shown in the article is not wrong. However, to increase the life of the tube, the anode is often placed outside the path of electrons which are allowed to fall on an anti-cathode made of the metal to be investigated.

A. W. JOSHI
Deptt. of Physics
Meerut University
Meerut (U. P.)

Electron microscope

Sir, Thank you for the article **The electron microscope** (*S.R.*, May 1977). I would like to know the following:

1. What is the value of refractive index (N) of the medium in electron microscope?
2. What can be the maximum value of Sin α in the expression N Sin α?
3. What is the approximate cost of a modern electron microscope?

R. CHANDRA SHEKAR
B-77, Airport Colony
Madras-600027

1. Since the entire electron optical path in an electron microscope is under deep vacuum, the refractive index (N) would obviously be unity.
2. The Sine of an angle has values between zero and one, and therefore the maximum value of Sin α in the expression would be one. However, the objective lens of modern microscopes is designed in such a way that at the position of the specimen the value of Sin α is one.
3. A modern transmission electron microscope costs between Rs. 2 lakhs and Rs. 20 lakhs, depending upon the inherent capabilities of the model to provide specific information and its precision.

Table 1

Type	Cost range Rs.
Table models of low resolution, low performance (TEM) microscopes	..2-5 lakhs
Medium performance (TEM) microscopes	..5-10 lakhs
High resolution, high performance (TEM) research microscopes with special accessories	..10-20 lakhs

A. K. MOHARIR
Asstt. Physicist, Nuclear Res. Lab.
IARI, New Delhi

Man's evolution

Sir, I wish to add following observations to **And so cometh man** by B. K. Behura (*S.R.*, September 1977).

The fossil material belonging to the genus *Ramapithecus*, the only hominid known from the Sivalik Hills of Indian subcontinent, was discovered by G. E. Lewis from east of Haritalyangar village in Bilaspur District of Himachal Pradesh and not from near Chandigarh as reported (p. 555). The Sivalik Hills near Chandigarh and Haritalyangar are separated by the shortest aerial distance of about 65 km. The palaeoprimatological evidences suggest that *Dryopithecus*—a well-known Miocene primate—served as a common stalk for *Ramapithecus* on one hand and *Gigantopithecus* on the other. The discovery of a nearly complete mandible of latter genus (identified as a new species, i.e., *Gigantopithecus bilaspurensis* by Prof. S. R. K. Chopra, Head of the Anthropology Department, Panjab University) in 1968 from the Sivalik rocks exposed further east of *Ramapithecus* locality in Himachal Pradesh should have been taken into account by the author. For, this find is likely to throw new light on the earlier stages of differentiation of man-like primates and hominids.

Had mammalian evolution leading to the appearance of man been discussed by Dr. Behura in the light of palaeoecological changes witnessed by the earth during Mio-Pliocene Epoch, the article would have been more beneficial to the readers. The paleopalynological and geological investigations strongly suggest that the palaeogeographic set-up, climatic conditions, variety of foods available to the organisms, etc., are some of the significant factors which had a bearing on the trend of mammalian, including primate, evolution in the past.

I. J. SUNEJA
Lecturer
Department of Anthropology
Panjab University
Chandigarh-160014

Phytoalexins

Sir, It was interesting to go through the short account **What are phytoalexins?** (*S.R.*, July 1977). But any organic chemist would be disappointed at the chemical structures of the few phytoalexins mentioned.

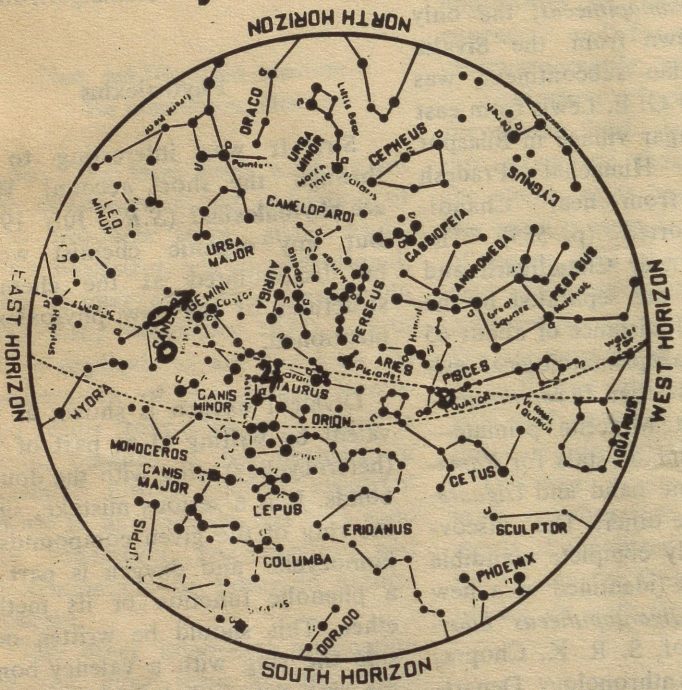
Divalent oxygen is shown as trivalent by writing O as part of the (heterocyclic?) ring with the double bonds. It is a serious mistake, since the ring of the given compounds is homocyclic and oxygen is part of a phenolic function or its methyl ether. This should be written outside the ring with a valency bond, the ring then will have the correct representation. Further, isocoumarin is wrongly represented without the double bonds. The side-chain of ipomeamarone is not correctly represented; one wonders if the long side-chain C has six valencies as shown. A reference to the *Proc. Royal Soc., London*, 1972, 181B, pp. 233-246 would be helpful.

I would like, for the benefit of *S. R.* readers, to refer to a new class of phytoalexins from grapevines, recently isolated and described as 'viniferins' which are stilbene derivatives and oligomeric.

S. SANKARA SUBRAMANIAN
Professor of Chemistry
Jawaharlal Institute of Postgraduate
Med. Edn. & Research
Pondicherry-605006

Planets and their positions

JANUARY 1978



PLANETS

♂ MARS

4 JUPITER

MAGNITUDES

1 0 ·1 ·2 ·3 ·4 ·5

MOON

☽ FIRST QUARTER 16TH

○ FULL MOON 24TH.

The Moon

New moon occurs on 9th at 9-30 a.m. and full moon on 24th at 1.26 p.m. I.S.T. The moon passes about two and a half degrees north of Mercury on 7th, about five degrees south of Jupiter on 21st, nine degrees south of Mars on 24th and five degrees south of Saturn on 26th.

The lunar crescent becomes first visible after the new moon day in the evening of 10th. The moon is at perigee or nearest to the earth on 8th and at apogee or farthest from it on 21st.

The earth is at perihelion or nearest to the Sun on 2nd.

The Planets

Mercury (Budha), a morning star, rises about one and a half hours before sunrise during the month. It is at the greatest western elongation of about 23 degrees from the Sun on 11th. It moves f m Scorpio (*Vrischika*) to Sagittarius (*Dhanus*). Its visual magnitude varies from +0.7 to —0.2.

Venus (Sukra) is too near the sun to be visible during the month. It is in superior conjunction with the sun on 22nd. It moves from Sagittarius (*Dhanus*) to Capricorn (*Makara*).

Mars (Mangala) rises at about sunset and sets at about sunrise. It is in opposition to the sun on 22nd. It is in Cancer (*Karkata*). Its visual magnitude is about —0.9.

Jupiter (Brihaspati) sets one and half hours before sunrise during the first half of the month and two and a half hours before it during the second half. It is in Gemini (*Mithuna*). Its visual magnitude is about —2.3.

Saturn (Sani) rises about three hours after sunset during the first half of the month and about two hours after it during the second half. It passes one degree north of the Star Regulus (*Magha*) on 20th. It is in Leo (*Simha*). Its visual magnitude is about +0.5.

(Source: Nautical Almanac Unit of the Meteorological Office, P-546, Block 'N' (1st floor), New Alipore, Calcutta-700053).

Night sky during January, 1978

The diagram shows the brighter stars as seen from Delhi at 9.00 p.m., 8.00 p.m. and 7.00 p.m., I.S.T. on the 1st, 16th and 31st January, 1978 respectively. The portion in the diagram bounded by the dotted lines represents the Milky Way. The moon's symbols show the phases of first quarter and full moon. The bounding circle of the diagram represents the horizon with the directions as indicated. To use the chart it should be held overhead with the centre of the circle pointing towards the zenith and the diagram turned in such a way that the North, South, East and West directions marked on the chart point to the correct directions.

2. The star chart meant for a particular day for a given hour can be used for the next day 4 minutes *earlier* and for the previous day 4 minutes *later*. For example, if a chart is meant for 8.00 p.m. for the 16th January it can be used on the 17th at 7-56 p.m. and on the 15th at 8.04 p.m. In the same way it can be used for other months: for the 16th December it is for 10.00 p.m., for the 16th November it is for 12-00 midnight and so on.

3. To find the position of a star at any hour on a particular day from the star chart meant for that day, one can proceed as follows :—

First locate the star in question in the chart and determine the hour for which the chart is meant for that day, and then find how long after the above hour is the time for which the position of the star is required. This time differences in hours multiplied by 15° will be the shift of the star to the West from its position shown in the chart; it will however be towards the east if the given time is earlier than the time of the star chart. For instance the position of a particular star at 12.00 midnight on the 16th will be (12-8.00) × 15° or +°60 to the West of the position of the star as given in the chart for the 16th meant for 8.00 p.m.

N. SUBRAMANIAN
M. S. VENUGOPAL

What are Earthquakes ?

EARTHQUAKE is perhaps the most insidious of the natural calamities that befall mankind. We cannot prevent it with a dam or by a powerful technology. The danger of an earthquake is enhanced manifold by fires, floods and landslides that follow in its wake. Statistics show that earthquakes take an average toll of 10,000 human lives a year (Table 1). In the recent earthquake of Tangshan city in China, about a million people are believed to have died. These figures could be considerably smaller if people could learn to predict earthquakes reliably. Unfortunately, it is difficult to predict earthquakes. Nobody, not even the cleverest of the scientists equipped with the most sophisticated hardware in experimental seismology, can tell when and where the next earthquake will occur.

As yet, there is no absolutely sure method of forecasting underground shocks. But we may look for an answer by comparing and analysing the diverse signs of the impending disaster. Understandably, the more such signs there are, the greater is the accuracy of the forecast. In this article, an attempt has been made to review the causes and prediction of earthquakes.

With better understanding of the causes of earthquakes, it is now possible to design safer quake-resistant buildings and even to predict when and where a quake would strike

Earth

For studying the causes of earthquakes it is necessary to study the structure of the earth. The probable structure is shown in Fig. 1. The crust is solid and varies in thickness; under continents it may be about 40 km thick, but under the great mountain ranges the thickness may be about 60 km, under deep oceans the thickness is as little as 5-8 km. 30 km may be taken as the average thickness of the crust. At the base of the crust is the boundary known as the Mohorovicic discontinuity, or briefly, the 'Moho'.

Below the crust is a layer of rock known as mantle; the whole of it seems to be in a plastic or semi-plastic state. The outer core is liquid and may well be a high-pressure variation of ultra-basic rock. The inner core is solid and consists of iron, with some nickel and other denser materials.

S/Shri Subramanian and Venugopal are research scholars in the Deptt. of Earthquake Engineering. at I. I. T., Madras

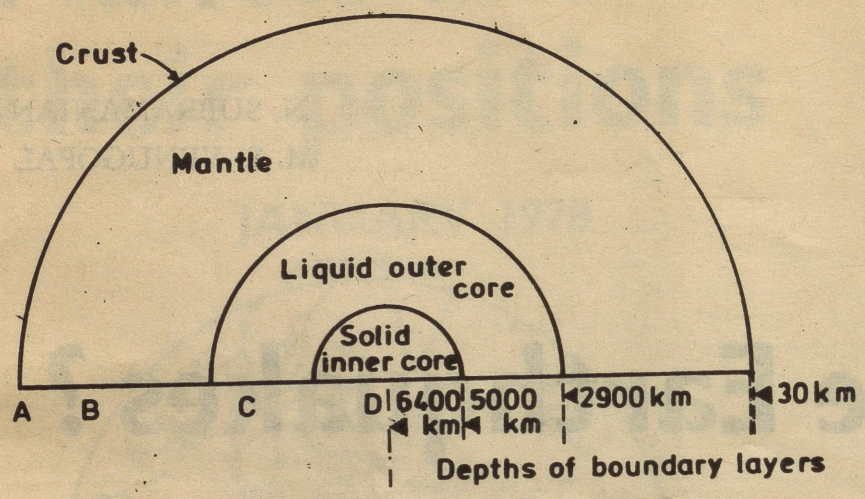


Fig. 1. Sketch of earth structure : (A) the crust, (B) various ultra-basic rocks, (C) liquid outer core, (D) the solid/metallic inner core

Causes of earthquakes

Earthquakes can be attributed to the following three main reasons:

1. Shrinkage of the earth's crust with cooling. This is not considered to be dominant;

2. Erosion and sedimentation. The estimated erosion of earth's surface is 100 mm in 3000 years over geological time. This rapidly accumulates and the pressure on mantle changes; and

3. Decomposition of radio-active material in the mantle. This generates heat, which is partly used up in causing plastic flow in the mantle and partly dissipated through the crust.

These factors combine to produce a state of strain in the mantle and crust. Where the stress reaches the breaking point there is fracture, and the strained rock rebounds under its own elastic stresses until the state of strain is wholly or partially relieved. Usually this fracture is along a fault plane and the movement may be horizontal, vertical or both.

The plane or line where the fault starts to move is called the 'focus' of earthquake; it is usually 5 km. to 110 km deep; on rare occasions it may be as much as 700 km deep. The point on the Earth's surface vertically above it is called the 'epicentre'. The shocks originating from 0 to 70 km depth are called shallow earthquakes. Those orginating from 70 to 300 km are called inter earthquakes; and from 300 to 700 km they are called deep earthquakes.

"This is all that is left of our Earthquake Control Research Laboratory."

In recent years the theory of 'plate tectonics' has received widespread acceptance. According to this theory, the crust is composed of large 'plates' which move about the surface of earth; each plate consists of a landmass and its attached continental shelf. Originally all the landmasses were joined near the South Pole; later they broke up and moved apart.

Modern surveys of the Atlantic Ocean floor show that there is a slow welling up of the mantle along a line down the middle of the ocean. As a result, the American plate is moving away from the African plate. Also, a northward movement is observed in the African plate and the Indian plate. Where two plates meet, the only way in which there can be relative movement is that one plate slides over the other. This causes immense stresses. The release of these stresses causes sudden movement, called earthquakes. So an earthquake must be expected wherever there is a relative plate movement.

Many seismologists agree that there is a relation between earthquakes and the reservoirs created by dams, but they disagree on the kind of relation. Such a relationship was first noticed in the late 1930's when the level of earthquake activity near the Hoover dam in the United States seemed to correlate with the water level of Lake Mead created by the dam. Since then many theories have come up on the subject.

Table 1

Place	Year	Lives lost
Shansi (China)	1556	830,000
Messina (Italy)	1908	100,000
Kansu (China)	1920	100,000
Kanto (Japan)	1923	100,000
Lisbon (Portugal)	1775	60,000
Quetta (Pakistan)	1935	30,000
Kangra (India)	1905	20,000

According to David M. Evans of Colorado School of Mines (U.S.A.)

earthquakes may be caused by hydrostatic imbalances at depth. He suggested that the weight of water causes the quakes by placing extra stresses on the rock below. The hydrostatic pressure can also affect the timing of quakes. Another theory proposes that water seeping through the rock makes the reservoir more vulnerable to the stresses that cause earthquakes.

Earthwaves

The sudden rupture at the focus of an earthquake causes vibrations to move out in all directions in the form of waves. These waves start as simple periodic waves with different modes of propagation. The crust of the earth contains materials through which the waves move in different ways and get damped. The waves are reflected and refracted at the earth's surface and at junctions between different layers inside the earth. Many of them reach the surface of earth at or near the epicentre.

There are mainly three types of earthquake waves. Longitudinal waves, also known as primary or 'P' waves, are the fastest. They cause compression and expansion like sound waves. They travel at speeds varying from 5 km per second at the surface to a maximum of about 135 km per second at depths of 2900 km. Next comes the shear or secondary 'S' waves, which vibrate at right angles to the direction of travel like light waves, and cause shear. They travel at about two-thirds of the speed of 'P' waves. The 'P' waves travel through both solid and liquid parts of the earth, while 'S' waves can pass only through solid. When these waves arrive at a boundary between layers, they may be refracted or reflected. Then either a 'P' or a 'S' wave may give rise to both 'P' and 'S' waves. The last to arrive are the surface waves, which are confined only to the crust and

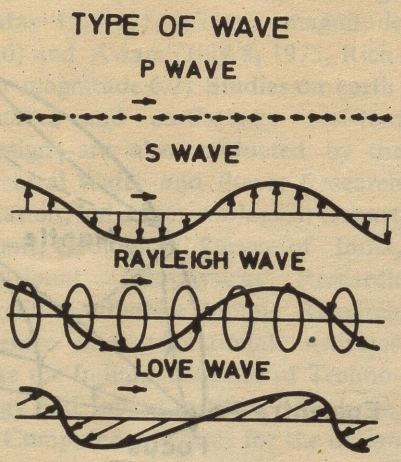


Fig. 2. (a) Propagational features of principal seismic waves

upper mantle. Surface waves travel through the crust at speeds from 2.5 to 4.5 km per second. They are mainly Rayleigh and Love waves (Fig. 2a). Rayleigh waves are characterized by a rolling type of ground motion in which the particles move in elliptical orbits in a plane normal to the surface, the sense of movement being opposite to the direction of wave propagation. Love waves are associated with a particle motion horizontal and normal to the direction of wave propagation.

The epicentre is the place on the earth's surface where the force of an earthquake is greatest, because it is the geographical point on the surface which is vertically above the focus (origin) of the earthquake **Fig. 2. (b)**

Magnitude and intensity

While studying earthquakes and their devastations, one comes across two very important parameters: magnitude and intensity. Magnitude is essentially a measure of the amount of energy released during the earthquake. It is calculated by finding out the ground movement at the observation point taking into account the depth of the focus and the epicentre distance. In 1935 C. F. Richter of the United States was the first to evolve a 10-point magnitude scale. Richter considered the magnitude of earthquakes in terms of the energy released. An approximate formula connecting energy in ergs and magnitude is

$$\text{Log}\, E = 11.4 + 1.5\, M$$

Where E is the energy in ergs and M is the magnitude on Richter scale. On this scale, the smallest perceptible shocks are near magnitude 2, and the largest recorded shock is about magnitude 8.9.

Intensity, on the other hand, is a measure of the physical damage caused by an earthquake and hence is maximum at the epicentre and decreases away from it.

When recording major earthquakes, a map showing the epicentre or epicentral area, surrounded by lines—called isoseisms—is drawn through places which record the same intensity of shock (Fig. 3). This helps in the classification of the seismic zones. The Roman numbers of the isoseisms given in Fig. 3 refer to the class in the modified Mercalli Scale.

"I told him I am a married man and have learnt to keep balance in the midst of temours. He gave me the job."

Earthquake prediction

The first practical use of earthquake prediction came from a Chinese scientist, Jan Hen, during A. D. 78-139. He used a specially designed vessel to determine the location of the centre of the earthquakes. Inside the vessel was a pendulum connected to eight radial movable levers. At the end of each lever movable mechanisms were connected to dragon jaws each of which gripped a ball. (Fig 4) During a seismic impact, the lever corresponding to the direction of the impact was set in motion opening the mouth of the dragon, and the ball fell from the dragon's mouth into the mouth of a frog under it. With this sensitive instrument earthquakes could be detected even at great distances.

In U.S.S.R., single and multi-pendulum seismometers were used to predict the Tashkent earthquake of 26th April 1966. More recently, a group of scientists at the Stanford University School of Medicine in U. S. A. discovered that even chimpanzees can be used to predict earthquakes. These animals were found to become abnormally restless when tremors are on the way. They then spend more time on the ground than on their tree perches and nesting areas.

After many years of study, Moscow and Tashkent scientists have established that there is a close connection between seismic activity and certain changes in chemical composition of underground waters. They found that just before an earthquake the concentration of

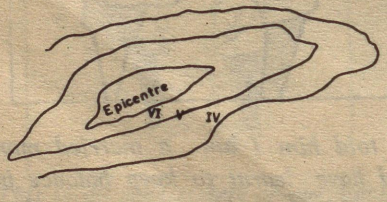


Fig. 3. Isoseismic lines with magnitudes on modified Mercalli scale

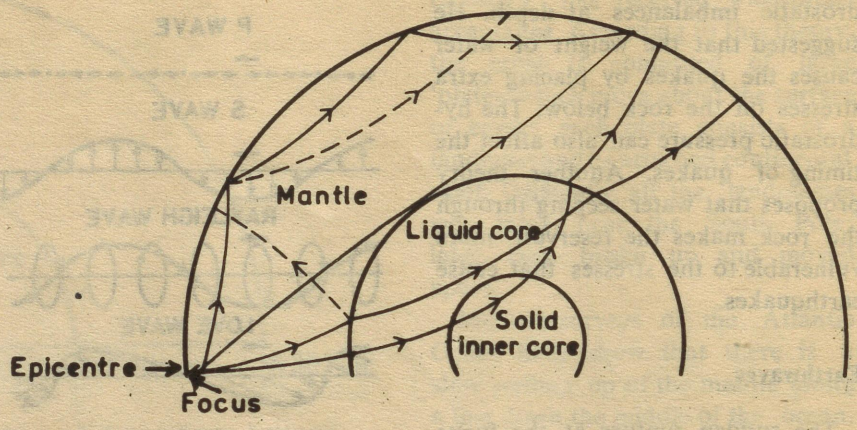


Fig. 2. (b) Focus, epicentre and paths of seismic waves

Forecasting earthquakes

MUCH of the loss of life in earthquakes could be prevented if it were possible to predict when and where a quake would strike. While absolute forecasting is not yet possible, good progress has been made in this direction by seismologists in the Soviet Union, United States and China. The methods of forecasting are based on observed changes in rock properties such as tilt, fluid pressure, electrical resistance, emmission or radon gas and changes in shock wave propagation velocities.

Much of the important early work on earthquake f recasting was done by the Russians. After a 20-year study following devastating Siberian earthquake of 1949, they discovered that prior to the onset of a shock, there is a sudden decrease in the ratio of velocities of seismic waves (Vp/Vs). Earthquakes occurred shortly after the ratio returned to normal.

Later work in the United States confirmed the Russian findings. Scientists at Columbia University's Lamont Doherty Geological Observatory found that the change in rock properties prior to a quake could be explained on the basis of 'dilatancy' or formation of cracks within the rock when it is under heavy strain. Rock strain and tilt could be monitored accurately using laser beams. Based on these studies, a few successful predictions were made about the place, time and even magnitude of impending quakes.

The world's first large-scale-earthquake warning system has been set up in China. It has 17 major observation centres which regularly receive data from 250 seismic stations, and 5000 observation points. In recent years, the Chinese system could successfully forecast at least two major earthquakes.

Some seismologists believe it may be possible in future not only to forecast but even to forestall quakes by artificially relieving rock strain before it reaches the breaking point. American scientists are experimenting with ways to control earthquakes by pumping out subsurface water, thus relieving pressure on rock formations that are under heavy stress.

B.B.

microelements rises noticeably in underground waters near the epicentre. It reaches its highest level during the shocks, after which the chemical composition gradually returns to normal. With this new method it is possible to predict an earthquake of 4 to 6 points on the Richter scale with a fair degree of accuracy.

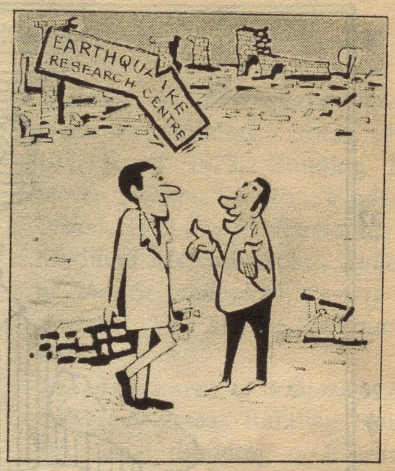
Seismic research in India

In India, after the Assam (1897, 1950) and Bihar (1934) earthquakes, a great interest was created in earthquakes. The Indian Standard Code (IS 1893-1962) *Recommendations for Earthquake Resistant Design of Structures* was published in 1962. The Koyna earthquake took place in 1967 after the publication of this code. It is interesting to note that the Koyna region has been classified as earthquake-free zone in the earthquake map of India contained in the above publication.

The Koyna earthquake, which occurred in Koynanagar (400 km south of Bombay) with a magnitude of 7.5 on Richter scale, was considered a major earthquake. About 200 people lost their lives and many houses collapsed. Interest was revived in the study of earthquakes and earthquake resistant design of structures after this earthquake. The revised Indian Standard Code, *Criteria for Earthquake Resistant Design of Structures* (IS: 1893-1970) was published in October 1971. It contained the general principles and design criteria of buildings, elevated structures, bridges, dams, embankments and retaining walls.

The School of Research and Training in Earthquake Engineering, University of Roorkee, has conducted excellent studies on the Koyna earthquake and also on some of the recent earthquakes of Kinnaur (Jan. 19, 1975, Richter magnitude 6.8), Koyna (October 17, 1973, Richter magnitude 5.2), Shimoga (May 12, 1975, Richter magnitude 5.0) and Assam (July 8, 1975, Richter magnitude 6.7). Studies on earthquakes and earthquake resistant designs are also conducted by the Central Water and Power Research Station, India Meteorological Department, Geological Survey of India, National Geophysical Research Institute, Bhabha Atomic Research Centre and educational institutes like the Indian Institutes of Technology and Indian Institute of Science.

Computer programs for the design of earthquake-resistant structures are being developed at the Indian Institute of Technology, Madras. For an efficient earthquake resistant structure, ductile materials like steel is recommended. If other materials such as concrete are used, sufficient anchorages and connections should be made so that the structure acts as a single unit at the time of earthquake. The factors that affect earthquake damage are : (i) amplification



"My research papers on moonquake have been destroyed in this earthquake."

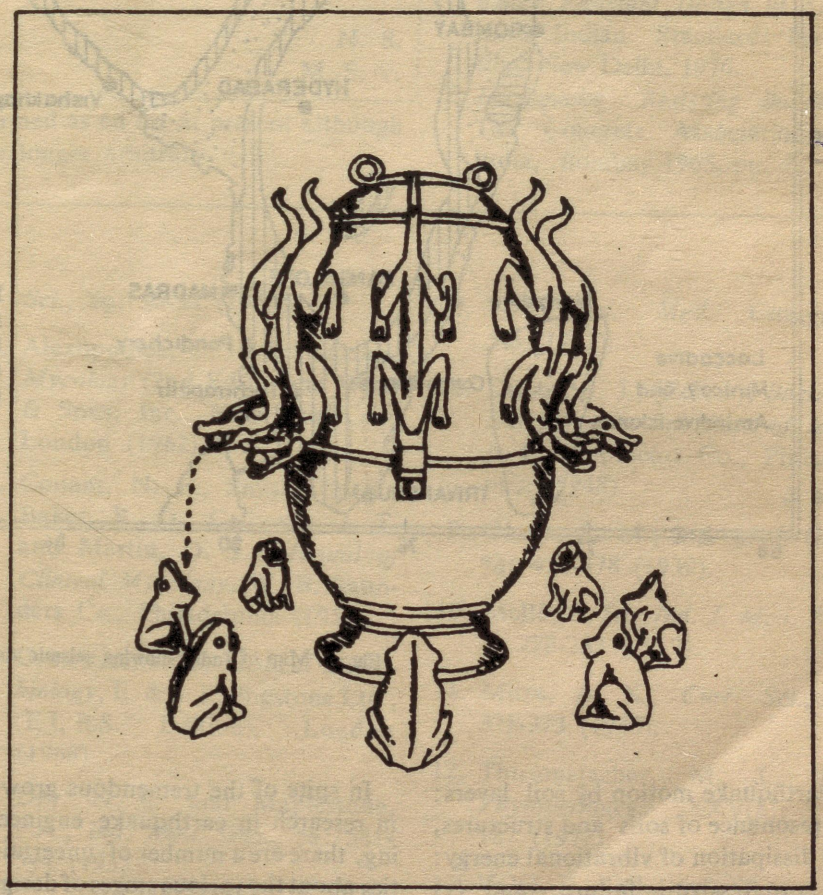


Fig. 4 Early Chinese earthquake warning device

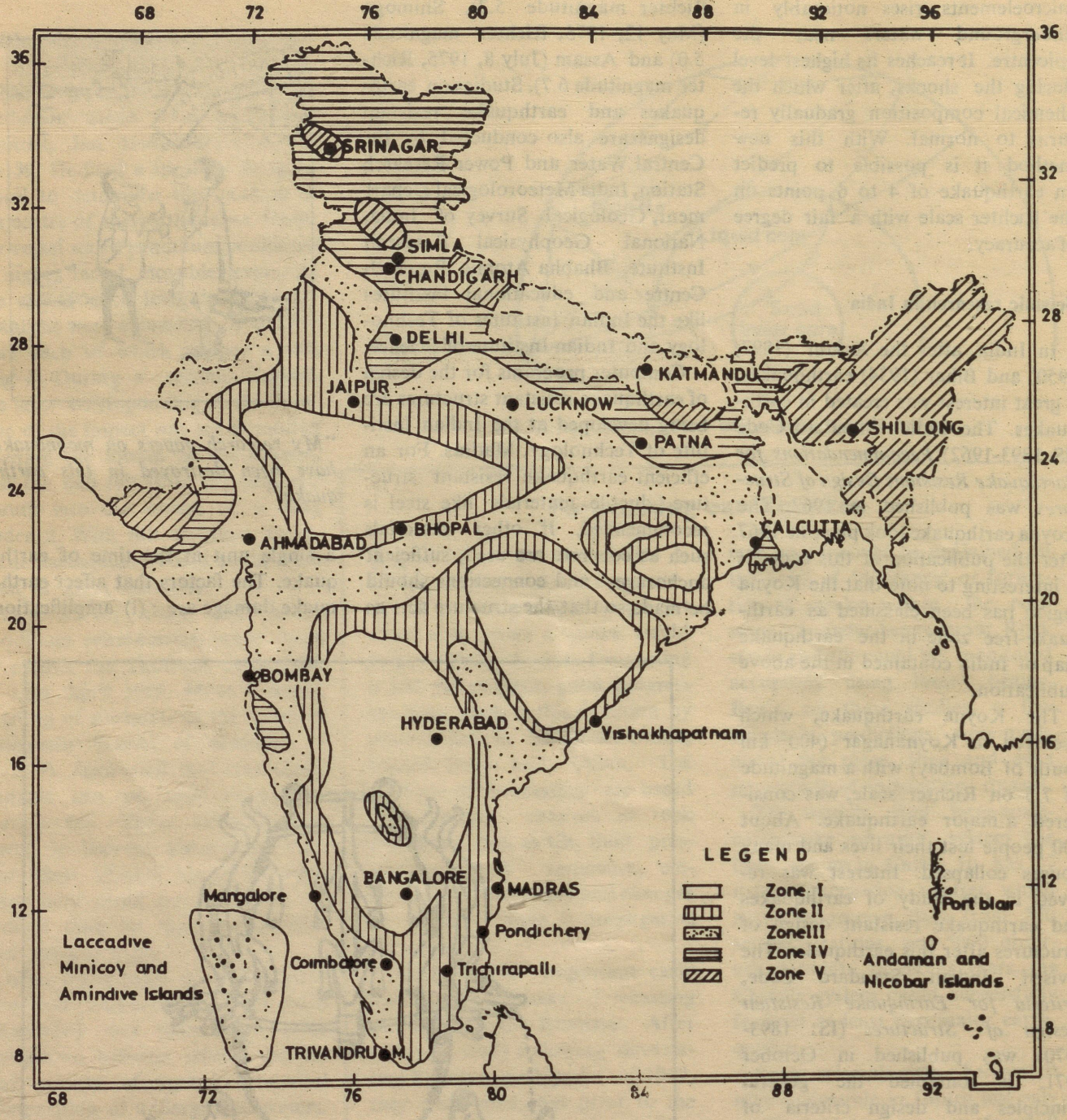


Fig. 4. Map of India showing seismic zones

of earthquake motion by soil layers; (ii) resonance of soils and structures, (iii) dissipation of vibrational energy; (iv) progressive failure; and (v) differential settlement.

In spite of the tremendous growth in research in earthquake engineering, there are a number of uncertainties about the various stages of design. The choice of ground motion and soil-structure interaction parameters pose a challenge to the designer. Since intuition and experience play a big part, the design worked out by two different groups could have

Seismic areas

THERE are two important belts where the earthquakes usually occur.

1. Mediterranean-Himalayas-South East to belt-2., and

2. Around the Pacific Ocean. New Zealand-East Indies-Japan-Aleutian Islands-West of Rocky Mountains—West of the Andes. A loop from this belt covers most of the West Indian Islands.

One more minor line of epicentres follows the valley of the great lakes in Africa.

Many earthquakes occur under the sea, and a shallow and severe shock cause 'seismic seawaves' or 'tsunami'. In deep water they may not be noticed by shipping, even if they are 1.5 m high, because their wavelength is several kilometers. However, in shallow water, their effect may be devastating. Generally, the sea recedes down the beach for some distance and then returns in a wave many meters high. The greatest tsunami on record occurred at Lopaka on the southern tip of Kamchatka peninsula in 1737 when the wave was 63 m high. Waves even 3 m high can do immense damage, and it is wise, when possible, not to site buildings in low land near the sea in risky areas.

For the purpose of determining the seismic forces, India has been classified into five zones (Fig. 4.) The seismic coefficients are also given in the Indian Standard Code (IS: 1893-1970), using which earthquake resistant structures could be designed.

N. S.
M. S. V.

considerable differences. Earthquake engineering design could be rightly termed as an art at present although no longer arbitrary.

Further reading

1. *Building in Earthquake Areas*, Overseas Building Notes, No. 103, April 1972, Building Research Station, Garston, England.
2. Wood, H.O., and Neumann, F., Modified Mercalli Scale, *Bulletin of the Seismological Society of America*, Vol. 21, No.1, January 1931.
3. *The Assessment of Vibration Intensity*, Overseas Building Notes, No. 19, Building Research Station, Garston, England, 1952.
4. Polyahov, S., *Design of Earthquake Resistant Structures*, Mir Publishers, Moscow, 1974.
5. Sixth World Conference on Earthquake Engineering, New Delhi, January 10-14, 1977,—Preprints, Vols. 1-12.
6. IS: 1893-1975, *Criteria for Earthquake Resistant Design of Structures*, Indian Standards Institution, New Delhi, 1976.
7. *Earthquake Resisting Buildings*, The Concrete Association of India, Bombay 1965, pp. 47.

FUNGI (*Continued from page* 775)

2. Persons affected with dermatomycoses should wash their clothes in boiling water (to kill the pathogen) and disinfect their shoes, socks and other articles with formalin.

3. One should not be careless about scratches and cuts on the skin.Antiseptic of proper concentration should be used to kill fungal spores and prevent infection.

4. Breathing in a dusty environment should be avoided to eliminate the possibility of bronchial and pulmonary infections.

5. Bathing or swimming in a rivulet or stagnant water should be avoided.

Further reading

1. Ajello, L., *Ann. N.Y. Acad. Sci.*, **89**: 30-38 (1960).
2. Alexopoulos, C. J., *Introductory Mycology* (2nd Ed.), John Wiley & Sons, Inc., New York and London (1962).
3. Conant, N. F., Smith, D. T., Baker, R. D., Callaway, J. T. and Martin, D. S., *Manual of Clinical Mycology*, W. B. Saunders Co., Philadelphia (1954).
4. Cruickshank, R., *Medical Microbiology*, E. & S. Livingstone Ltd., (E.L.B.S. Edition), London (1968).
5. Dey, N. C. and Maplestone, P.A., *Ind. Med. Gaz.*, **70**: 541-544 (1935).
6. ——*Ind. J. Med. Res.*, **23**: 687-699 (1936).
7. —— *Ind. Med. Gaz.*, **77**: 5-6 (1942).
8. Dubos, R. J., (Editor), *Bacterial and Mycotic Infections of Man*, J. B. Lippincott Co., Philadelphia (1948).
9. Ghosh, L. M., *Ind. Med. Gaz.*, **74**: 476-478 (1939).
10. Mello, F. De, *Ind. J. Med. Res.*, **5**: 220-233 (1917).
11. Mitra, A. K., *Curr. Sci.*, 9 : 371-373 (1940).
12. Thirumalachar, M. J., *Ind. Phytopathology* XXV(2): 183-187 (1972).
13. Vakil, R. J. (Editor), *Text Book of Medicine*, The Association of Physicians of India (1973).

THE INTELLECTUAL MACHINE

Pattern recognition machines have a number of potential applications

ASOKE K. TALUKDER

T. K. DAS

THE cover of a magazine displays a pretty young girl sitting in front of an enormous electronic computer. The advertisement is surely a bad one though. Of course, the girl has nothing to do with the whole business. It is neither the girl nor the machine that does the work. Problems are solved by mathematicians. Behind the solution of each problem handled by a computer is the genius of generations of great mathematicians, including present day scientists.

As for the electronic equipment itself, if the problem is merely to speed up the work of human calculators, there would be no need to devise computers capable of performing tens of thousands or millions of arithmetical operations per second. Because such work could be done by much simpler and cheaper devices. What is really important is the possibility of solving qualitatively new problems. For example, it is almost impossible to compute manually, the trajectory of a spaceship in flight but an electronic computer can do that.

Readers may not think for a moment that the authors want to convince them that computers are unimportant. What we want to say is: Why do we use a computer for such jobs which could easily be done by human beings? A computer is a costly machine; why do we not use it for costly jobs? To do so, we have to use the intellect of a computer (if they really are intellectual).

Mathematicians have compiled programs for playing chequers, certain card games, and chess. There are computers that play fairly a good game. Machines nowadays are also programmed to prove theorems of elementary geometry. The hard core rationalist among the readers will, of course, ask who pays for all this recreation on the part of mathematicians. Let us remind the reader that the programming of a game like chess, or to prove theorems, is not done for fun, it represents a model of the intellectual activity of a human being.

At present, a good deal of attention is being paid to programs for translating one language into another, either by reading or hearing. It is still cheaper, of course, to hire a translator, but the time will probably come when machine translation will be cheaper. But, again, it is not a matter of money: machine translation is also a model of the intellectual activity of man.

Truly speaking, computers perform only arithmetical and elementary logical operations, enumeration

S/Shri Talukder and Das are research scholars in the Deptt. of Electronics & Telecommunication Engg., Jadavpur Univ., Calcutta 700032.

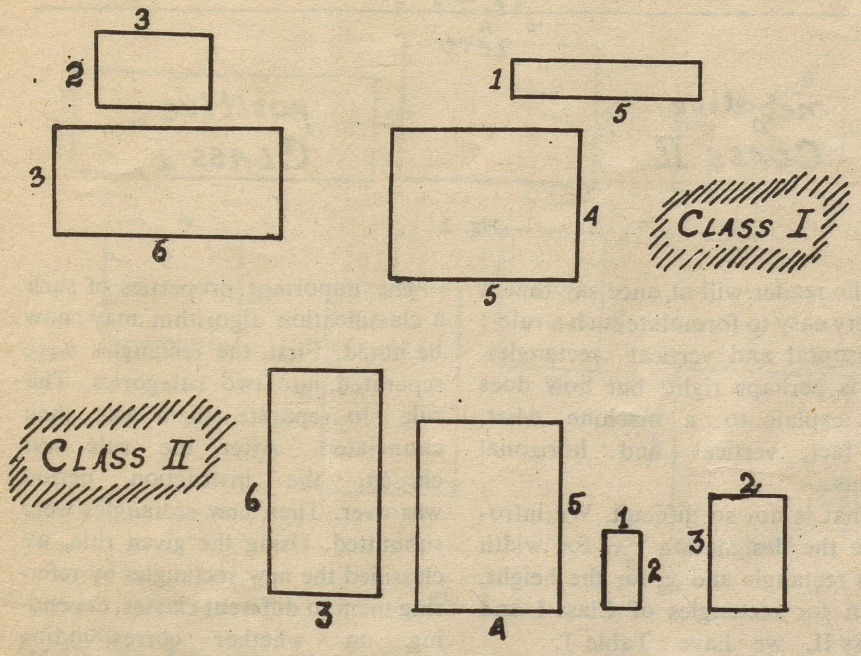


Fig. 1

operations, comparison of numbers and the operation of choice (say, choosing the largest number in a group of numbers).

Playing chess, composing music, solving equations and proving theorems can all be done by computers

"But for my association with you, Sir, I would not have got the compulsive urge to invent this electronic thinking brain."

in accordance with definite rules that specify the sequence of logical or arithmetical operations. These rules, that is, programming, are compiled by a human being.

As soon as a mosquito pierces the skin of a sleeping man, information goes to his central nervous system (brain) and is at once analysed. As a result his hands move to the mosquito either to kill or to brush it away. Can mathematical machines, like human beings and other living organisms, compile programs of actions by themselves for achieving specific aims as described above, or is it that without a detailed man-made programme they can do nothing? In this context, the word 'Machine' is understood to mean something made by human beings using hammer, wrench and soldering iron.

Today this question is being vigorously debated. Biologists, physicians and specialists in humanities are particularly active in defending the non-reproducibility of the living entity behaviour; i.e., the superiority of the living organism over machine. However, a machine can be taught to construct plausible arguments and in this respect it has overtaken its human teacher in a certain sense.

This is a complicated situation. But we will try to analyse it. The word 'Mama', 'Papa', 'Granny' are repeated, and fingers are pointed at them, and that is the way a baby learns. The mother all the time changes her appearance—different hair styles, different clothes—but she always remains Mama. The same applies to the father. Gradually the baby learns to distinguish other men besides his father. How are all these achieved? What is the process of learning and subsequent recognition of faces, cats, autos and so on? What is the mechanism like? We are not yet sure about anything in this direction.

How does a person distinguish a portrait of a woman from that of a man, birch leaves from oak leaves? It is not possible at present to teach a mathematical machine to separate a variety of objects into classes of similar objects, as we teach children to distinguish the letters of the alphabet written by different people (they are not exactly alike!). Or take clinical diagnosis when there are no two identical persons or two identical diseases. In this process no formalized criterion can be given to the machine for the classification of entities. We can only supply it with several objects of the classes, say, a dozen oak leaves and a dozen birch leaves.

The same problem arises when designing a machine for reading handwritten or typed texts, when compiling programs for a computer that classifies stages of schizophrenia or diagnoses cancer. Such an automatic machine, of course, models the thinking process in the human brain.

The first automatic devices for recognition of visual patterns were based on an analogy with the optic system of animals. The optic system is one of the most sophisticated and remarkable sensory organs, comprising roughly 130 million light sensitive cells (rods and cones). Beyond the layers of these receptors there are more layers of cells. They process incoming signals in a complex manner and send them on to the brain. There the signals are processed a number of times. The way light signals are treated by the visual analyser is still not clear to scientists, and the models set up to help us understand how this highly intricate apparatus operates have yielded only a very rough picture.

One of the pioneers in the modelling of the functions of thought by means of automatic devices was the American engineer F. Rosenblatt of Cornell University, U.S.A. He gave the name 'Perceptron' to automatic devices capable of modelling the functions of neurophysiological systems.

We will not dwell either on the theory of perceptrons or on the building of their models. The idea behind various perceptrons is very interesting; but, so far practical solutions of complicated problems have encountered considerable difficulties. For this reason many scientists engaged in the problem of modelling 'pattern recognition' have set out in other directions, one of which is described here.

Fig. 1 depicts rectangles of two classes. Can a machine be taught to classify such figures? Let us pose the problem more precisely. One is first shown only the eight rectangles depicted in the figure. Then a new rectangle is shown that does not coincide with any one of the 8 figures shown earlier. Is it possible to construct an algorithm (rule) for unambiguously placing the new rectangle in one of the two classes of figures?

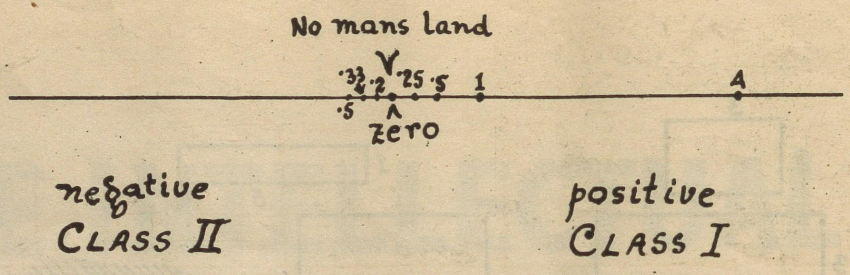


Fig. 2

The reader will at once say that it is very easy to formulate such a rule : horizontal and vertical rectangles. He is perhaps right; but how does one explain to a machine what, in fact, vertical and horizonal means.

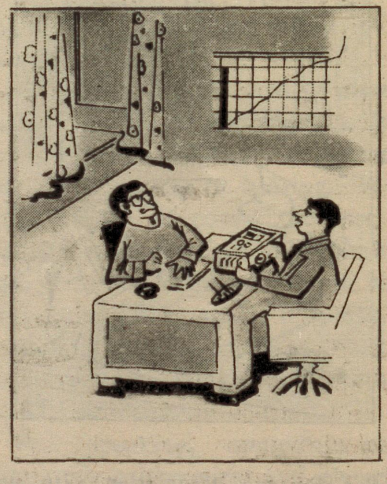
That is not so difficult. We introduce the designation : x_1 for width of a rectangle and x_2 for the height. Then for rectangles of Class I and Class II, we have Table 1.

The important properties of such a classification algorithm may now be noted. First, the rectangles were separated into two categories. The rule to separate them was then enunciated. After the rule was chosen, the instruction period was over. Then new rectangles were submitted. Using the given rule, we classified the new rectangles by referring them to different classes, depending on whether corresponding

Table 1

Class	x_1	x_2	$x_1 : x_2$	$(x_1 : x_2) - 1$	Class	x_1	x_2	$x_1 : x_2$	$(x_1 : x_2) - 1$
	3	2	1.5	.5		1	2	.5	−.5
	5	1	5	4		2	3	.67	−.33
I	6	3	2	1	II	4	5	.8	−.2
	5	4	1.25	.25		3	6	.5	−.5

We now plot (X_1, X_2), where $X_1 = (x_2 : x_1) - 1$ for Class I and $X_2 = (x_1 : x_2) - 1$ for Class II. We see that the two-dimensional data sets are already reduced to one-dimensional ones and X_1 and X_2 are on a straight line where X_1 is always positive and X_2 always negative. In other words, if we take the origin as zero, the left side is Class II and the right side is Class I. Then there would be no scope for any problem in distinguishing between Class I and Class II (Fig. 2). Let us say the machine takes a ratio of x_1 to x_2 and then subtracts 1 from it. If the result is negative, the rectangle belongs to Class II and if positive it belongs to Class I.



"One sure test of your intellectual accomplishments is how much you are prepared to invest in itsmanufacture."

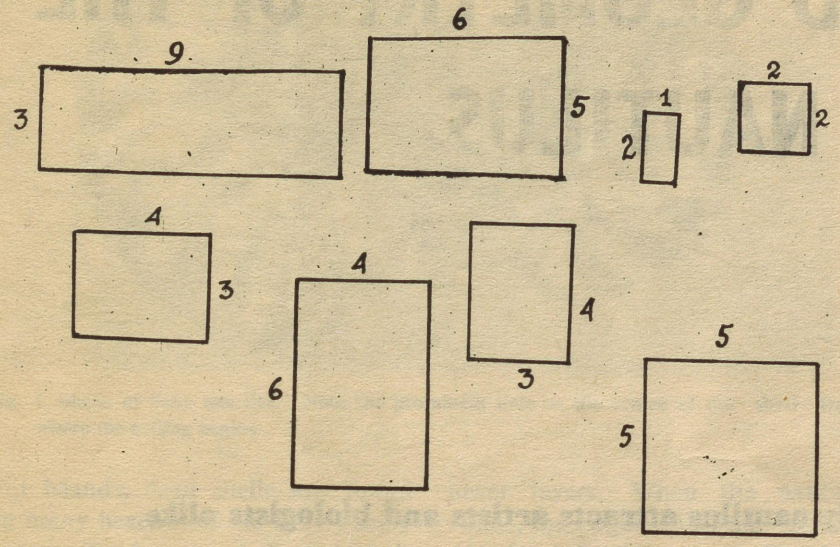


Fig. 3

points on the line appeared on one side or the other of the origin.

It is like an examination. Our assessment of the quality of the chosen rule depends on the results of the examination. Of course, we must know before hand to which of the two classes each of the new rectangles really belongs. The examiner always has to know the right answer. Then we can judge the quality of the chosen rule by the mistakes made at the examination.

Now let us discuss the results of the examinations. To verify the quality of the rule of classification used, eight rectangles shown in Fig. 3 were submitted. From the result, it is evident that rectangles (9, 3), (6, 5) and (4, 3) belong to Class I, (1, 2), (4, 6) and (3, 4) to Class II and the squares (2, 2) and (5,5) may be put in either class or in neither class, as both of them fall on the 'no man's land', i.e., the origin (Table 2). A machine can be taught to place the undecided class into Class III, where Class III represents squares.

In an easy problem like the one described above, we can divide the decision rule in three classes, but in real problems of pattern recognition the number of classes are quite large and so it is difficult to define the nature or even the distribution of the data set *a priori*.

Today, to keep pace with the increasing amount of information that is to be processed, rapid formulation of newer pattern recognition methods is being developed. The worst thing that pattern recognition scientists often face is misclassification. So they are trying to have a tool that is efficient and at the same time gives cent per cent correct result. There is even a suggestion for the introduction of a new parameter called 'misclassification factor' which perhaps could decrease this havoc.

Pattern recognition machines have a number of potential applications. For example, they can be used in detection of crime and criminals, in estimation of natural resources etc. The pattern recognition scientists are even thinking of designing and making computers that can hear and understand, or machines that can speak and make us understand !

Table 2

x_1	x_2	$x_1 : x_2$	$X=(x_1 : x_2)-1$	Decision
9	3	3	2	Class I
6	5	1.2	.2	Class I
1	2	.5	−.5	Class II
2	2	1	0	Undecided
4	3	1.33	.33	Class I
4	6	.67	−.33	Class II
3	4	.75	−.25	Class II
5	5	1	0	Undecided

Further reading

1. Tou, J.T., and Wilcox, R.H., *Computer and Information Sciences*, Spartan Books (1964).
2. Khurgin Ya, *Did You Say Mathematics*? Mir Publications, Moscow (1974).
3. Nilson, N.J., *Learning Machines —Foundations of Trainable Pattern Classifying Systems*, McGraw Hill, New York (1965).
4. Fu, K. S. *Sequential Methods in Pattern Recognition & Machine Learning*, Academic Press, New York & London (1968).
5. Mendel, J.M. & Fu, K.S. (Eds.), *Adaptive Learning & Pattern Recognition Systems*, Academic Press, New York & London (1970).

BIOLOGY AND GEOMETRY OF THE CHAMBERED NAUTILUS

T. ANTONY DAVIS

The pearly nautilus attracts artists and biologists alike

ONE of the most acclaimed natural beauties is the shell of the chambered nautilus (*Nautillia* sp.). Painted, drawn, and photographed innumerable times, saluted in poetry, its graceful shape appeals to all viewers, even the artistically ungifted. There is an international science journal named *The Nautilus* founded in 1889 by Pilsbry, and the Delaware Museum of Natural History at Greenville (U.S.A.) is publishing a quarterly, *Chambered Nautilus Newsletter* which is now in its third year of publication. The remarkable nautilus lent its name to the deep-diving submarine in Jules Verne's adventure, *Twenty Thousand Leagues Under the Sea*. The air-tight chambers of the shell act as ballast tanks. Nautilus is also the name of one of the rafts used by the Indo-United States Ganga Expedition to navigate an unchartered gorge in the Ganges in 1976.

The great family of nautilus

Cephalopoda, to which the nautilus belongs, is a group of highly organised invertebrate animals of exclusively marine distribution constituting a class of the phylum Mollusca. They appeared late in the Cambrian, and with shells four metres long, they were the largest shelled invertebrates that ever lived. Some 3,500 different nautiloid species once flourished in the shallow seas that covered the prehistoric earth. The fossil of a long extinct species whose shell measured 2.7 metres was discovered in an Arkansas river-bed. About 130 genera and 650 species of living cephalopods are known of which octopus, squid, cuttle-fish and nautilus are the most familiar representatives. Cephalopods are characterised by a head with eight or more tentacles and highly developed eyes. The sexes are separate.

Now there exist only half a dozen species of nautilus; the main region of their survival is the Pacific Ocean from the Philippines to Fiji. They live in the sea as deep as 600 metres but ascend closer to the surface during nights. Although evolution has whittled these descendants to not more than 25 cm—only a small fraction of the size of their giant ancestors—their form has remained remarkably the same for ages.

Distribution

Nautilus is a popular name applied to two distinct genera of cephalopod molluscs—the pearly nautilus, also called the chambered nautilus, because of the many chambers in its shell, and the paper nautilus, *Argonauta*, a cosmopolitan genus of open ocean octopod.

Although the pearly nautilus lives mostly between the Philippines and

Dr. Davis is Professor at Indian Statistical Institute, Calcutta. He is presently F.A.O. Coconut Agronomist at LPTI, Jalan Cimanggu No. 1, Bogor, Indonesia.

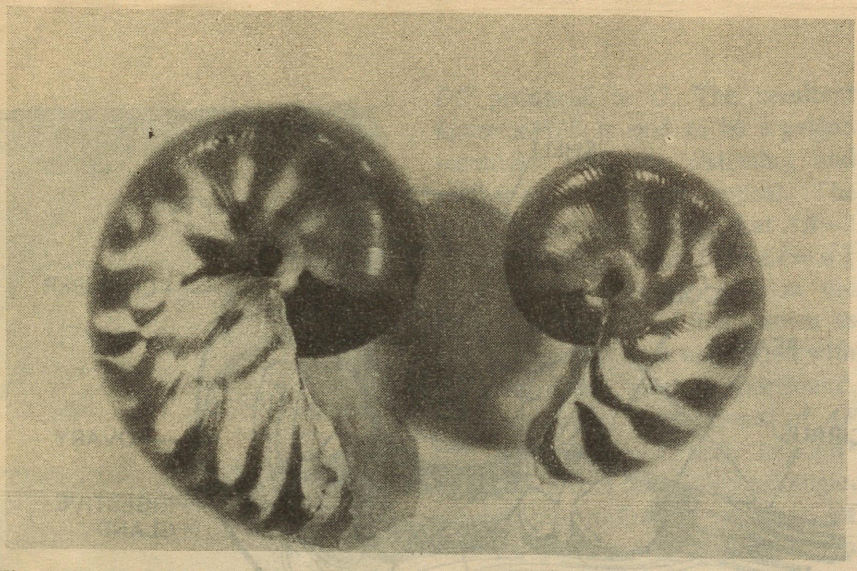


Fig. 1. Shells of baby nautilus. Note the prominent hole at the centre of the shell from where the coiling begins

Fiji Islands, dead shells are found on many beaches of the Indo-Pacific region. Traders in shell and shell products at Port Blair (Andaman Is.) flourish on the sale of nautilus shells which their agents collect locally. During our two expeditions to the uninhabited South Sentinel Island in 1973 and 1974, we collected a large number of nautilus shells, their sizes ranging from 2.5 cm to 22.5 cm (Figs. 1 and 2). The animal produces a series of ever-larger chambers, at an estimated rate of a new chamber every 2 or 3 weeks. The first four chambers of the shell are formed while the young nautilus is still within the egg. The mollusc fashions as many as 38 chambers, increasing in size with a mathematical consistency (*see cover*). The baby nautilus begins to coil its shell in such a manner that a hole, wide enough to insert a needle, is left at the centre (Fig. 1). But this hole gets covered later when more chambers are built with the secretion of pearly material (which the animal daubs on the shell in such a way that the central point of the shell is no longer visible). All the chambers are connected by a tube called siphuncle (Fig. 3) through which gases are released into or absorbed from the chambers as necessary. The shell thus acts as a float or hydrostatic organ that aids in ascending from sea bed to upper layers of water or descending to lower layers. When the nautilus swims, the largest (also the newest) chamber is the lowermost. The main food hunting region of this mollusc is the muddy ocean floor which abounds in small crabs, shrimps and shellfish, its main diet.

Unlike the octopus and the squid, the chambered nautilus has about 90 tentacles, most of them are small. They may be separated into three groups. Each eye has two tentacles, one in front and the other at the back. There is an outer ring of nineteen pairs of tentacles and an inner circle of many short tentacles around the mouth and beak. The first and third of these tentacles are said to be capable of being withdrawn into their sheaths. The tentacles of the nautilus are ridged to give them good grip on anything they hold, and they look different from the tentacles of octopuses and squids as they do not have any sucker. Some of the tentacles are extended while searching for food. As soon as they grasp a fish or a crab, they pass it to the ten tantacles near the mouth. It is now known that these appendages do not help the animal to crawl as was believed earlier. Two trailing tentacles support the nautilus while it tramples over the uneven surface of the ocean floor (Fig. 4). Locomotion is effected by jetting out of water through the funnel located below the layer of the tentacles (Fig. 3). When the animal has to move in a reverse direction, it aims its funnel forward and spurts off water. There is a prominent leathery hood with which the mouth of the shell is closed after drawing in the tentacles. The animal rests usually covering itself under the hood.

Use of nautilus shell

As mentioned earlier, the many-chambered spiral shell acts as ballast tanks and helps the nautilus ascend

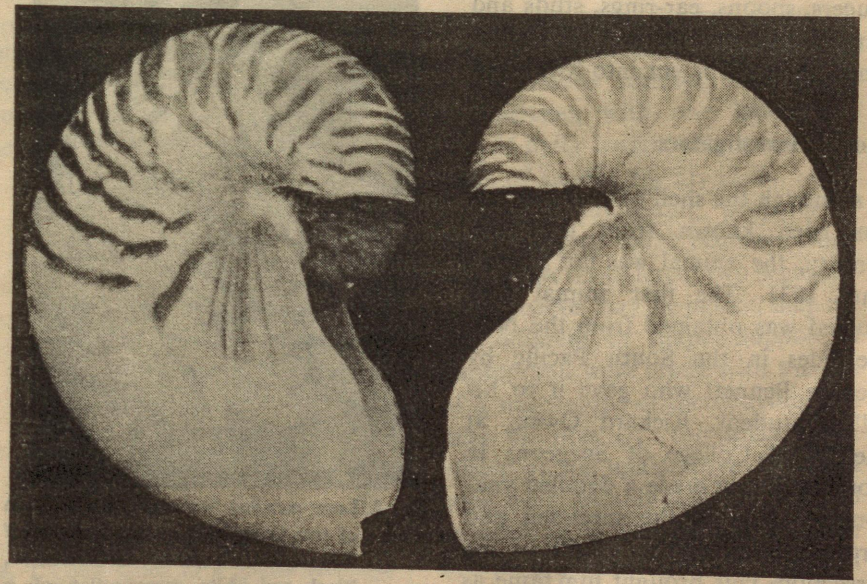


Fig. 2. Empty shells of two adult chambered nautilus. Flame markings on the shell are conspicuous on the older portion

or descend in the ocean. It offers, together with the hood, a good shelter for the resting animal. But perhaps the most important function the shell has is to protect the boneless, succulent animal from its predators. Judging from the injuries seen on many shells (one had upto 13 injury marks), it is clear that predators try to reach the prey by breaking the rim of the shell. But as the shell offers tough resistance to the smaller predators, the nautilus escapes from such attacks with minor injuries. The animal has even the capacity to repair and reshape the broken shell (Figs. 5 and 6). The animal daubs the shell in narrow strips with a special secretion of its body. These strips remain as permanent lines. When a bit of the broken shell is patched up with new material, the construction lines of the new surface do not match with the markings on the original shell as revealed in Figs. 5 and 6.

The shell, with its reddish brown flame markings on a white background, is a thing of beauty and consequently an object of commercial importance. When polished, it reveals its rare mother-of-pearl lustre. The shells are fashioned into lamps and other decorative items. They are also worked into cups, saucers, spoons, ear-rings, studs and bangles. In Polynesia and the Philippines, the shell is cut into fish lures.

Pioneer investigators

Although the shell of the nautilus has been known from the 16th century, the animal was not studied until 1831. The first animal ever studied was obtained from the New Hebrides in the South Pacific by George Bennett who gave it to his fellow student, Richard Owen, at the Royal College of Surgeons in London. Owen made a detailed anatomical study of the specimen and wrote a book on the results of his dissection. This brought him fame as the greatest anatomist of his time.

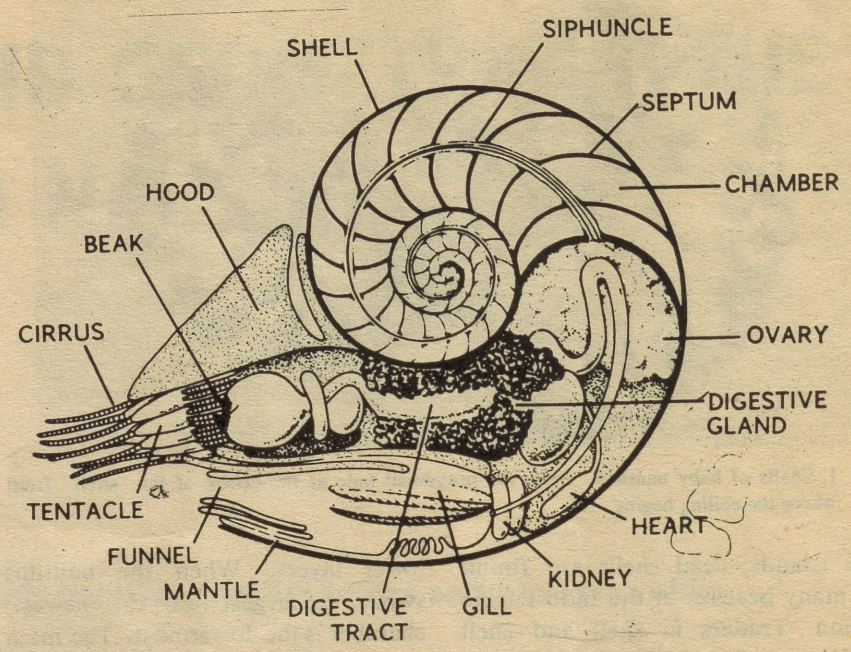


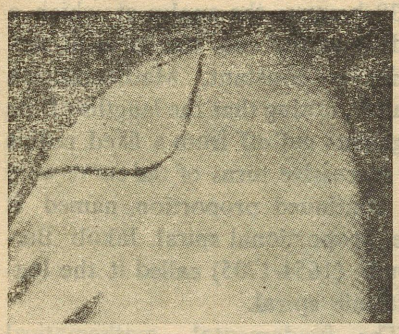
Fig. 3. A section through a live nautilus showing the important organs (*Courtesy*: *National Geographic Magazine*, Washington)

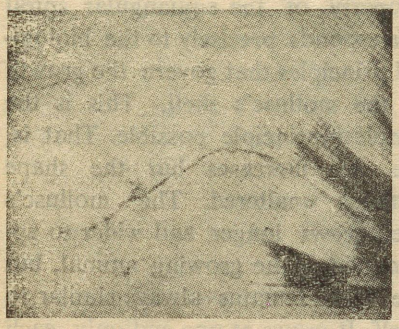
He died in 1892 as Sir Richard Owen. Among other early workers on nautilus, Anna Bidder of Cambridge University who went to New Hebrides to study the animal, E.J. Denton of the Plymouth Laboratory, J. B. Gilpui-Brown of the University of Auckland, are the more important ones. H. K. Dugdale publishes regularly the recent work on nautilus in his *Chambered Nautilus Newsletter*.

Fig. 4. Lone nautilus 'walking' with the help of two tentacles (*Courtesy* : *National Geographic Magazine*, Washington, Black and white reproduction of a colour plate with permission)

The paper nautilus

The paper nautilus (*Argonauta* sp.) is found in all tropical and subtropical seas, living near the surface. However, specimens of this nautilus have also been captured below 900 metres. It belongs to the eight-armed order octopoda, but differs from the octopods in having a thin unchambered, coiled shell, unlike either the internal shell of the squid or cuttlefish, or that of the chambered nautilus. The *Argonauta* shell is formed by large flaps or membranes found on the dorsal arms of the females (the males do not have shells). It is in this shell, cradled by the flaps, that the eggs are laid and the young hatch out. Large shells, which attain a diameter of 30 to 40 cm, are very fragile and highly prized by collectors. They are often found on the Florida coast in U.S.A. In contrast to the other octopods, the male of *Argonauta* is only about 1/20th the size of the female and possesses no shell. The male was once thought to be parasitic in the shell of the female. For many years the argonauts were pictured as sailing about the surface





Figs. 5. 6. Portions of shells of nautilus showing patched up injuries

of their seas with the arm flaps extended as sails, until the true function of het flaps was discovered. In all other essentials, the female resembles the octopus.

Incidentally, the word Argonaut is derived from the Greek *Argonautes* which means the sailor in the 'Argo'. According to a famous story in Greek mythology, it refers to legendary heroes who sailed with Jason in the Argo in search of the golden fleece.

The geometry of the nautilus shell

It is known that a rectangle of certain proportions has an appeal to a wider population than a rectangle of any other shape. Such a more appealing rectangle is known as the golden rectangle, e.g., *AFGD*, in Fig. 7. It is constructed in the following way. The side *AB* of a square *ABCD* is bisected at *E*. With center *E* and radius *EC*, an arc of a circle is drawn cutting *AB* produced in *F*. *FG* is drawn perpendicular to *AF* meeting *DC* produced in *G*. The resultant figure *AFGD* is said to be a golden rectangle with its charming and aesthetically pleasing appeal. The proof is also very simple. Let $AB=2$ units of length. Then $EC=EF=\sqrt{5}$ units. *AF* is divided by *B* in the golden section. *B* is also known as the 'golden cut'. It is associated with the idea of the 'mean proportional'. *AB* is the mean proportional of *AF* and *BF*. $AB/BF=AF/AB$, i.e. $AB^2=AF.BF$. From the golden rectangle, almost an unlimited number of squares, progressively decreasing in area, can be obtained as per procedure shown in Fig. 8. For the rectangle *ABCD*, $AB : BC = \phi = 1$. Through *E*, the golden cut of *AB*, *EF* is drawn perpendicular to *AB* cutting off from the rectangle the square *AEFD*. Then the remaining rectangle *EBCF* is a golden rectangle. If from this, the square *EBGH* is lopped off, the remaining figure *HGCF* is also a golden rectangle. This process can be repeated indefinitely until the limiting rectangle *O*, indistinguishable from a point, is reached. Such a figure offers the following interesting features :

1. The limiting point *O* may be called the *pole* of a unique spiral known as the equiangular spiral (logarithmic spiral) which passes through the golden cuts *D*, *E*, *G*, *J*,...The general equation of this spiral is $r=ae^{\cos a}$. The sides of the rectangle are nearly, but not wholly, tangential to the curve. This shows the connection between the logarithmic spiral and the golden section.

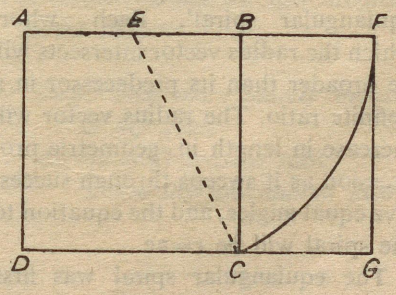


Fig. 7. Construction of a golden rectangle

2. Alternate golden cuts on the *rectangular* spiral *ABCFH*...lie on the diagonals *AC* and *BF*. This suggests a convenient method of constructing the figure.

3. The diagonals *AC* and *BF* are perpendicular to each other.

4. The points *E*, *O*, *J* are colinear, as also are the points *G*, *O*, *D*.

5. The four right-angles at *O* are bisected by *EJ* and *DG* so that these lines are mutually perpendicular.

6. $AO/OB=OB/OC=OC/OF=$ ... There is an infinite number of similar triangles, each being one half of a golden rectangle.

The relationship of the spiral to the Fibonacci series is evident from Fig. 8, for, the spiral is seen to pass through diagonally opposite corners of successive squares such as *DE*, *EG*, *GJ*,..... The lengths of the sides of these squares form a Fibonacci series. If the smallest square shown in Fig. 8 has a side of length d, the adjacent square also has sides of length d, the next square has sides of length 2d, the next 3d and so on, giving the series 1d, 1d, 2d, 3d, 5d, 8d,.... Therefore, it is very easy to draw the golden rectangle whose sides will have the measurements of two consecutive Fibonacci numbers. Say, in a rectangle if the length is 89 units and width 55 units, the rectangle is said to be a golden one. We can obtain from this figure, a continuous number of squares commencing with one having the side 55 units length, and others with units of lengths 34, 21, 13, 8,... etc.

Another interesting property of this charming spiral becomes obvious. However different two segments of the curve may be in size, they are not different in shape. Suppose a photograph were taken with the aid of a microscope of the convolutions near the pole *O*, too small to be visible by the unaided eye. If such a copy were suitably enlarged, it could be made to fit exactly on a spiral of the size of Fig. 8. The spiral is without

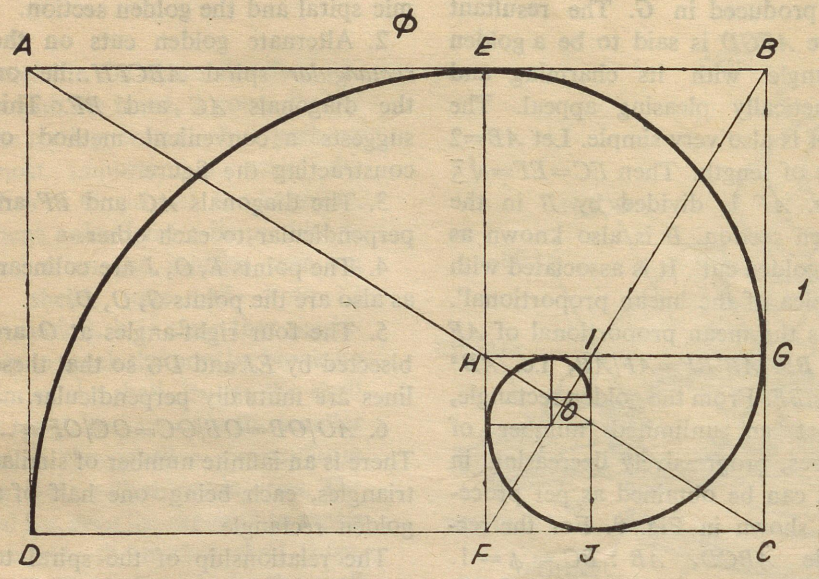


Fig. 8. Producing an equiangular spiral

a terminal point. That is, it may grow outwards (or inwards) indefinitely, but its shape always remains unchanged.

This is one of the examples of the Fibonacci series in nature. The successive chambers of the nautilus, as we have already seen, are built on a framework of a logarithmic or equiangular spiral. As the shell grows, the size of the chambers increases but their shape remains unchanged.

Equiangular spiral

A spiral may be defined as a curve which, starting from a point of origin, continually diminishes in curvature as it recedes from that point. In other words, its *radius of curvature* continuously increases. After a stage, the diminishing curvature tends to turn up in a straight line. Such a curve, of course, excludes the simple screw or the cylindrical helix, which neither starts from a definite origin nor changes its curvature as it proceeds. But true spirals are noticed in the horns of mammals, shells of molluscs, in the florets of a sunflower head, in the outline of a cordiform leaf, in the coil of an elephant's tusk and the like. Two important spirals of relevance for the present are the equable spiral (spiral of Archimedes), and the equiangular spiral (logarithmic spiral). Spiral of Archimedes appears when a rope of uniform thickness is coiled tightly on a horizontal surface. In this spiral, each whorl is of the same breadth as that preceding it and that which follows it.

In contrast to the spiral of Archimedes, in the equiangular spiral of the nautilus the whorls continuously increase in breadth, and do so in a steady and unchanging ratio. D'Arcy Thompson, the author of the classic, *On Growth and Form*, defines such a spiral as follows: 'If instead of travelling with a uniform velocity, our point moves along the radius vector with a velocity increasing as its distance from the pole, then the path described is called an equiangular spiral'. Each whorl which the radius vector intersects will be broader than its predecessor in a definite ratio. The radius vector will increase in length in geometric progression as it sweeps through successive equal angles, and the equation to the spiral will be $r=ae$.

The equiangular spiral was first recognised and designated so by the French philosopher Descartes in 1938 because the angles at which a radius vector cuts the curve at any point is constant. Mathematician Halley, noting that the lengths of the segments cut off from a fixed radius by successive turns of the curve were in continued proportion, named it the proportional spiral. Jakob Bernoulli (1654-1705) called it the logarithmic spiral.

The fundamental mathematical property of the equiangular spiral corresponds precisely to the biological principles that govern the growth of the mollusc's shell. This is the simplest principle possible. That is, the size increases but the shape remains unaltered. The mollusc's shell grows longer and wider to accommodate the growing animal, but the shell remains always similar to itself. It grows at one end only, each increment of length being balanced by a proportional increase of radius so that its form is unchanged. The shell grows by accretion of material which it accumulates rather than due to biological growth. The only mathematical curve to follow this pattern of growth is the logarithmic spiral.

Logarithmic spiral and golden triangle

A golden triangle may be easily reached after a brief look at what is called a *gnomon*. A gnomon is a portion of a figure which has been added to another figure so that the whole is

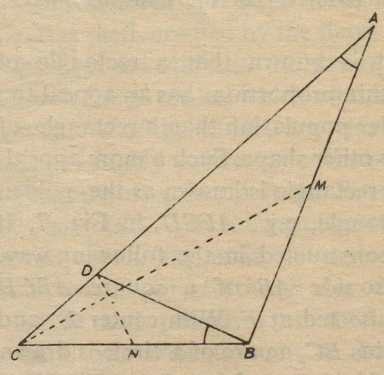


Fig. 9. Gnomons

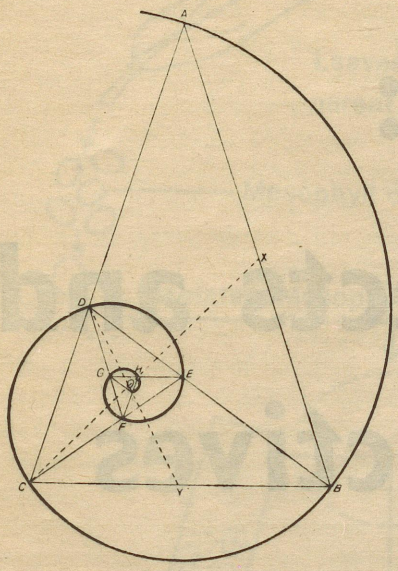


Fig. 10. Golden triangles and logarithmic spiral

of the same shape as the small figure (Fig. 9). Mathematicians have shown that in any triangle *ABC*, triangle *ABD* is a gnomon to triangle *BCD*, if angle *CBD* = angle A. If we add to or subtract from this triangle a series of gnomons, it turns out that all the apices lie upon an equiangular spiral. Radial growth (dr) and intrinsic growth in the direction of the curve (ds) bear a constant ratio to each other : dr/ds=cos *a*=constant. The equiangular spiral is the only curve to possess this property.

An application of the gnomon principle which interested the contemporaries of Pythagoras concerns the isosceles triangle *ABC* (Fig. 11) which has base angles 72° and apex angle 36°. Here *AB* : *BC*=ϕ/1. Hence the triangles of this figure may be termed 'golden triangles'. The bisector of angle *B* meets *AC* in *D*, so that *D* is the golden cut of *AC*. By this the triangle *ABC* has been divided into two isosceles triangles both of which could be called 'golden', their apex angles being 36° and 108°, and the ratio of their areas ϕ= 1. Bisecting angle *C*, we obtain *E*, the golden cut of *BD*, and two more golden triangles. This process, producing a series of gnomons, converges to a limiting point *O*, which is the pole of a logarithmic spiral passing successively and in the same order through the three vertices of each of the series of triangles, *A*, *B*, *C*, *D*, *E*,.. . . . .

Aesthetic appeal

H.E. Huntley, author of the fascinating book, *The Divine Proportion*, quotes the opinion of marine biologists, artists, poets, psychologists and above all, mathematicians, on how they regard the beauty of the smooth curvature of the shell of the chambered nautilus. Poet Oliver Wendell Holmes wrote the following poem, entitled *The Chambered Nautilus*:

This is the ship of pearl, which, poets feign,
Sails the unshadowed main—
The venturous bark that flings
On the sweet summer wind its purpled wings
In gulfs enchanted, where the siren sings,
And coral reefs lie bare,
Where the cold sea-maids rise to sun their streaming hair.

The poet goes on to draw a moral in his last stanza on the life-history of the mollusc.

Build thee more stately mansions, O my soul,
As the swift seasons roll!
Leave thy low-vaulted past!
Let each new temple, nobler than the last,
Shut thee from heaven with a dome more vast
Till thou at last are free,
Leaving thine outgrown shell by life's unresting sea.

The pearly nautilus attracts the artist both by the tints of its lustrous exterior and by the perfection of its spiral curve. Aesthetic appreciation of any sort has a dual aspect. Beauty evokes an immediate sensuous pleasure which is a common human experience. The sensuous satisfaction which is produced by simple lines has been studied by psychologists. Results of some of Lundholm's experiments summarised by H. E. Huntley are reproduced below :

Expressiveness of lines. When asked to draw a beautiful line, Lundholm's (1921) subjects tried to make one that was smooth, curved, symmetrical, continuous with rhythm or repetition and expressive of a single idea. For an ugly line they drew an unorganised mass without continuity, with mixed angles and curves and unrelated spaces ..., and when they wished to express merrment, playfulness, agitation or fury, they drew sharp waves of zigzags.

The subjects said : 'Small waves make the movement of a line go more quickly. The calm line has long slow curves.'

The long slow curve of the equiangular spiral, according to the above, must be evocative of calm feelings which may be regarded as a part fo the mathematicians' aesthetic experience.

Mathematician Jakob Bernoulli was so fascinated by the beauty of the logarithmic curve that he asked that it might be engraved on his tombstone!

P. N. UNNI & R. SREEKUMAR

TISSUE CULTURE : Prospects and Perspectives

Plant tissue culture has a great potential in crop improvement programmes

THE term 'tissue culture' is used in a broad sense to describe the growth of isolated embryos, plant organs, tissues or cells *in vitro* under aseptic conditions (in the absence of contaminating micro-organisms). The main types of aseptic cultures are plant culture (culture of seedlings or larger plants), embryo culture (culture of isolated embryos), organ culture (culture of isolated plant organs such as root tips, stem tips, leaf tips, flowers, etc.), tissue or callus culture (culture of tissues produced by proliferation from cut segments of plant organs), cell or tissue suspension culture (culture of suspensions of single cells or smaller cell aggregates dispersed in liquid media) and protoplast culture (culture of mechanically or enzymatically isolated protoplasts). The technique of tissue culture has advanced much in recent years, particularly the development of more refined methods, culture media, etc. E.C. Cocking, of Department of Botany, University of Nottingham, U. K. (*Nature*, **187** : 1960) has demonstrated even the possibility of isolation of naked protoplasts by dissolving cell wall with enzymes. This has opened up the possibility of fusing plant protoplasts of different species to produce hybrid cells. Recently developed techniques enable protoplasts, during their isolation by cell wall dissolution, to take up nuclei or other cell organelles. They do it by enclosing the organelles in a vesicle of plasma membrane just as an amoeba feeds on its prey. Later, the ingested 'foreign' structures may release their DNA in the cells in an active form, which get incorporated into the genome. The property of naked protoplasts to get fused spontaneously in culture makes somatic hybridization (parasexual hybridization) in plants possible, using either diploid or haploid protoplasts. This technique of tissue culture has also opened up new vistas in mutation breeding and offers the possibility of rapid eco-

S/Shri Unni and Sreekumar are Research Associates in SERC Project on Tissue Culture, Botany Deptt., Calicut University, Calicut-673635

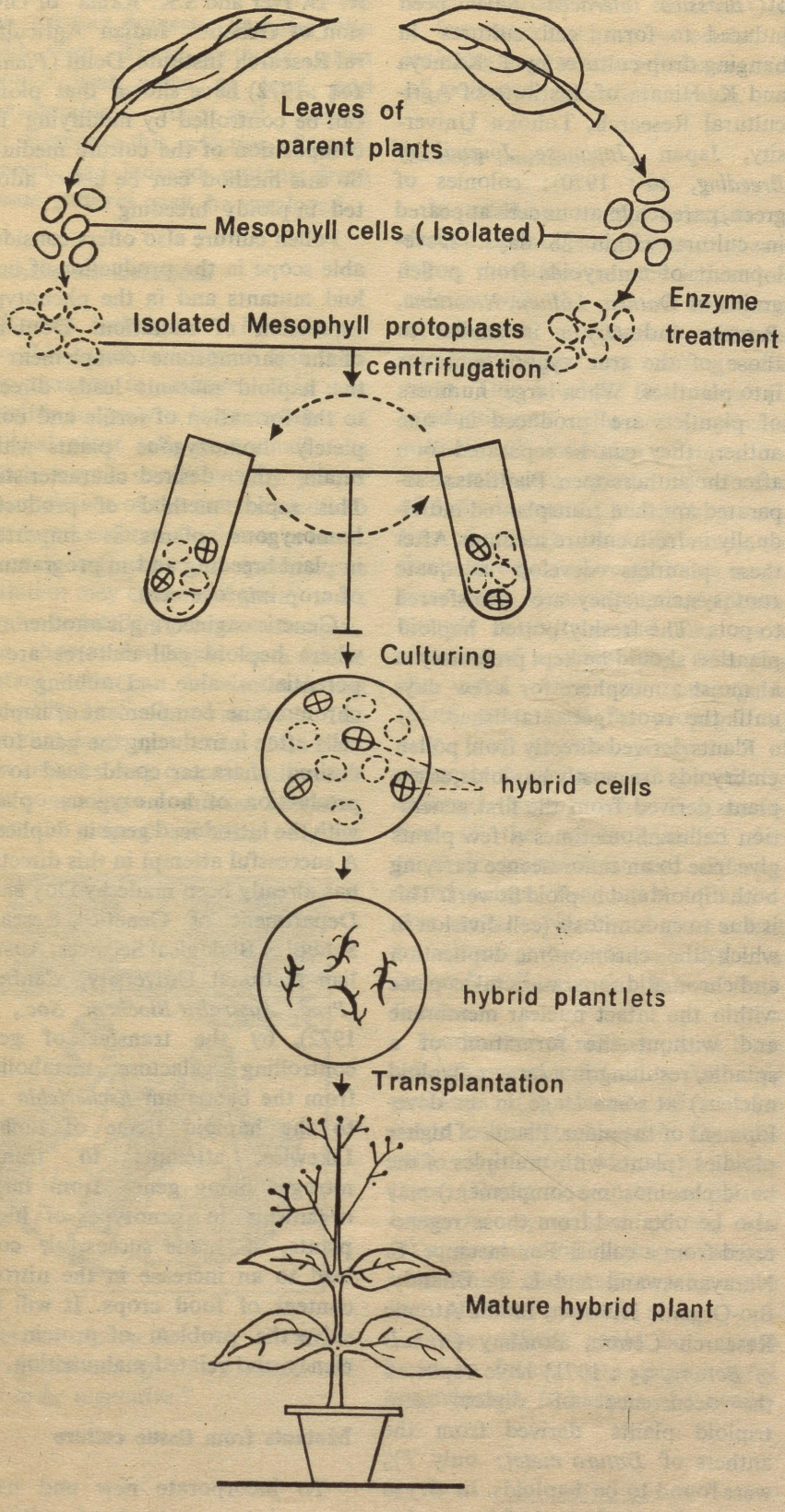


Fig. 1. Process of parasexual hybridization

nomic isolation of specific mutant types of agricultural utility.

Parasexual hybridization

Parasexual hybridization, a recent development in tissue culture technique where the cells of two sexually incompatible species are hybridized, involves three steps : (1) isolation of somatic protoplasts, (2) fusion of the isolated protoplasts, and (3) culture of the fused protoplasts in a nutrient medium (Fig.1).

Isolation of protoplasts. Viable protoplasts can be isolated by treatment with cellulolytic enzymes such as cellulase, pectinase and macerozyme. Protoplasts were first isolated from cells of a root tip, using a fungal cellulase, by Cocking (1960). S. S. Bhojwani of the Department of Botany, University of Delhi, and E.C. Cocking (*Nature New Biology*, **239**) reported in 1972 another promising technique of isolating haploid protoplasts from pollen tetrads. The isolated protoplasts, when transferred to culture, can regenerate their cell walls and start dividing. Such protoplasts can be used either directly for parasexual hybridization or for the multiplication of the parental stock. It is now possible to isolate protoplasts under conditions which prevent their fusion and later transfer them to an appropriate medium to induce fusion.

Fusion of the isolated protoplasts. The first successful attempt to fuse isolated plant protoplasts was made by J.B. Power *et al.* of Department of Botany, University of Nottingham, U.K. (*Nature*, **225** : 1970). Fusion may occur spontaneously under certain conditions, but can be considerably enhanced by application of suitable chemicals such as sodium and calcium in appropriate concentrations; pH of the solution used is critical in bringing forth successful fusion. Fusion of protoplasts from

two different species has now been observed in protoplast cultures of Maize×Oat, *Torenia bailloni*×*Torenia fournieri*, *Glycine max*×*Vicia hajastema*, *Petunia hybrida*×*Nicotiana tabacum* and *Nicotiana glauca*×*Nicotiana langsdorfii*.

Culture of hybrid protoplast. The hybrid protoplasts are transferred to suitable culture media under aseptic conditions to produce new clones that grow successfully in culture. These clones establish themselves, when transferred to soi, land produce flowers and fruits with viable seeds; they can also be grafted on to the parent stocks to make the scions mature into branches that produce flowers and fruits.

P.S. Carlson *et al.*, Department of Biology, Brookhaven National Laboratory, New York, U.S.A. (*Proceedings of the National Academy of Sciences*, U. S. A., **69** : 1972) were the first to utilize the technique of parasexual hybridization effectively. Using isolated mesophyll protoplasts of *Nicotiana glauca* and *Nicotiana langsdorfii*, they were able to produce plants with hybrid genetic constitution that produced flowers and fruits with viable seeds.

Culture of haploid cells

Microspores possess a true copy of every gene present in the diploid parent as a result of pairing and segregation during meiosis. Exploitation of this unique genetic potential is the basis of pollen culture for producing clones of cells and whole plants carrying a single set of genetic information (haploids). The discovery of S. Guha and S. C. Maheswari of Department of Botany, University of Delhi, (*Nature*, **204** : 1964) that haploid plantlets could be obtained from anther cultures of *Datura innoxia* gave an impetus to the utilization of haploids in higher plants.

Techniques of angiosperm pollen culture have not yet been perfected. However, mature pollen grains of *Brassica oleracea* have been induced to form 'cell cultures' in hanging drop cultures by T. Kameya and K. Hinata of Institute of Agricultural Research, Tohoku University, Japan (*Japanese Journal of Breeding*, **20** : 1970); colonies of green, parenchymatous cells appeared in culture within 28 days. Development of embryoids from pollen grains of *Datura*, *Lolium*, *Nicotiana*, *Petunia* and *Oryza* is similar to those of the true zygotic embryos into plantltes. When large numbers of plantlets are produced in one anther, they can be separated soon after the anthers open. Plantlets so separated are then transplanted individually in fresh culture medium. After these plantlets develop adequate root system, they are transferred to pots. The freshly potted haploid plantlets should be kept preferably in a moist atmosphere for a few days until the roots get established.

Plants derived directly from pollen embryoids are mostly haploids, as are plants derived from the first generation callus. Sometimes a few plants give rise to an inflorescence carrying both diploid and haploid flowers. This is due to endomitosis (cell division in which the chromosome duplication and chromatid separation takes place within the intact nuclear membrane and without the formation of a spindle, resulting in a large polyploid nucleus) at some stage in he development of the plant. Plants of higher ploidies (plants with multiples of the basic chromosome complement) may also be obtained from those regenerated from a callus. For instance, S. Narayanaswami and L. P. Chandy, Bio-Organic Division, Bhaba Atomic Research Centre, Bombay (*Annals of Botany*, **35** : 1971) have reported the occurrence of diploid and triploid plants derived from the anthers of *Datura metel;* only 7% were found to be haploids. In *Oryza svtiva* plants derived from anther cultures have shown ploidy levels ranging from haploid to pentaploid. R. D. Iyer and S.K. Raina of Division of Genetics, Indian Agricultural Research Institute, Delhi (*Planta*, **104** : 1972) have shown that ploidy can be controlled by modifying the composition of the culture medium. So this method can be better adopted in ploidy breeding.

Pollen culture also offers considerable scope in the production of haploid mutants and in the phenotypic expression of mutation. Doubling of the chromosome complement of the haploid mutants leads directly to the formation of fertile and completely homozygous plants which retain the desired characteristics. This rapid method of producing homozygous plants is important in plant breeding and in programmes of crop improvement.

Genetic engineering is another area where haploid cell cultures are of potential value. Doubling the chromosome complement of haploid cells after introducing the gene for a desired character could lead to the production of homozygous plants with the introduced gene in duplicate. A successful attempt in this direction has already been made by Doy *et al.*, Department of Genetics, Research School of Biological Sciences, Australian National University, Canberra (*Proc. Australi. Biochem. Soc.*, **5** : 1972), by the transfer of genes controlling galactose metabolism, from the bacterium *Escherichia coli* to the haploid tissue of tomato. Likewise, attempts to transfer nitrogen fixing genes from microorganisms to genotypes of higher plants, if made successful, could lead to an increase in the nitrogen content of food crops. It will also solve the problem of protein deficiency and related malnutrition.

Mutants from tissue culture

To incorporate new and useful genes into genotypes of cultivated varieties, plant breeders have several

conventional methods of hybridizing the existing domestic varieties with wild ones. These methods often require vast areas of land, and considerable time and labour. To overcome this, selection of spontaneous and induced mutants from tissue cultures may be employed.

Spontaneous mutations

Recent techniques have made possible rapid isolation of spontaneous mutants in culture. It is now possible to grow a large number of isolated plant cells in a small area under aseptic conditions by proper manipulation of the culture media to regenerate embryoids, shoots or roots. In such cell cultures, spontaneous mutation may occur and the mutants can be isolated by proper techniques. The shoots developed from these mutant cells can be isolated and rooted by horticultural methods. The fact that large quantities of suspension cultures may contain only a few cells possessing a dominant mutation limits the scope of selection of spontaneous mutants from cultures. Only a few workers have succeeded in isolating spontaneous cellular mutants of potential agricultural value.

"And my theory is that a culture that grows out of mere tissue will tend to be vegetative."

Induced mutations

In addition to the selection of desired spontaneous mutant phenotypes, mutations can be induced in culture with the aid of mutagenic agents such as chemical mutagens and ionising and non-ionising radiations. This involves four steps: (1) production of callus or suspension cultures; (2) induction of mutations using mutagenic agents; (3) selection of desired mutants, and (4) regeneration of mutant plants. This may, no doubt, produce more desirable mutations than those occurring spontaneously in culture and may make selection of mutants easy. Mutating the seed or any propagules (plant parts used for propagation) may lead to the production of chimeras (a mixture of genetically different tissues) rather than mutation of the whole material due to their multicellular and differentiated nature. Production of chimeras can be avoided to a great extent by mutating the cells in culture or isolated pollen grains before fertilization.

Production of mutant plants from cell cultures encounters the following problems: (1) absence of suitable tissue culture techniques; (2) difficulties in selection of mutant phenotypes; (3) retention of mutant phenotypes in regenerated plants, and (4) appearance of cytological alterations which may lead to progressive loss of total potency.

Tissue culture could be a great boon to future crop improvement programmes. It hastens the availability of new varieties, with commitments of less land and labour, and time. Even with cultivars that are propagated through conventional asexual techniques, tissue culture can be utilized to boost up their rate of multiplication. But the techniques available are inadequate for the proper identification and selection of mutants in culture. Moreover, cytological instability of cells in culture leading to a progressive loss in total potency limits the scope of tissue culture in the present plant breeding programmes.

Further reading

1. Carlson, P. S., Smith, H. H., and Dearing, K. D. (1972), *Proc. Nat. Acad. Sci.*, **69**: 2292-2294.
2. Cruse, P.F., and Patterson, M. K. (Ed.) (1973), *Tissue Culture: Methods and Applications*, Academic Press, London & N.Y.
3. Kachroo, P. (Ed.). (1976), *Recent Advances in Botany* (Prof. P. N. Mehra Commemorative Volume), Periodical Experts Book Agency, Delhi, Pp. 296-308.
4. Murashige, T. (1974), *Ann. Rev. Plant Physiol.*, **25**: 135-166.
5. Nabors, M.W. (1976), *BioScience*, **26**: 761-768.
6. Smith, H. H. (1974), *BioScience*, **24**: 269-276.
7. Street, H. E. (Ed.) (1973), *Plant Tissue and Cell Culture*, Botanical Monographs, Vol. II, Blackwell Scientific Publications, Oxford.
8. Street, H.E. (1974), *Tissue Culture and Plant Science*, Academic Press, London & N. Y.

SOME FUNGI ARE HARMFUL TO HUMANS

Fungi play an important role in our daily life, but some of them are dangerous too

S. K. PRABHUJI

S. CHAKRABARTI

UNLIKE most microorganisms, fungi have been quite useful to man. They are used for making bread, fermented drinks, cheese and, more recently, useful organic chemicals including antibiotics. Their role in nature is that of scavengers; they break down complex carbohydrates and proteins of dead bodies into simple molecules. Only a few of them are pathogens and most of those affecting man are facultative (organisms that can grow on both living and dead organic matter) rather than obligate (organisms which can live only on living matter) parasites.

Infections produced by the true fungi, or eumycetes, are called mycoses. Nowadays, there are as many deaths reported from mycoses in U.S.A. as from whooping cough, diphtheria, scarlet fever, typhoid, dysentery and malaria put together. Furthermore, the superficial fungal infections such as ring worm and athlete's foot, though not dangerous, are extremely common in India. In north and north-eastern or tarai regions in India, fungal diseases (mostly dermatomycoses) are common because of the ever prevailing moist conditions.

In India, research work on the pathology of mycoses is being done at the All India Institute of Medical Sciences, New Delhi, Institute of Medical Sciences, B.H.U., Varanasi and K.G. Medical College, Lucknow.

The fungal spores (soil-borne or air-borne) may reach an wounded part of the body, respiratory tract and its associated sinuses, conjuntivae or the ear canal, or may be ingested. Under normal conditions they are eliminated, but if the body defences are impaired some non-pathogenic organisms may establish themselves as 'opportunistic pathogens' or 'opportunist organisms.'

A majority of the pathogenic moulds, yeast, yeast-like fungi and dimorphic fungi belong to the group *Deuteromycetes* (*Fungi imperfecti*) including some members of *Phycomycetes* and *Ascomycetes*.

Distribution

As early as 1960, Dr. L. Ajello of the United States Public Health Service had discussed the geographic distribution of these fungi. According to him, of the twenty known species, eleven are cosmopolitan; *Trichophyton megninii* is European, *Microsporum nanum* has been reported from Cuba only, while a few are endemic to Africa.

Sh. Prabhuji teaches botany at St. Andrew's College, Gorakhpur 273001 (UP); Miss Chakrabarti is a research scholar in the same college

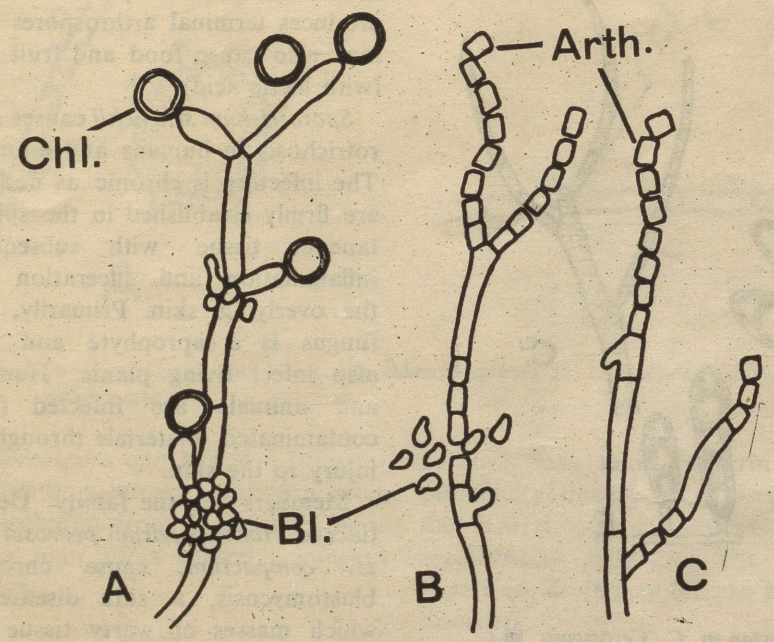


Fig. 1. A. *Candida albicans*, B. *Trichosporon beigeli*, C. *Geotrichum*, sp. (Chl. Chlamydospore; Bl. Blastospore; Arth. Arthrospore)

The dermatophytes (fungi causing diseases of skin) are studied under two heads for convenience : those causing superficial infection wherein only epidermal tissues are affected, and those involving underlying deep tissues.

Agents of superficial mycoses

The fungi causing dermatomycoses have the unusual ability of digesting and utilizing keratin (tough fibrous protein containing sulphur), and are capable of parasitising the keratinous structures of the body, e.g., the horny layer of the skin, the hairs and the nails. They do not invade the underlying living tissues that form the keratin, or the deeper tissues and organs of the body.

"I need your scalp, dear, to study the fungi that cause dandruff"

Tinea or ring worm is caused by four genera of *Deuteromycetes*, viz., *Microsporum*, *Trichophyton*, *Epidermophyton* and *Keratinomyces*. In this affliction, the spreading edge of the lesion is commonly seen as a red inflammatory ring (5mm-50mm in dia.) studded with vesicles and pustules, while the recovering central region is scaly and less reddened. Infected hair become weak and are readily broken off to produce bald patches. In some cases they show characteristic green fluorescence under ultraviolet irradiation. Infected nails become deformed, discoloured, brittle and broken.

Inside the host, the fungi occur in only two forms: (i) as vegetative mycelium growing through the keratinous structures, and (ii) as chains of cylindrical or rounded thick-walled 'arthrospores', formed by segmentation and separation of hyphae. The arthrospores are capable of infecting intact skin but they infect more readily if the skin is subjected to minor injury by rubbing, scratching or prolonged moistening. Hyphae in skin, nail or hair eventually give rise to arthrospores. In hair, the arthrospore formation may be endothrix (from hyphae within the hair shaft; large arthrospores) or ectothrix (from hyphae growing over the surface of the hair; small arthrospores). In the latter case, the hair bears a thick white coat of spores (Fig. 3).

Among human dermatophytes, some, e.g., *Trichophyton mentagrophytes*, *T. interdigitale* and *T. sulphureum* can attack many parts viz., scalp and hair of the head (*Tinea capitis*), skin and hair of the beard region (*Tinea barbae*), skin of the feet (*Tinea pedis*), skin of the groin (*Tinea cruris*), skin of the other parts of the body (*Tinea carporis*) and the nails (*Tinea unguim*). The dermatophytic species are divided into anthropophilic, i.e., primarily parasites of man and rarely of other animals, and zoophilic, i.e., primarily parasites of some animals and only occasionally infecting man. Species that are anthropophilic include *Microsporum andouinii*, *Trichophyton interdigitale*, *T. rubrum*, *T. sulphureum*, *T. violaceum*, *T. schoenleinii* and *Epidermophyton floccosum*.

The fungus spreads by contact and through air in the form of arthrospores. They are highly resistant to environmental conditions and may remain alive for years in infected sites and survive in clothing even after many successive washings. A parasitic form, *Microsporum gypseum*, has been found in soil and is capable of growing saprophytically. It is believed that the soil may occa-

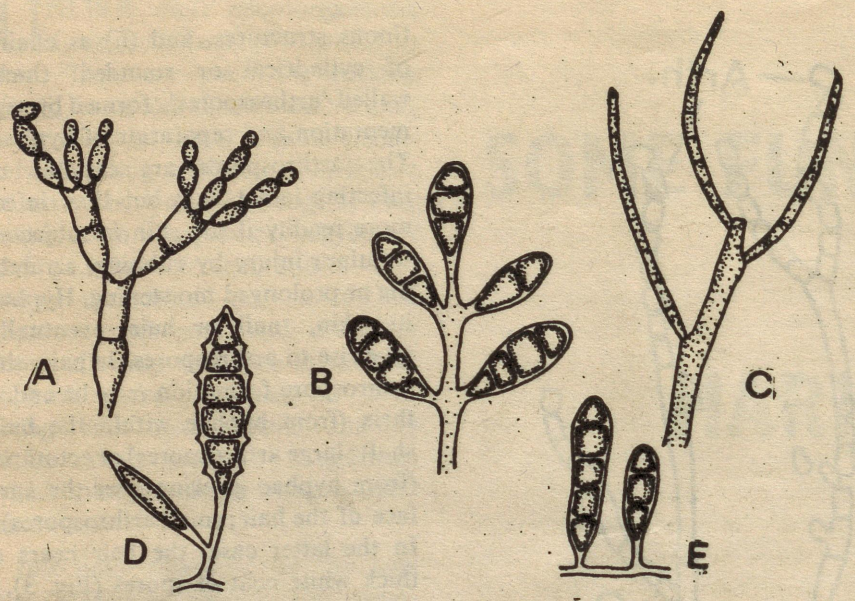


Fig. 2. A. *Hormodendrum* sp.; B. *Epidermophyton* sp. C. *Cercospora* sp.; D. *Microsporum* sp.; E. *Trichophyton* sp.

sionally act as a source of infection to man and animals. Other fungal members causing superficial infections, invading hairs and horny layers (not necessarily digesting the keratin) include filamentous *Trichosporon beigelii*, the yeast-like organisms *Candida albicans* and *Malassezia furfur* and the yeast *Pitryrosporum ovale* (causal organism of dandruff).

Trichosporiasis, also called 'white piedra', is a disease of the beard and moustache caused by the fungus *Trichosporon beigelii*. Treatment —just shave it off.

Agents of deep mycoses

Deep mycoses are diseases of the human body which affect tissues below the outer skin. They are usually chronic and serious in their effects.

The cutaneous blastomycosis is usually a primary infection of the skin. There is papule and pustule formation followed by ulceration and a slow peripheral spread in the skin, but there is no systemic dissemination. The causative agent is a fungus—*Blastomyces dermatitidis*. Systemic blastomycosis usually results from a primary infection of the lungs with subsequent bloodborne dissemination to the skin. The source of infection is unknown and the fungus has not been found as a saprophyte in the soil or elsewhere. Presumably, it enters the body by inoculation through the skin or by inhalation into the lungs.

Certain species of *Geotrichum* are known to be pathogenic to man. Conant and coworkers (1954) of U.S.A. described four forms of geotrichosis : oral, intestinal, bronchial and pulmonary. The fungus produces terminal arthrospores and may also cause food and fruit rots (with lactic acid).

Sporotrichum schenckii causes sporotrichosis in humans and animals. The infection is chronic as nodules are firmly established in the subcutaneous tissue with subsequent inflammation and ulceration of the overlying skin. Primarily, the fungus is a saprophyte and can also infect living plants. Humans and animals are infected from contaminated materials through an injury to the skin.

Members of the family Dematiaceae, *Hormodendrum pedrosoi* and *H. compactum*, cause chromoblastomycosis, a skin disease in which masses of warty tissue are formed over infected parts of the body, usually the legs, feet, arms and hands. They live saprophytically on wood and vegetation and enter the body through leg skin injury caused by wood.

Maduromycosis or Madura foot in man is caused not only by actinomycetes such as *Nocardia madurae*, *N. pelletieri* and *Streptomyces somaliensis*, but also by a variety of fungi like *Madurella mycetonii*, *M. grisei* and *Cephalosporium falciforme*. These fungi are believed to occur as saprophytes in the soil and on vegetative matter. They enter the tissues of the foot through thorn pricks and other minor injuries.

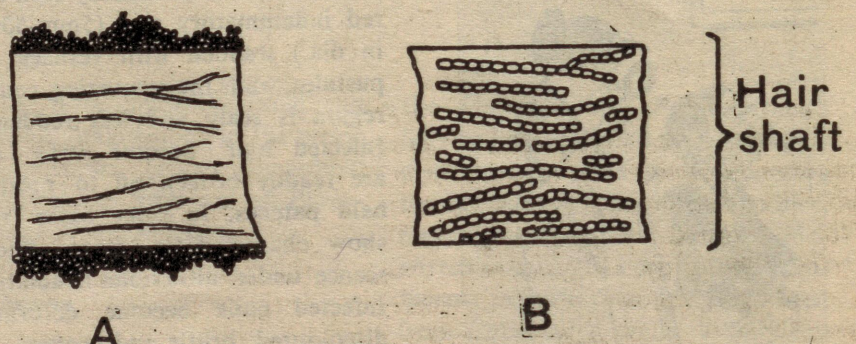


Fig. 3. Infected hair showing arthrospore formation : A. Ectothrix; arthrospores produced superficially, more in number and smaller in size; B. Endothrix; arthrospores produced inside the hair shaft, lesser in number and larger in size

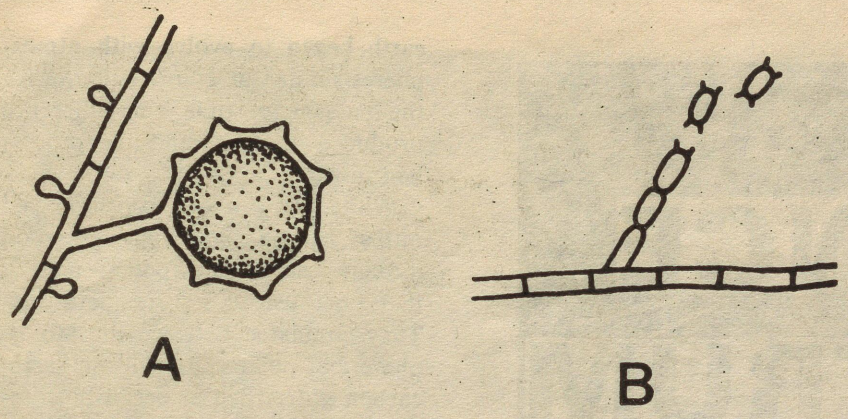


Fig. 4. A. *Histoplasma capsulatum* **with chlamydospores; B.** *Coceidiodes immitis* **with arthrospores**

Cercospora apii has also been reported as a human pathogen after its isolation from the thick leathery facial skin of a severely infected patient.

Diseases other than dermatomycoses

Various normally saprophytic species of *Aspergillus*, *Penicillium*, *Mucor* and *Rhizopus* are found in infections of the bronchi and lungs in humans and animals. *Aspergillus fumigatus*, *A. flavus*, and *A. niger* are animal and human pathogens which cause a group of diseases collectively known as 'aspergilloses'. In man, infection appears usually to supervene on a pre-existing pulmonary disease such as bronchitis, tuberculosis or pneumonia. It occurs most frequently in agricultural workers and others who inhale dusts of organic materials contaminated with fungal spores. The fungus may grow in the damaged bronchi or lung tissues and form a compact mass of mycelia called 'mycetoma'. In some cases broncho-pulmonary infection by *A. fumigatus* causes an asthmatic disease with plugging of bronchi by exudate containing mucus, fibrin and eosinophils.

The false yeast, *Cryptococcus neoformans* (syn. *Torula histolytica*), produces sporadic, but fatal infections known as cryptococcosis or torulosis in man and animals. Cryptococcosis may take the form of a pulmonary disease or a disease of the central nervous system called cryptococcus meningitis. The latter is serious, as it may lead to mental disorders.

Candida albicans (syn. *Monilia albicans*) is the only important pathogenic species in the yeast-like genus *Candida*. It is a common cause of acute and sub-acute infections (candidiasis or moniliasis) in man and animals. *C. tropicalis*, however, has been apparently found as the causal pathogen in oral and vaginal thrush but rarely in broncho-pulmonary infections. In 1954, Conant and coworkers (U.S.A.) recognized the following types of candiasis: candidiasis of mucous membranes (oral and vaginal thrush), cutaneous candidiasis (skin and nails, etc.), broncho-pulmonary candidiasis, and pulmonary candidiasis which is probably the most serious of all. Infection is generally dependent on a weakening of the body's defence mechanism, e.g., by diabetes, leukaemia, iron-deficiency anaemia, senility, alcoholism, etc. Infection of skin is promoted by prolonged exposure to moisture and lesions, generally localized in damp folds (intertriginous candidiasis), e.g., in the axillae, groin, infra-mammary areas, interdigital clefts, umbilicus and gluteal folds, etc.

One of the dimorphic fungi (fungi occurring in both mycelial and yeast-like forms), *Histoplasma capsulatum*, is the cause of histoplasmosis, a granulomatous disease in man. It usually occurs as asymptomatic infection of the lungs, or, rarely as a progressive, fatal systemic infection involving skin, upper respiratory tract, mouth and intestine. The fungus is found in the soil of endemic areas, but whether it grows in the soil as a saprophyte or enters the soil from infected animals is uncertain. Infection occurs due to inhalation of soil dust.

Coccidiodes immitis is another dimorphic fungus causing coccidiodomycosis, a granulomatous disease affecting man. It causes infection of lungs that spreads to skin, bones, meninges and other organs. The fungus occurs in the soil as saprophyte or perhaps is derived from infected animals. Infection is probably due to soil dust inhaled or introduced through injured skin.

Rhinosporidiosis is a chronic polyp-forming infection of the submucous tissue of nose, eyes, ears and larynx, and occasionally of the genitalia and skin. It is common in India and occurs sporadically in humans, horses and cows. The source of infection is unknown, though persons swimming in rivers and stagnant water are frequently infected. The causative organism, *Rhinosporidium seeberi*, has not been cultured, but its appearance in tissue indicates that it is a fungus.

Precautions

In view of the hazards of mycoses one should know how to minimise the number of deaths due to these microorganisms and how to check their transmission. The suggested precautions are:

1. Physical contacts with persons carrying dermatophytes should be avoided.

(*Continued on page* 757)

SCIENCE SPECTRUM

Mars is cloudy and windy

IN the past, man wrongly took Mars to be inhabited by intelligent beings. Likewise, he made wrong assumptions about the atmosphere of this planet. With Vikings there for more than a year, quite a detailed picture of Martian atmosphere is now available. No doubt the data collected by the earlier Mariner missions also enabled scientists to fill up gaps in the picture of Mars. And with the presumption that all that happens on Mars has not yet been revealed to the senses of Vikings, let us see what kind of world is that which has mystified man through ages.

Composition of atmosphere

It was previously deduced that atmosphere of Mars was not different from that of the earth. In other words, nitrogen should be present there in abundance and other gases in similar proportions. However, it is now found that carbon dioxide is abundantly available on this planet. It forms as much as 96 per cent of its atmosphere; 2.5 per cent of it is nitrogen, 0.1 per cent oxygen, and the rest is noble gases. The surface pressure is accordingly low. It is only 5 to 7 millibars as compared to the 1,013 millibars on the earth.

Why is there so much difference in atmospheric composition of these two close, similar planets? A planet possesses atmosphere, we know, when it releases gases from its surface during volcanoes or such like phenomena. Once gases envelope the planet, their "sticking" to it depends upon many factors, such as, the planet's gravity, the heaviness or lightness of the gas, the energetic rays falling on the planet, etc. Though it is easy to assume that Mars and earth were evolved in a similar fashion when solar system formed and they must have possessed envelopes of gases of almost similar composition, it is difficult to explain the contrast as found now. However, some explanation based on models has been offered.

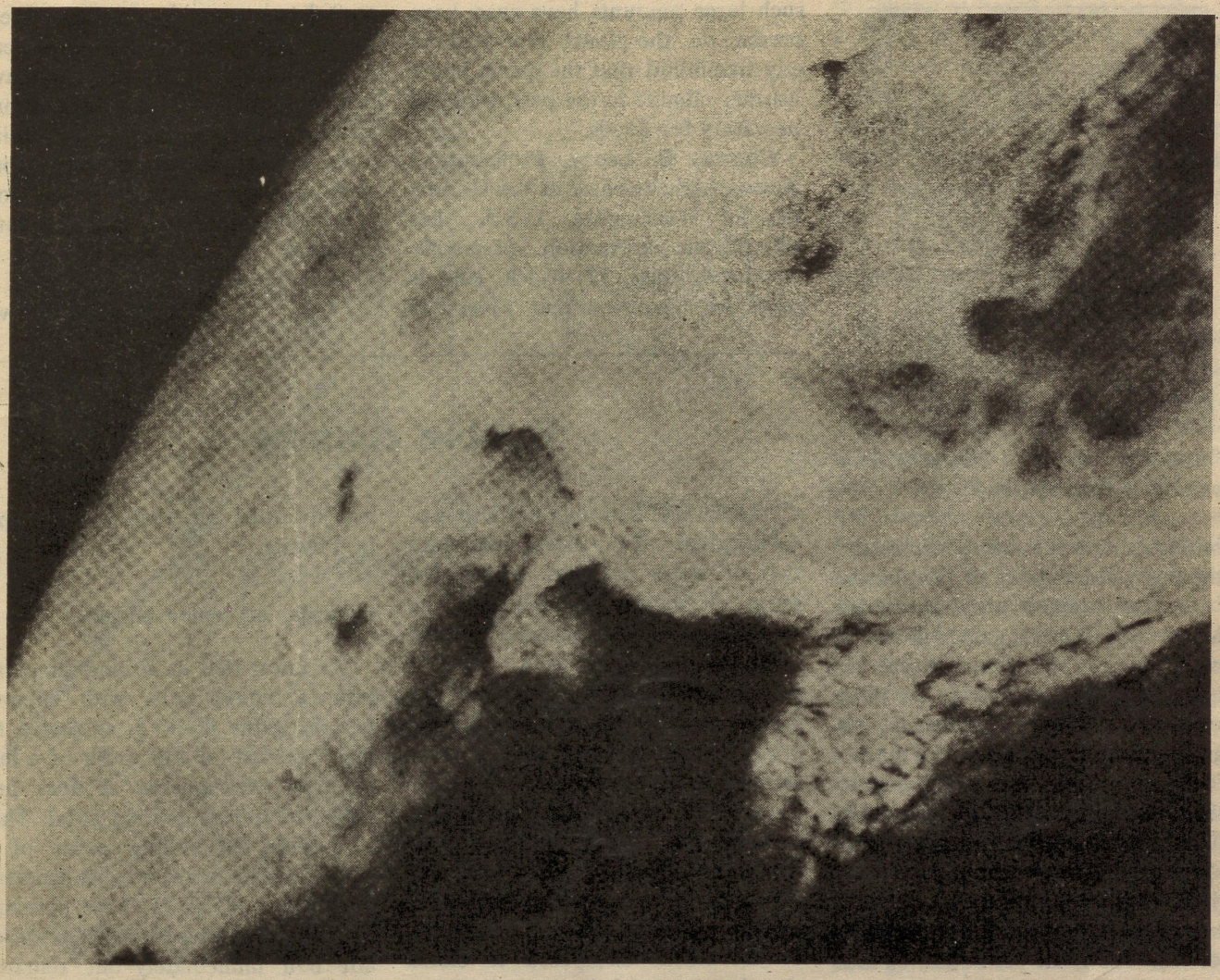
Mars is covered, unlike earth, with no layer of ozone. It is therefore not shielded from the ultraviolet rays coming from sun. These rays energise certain gases and, as the gravity of Mars is weaker than that of earth, it is easy for some to leak out of its atmosphere. On the earth, nothing of the kind happens except for a few gases. So even though Mars and earth began to evolve with atmospheres similar in composition, with the passage of time one difference produced another, and the process continued.

While nitrogen and oxygen leaked out of Martian atmosphere, carbon dioxide and water vapour remained there because of low temperatures. They circulated between the atmosphere and polar caps. On the earth, carbon got settled at ocean bottoms and beneath the rocks while carbon dioxide remained in the atmosphere in small quantities. Oxygen was released as life began to evolve, water vapour condensed to produce oceans, and nitrogen more or less remained "tied" to the atmosphere. This explains in a simple way the contrast now observed.

Climate

Speaking in terms of earthly conditions, Mars has a dry climate. But if the low pressure existing on its surface is taken into account, it has a highly humid climate. Like the earth, the humidity is not same at all latitudes. It increases with latitude. As Mars has no umbrella of ozone layer, its surface and atmosphere are directly exposed to the piercing ultraviolet rays coming from the sun. Apparently, some reactions take place. For instance, according to calculations, ozone, atomic hydrogen, carbon monoxide and hydrogen peroxide should be produced.

The escape of atomic hydrogen from the upper atmosphere of Mars has been detected by the Vikings while descending. Also, ozone in small amounts has been detected mostly in polar regions. The confirmation of the production of these two gases on Mars has proved our calculations to be right. Therefore, yet undetected carbon monoxide and hydrogen peroxide must also be produced there. The reason why the Martian soil appears oxidized (from the photos) is attributed to the action of hydrogen peroxide.



The vast Martian dust storm that occurred in February 1977. This was photographed by the *Viking 2* orbiter at a point 33,000 km. above the surface of the planet

The presence of clouds on Mars may not surprise any one. But the fascinating aspect of the Martian atmosphere is that it has, besides clouds carrying water ice (frozen water), also those carrying dry ice (frozen carbon dioxide). This is suspected on seeing the photos sent by the Vikings. The only difference in appearance between these two types of clouds is that, while water-ice clouds look diffuse, the dry ice clouds have sharp edges.

Like those on the earth, Martian clouds also grow and decay with remarkable regularity, indicating a day-to-day weather on this planet. The dry ice clouds are mostly found in the polar or higher altitude regions where temperature is low. It is also suspected that the dry ice snowstorms may also be occurring in winter and might have a hand in creating the famous seasonal dry-ice polar caps.

Martian winds are—like the terrestrial ones—westerly in direction upto a considerable altitude. 10 meter/ sec to 20 meter/sec is the typical wind speed recorded at the surface while greater than 100 meter/sec at an altitude of 10 kilometer. If these winds are to be compared with those recorded on earth at the same levels, Martian winds are fierce, so to say.

The most unexpected discovery that Viking made when it landed on Mars was the presence of ground fogs. While some low lying areas remain covered with fog throughout the day, in the rest it lifts with the rising of sun. It again spreads with the approach of the night.

The seasonal changes on the surface of Mars, which the Italian astronomer G. Schiaparelli attributed to the working of intelligent beings, were clarified by earlier Mariner missions to be nothing more than dust storms regularly occurring on this planet. Schiaparelli's conjecture now looks like a hilarious joke! Now that Mars' atmosphere has been probed, the reason why dust storms occur, to a certain extent, is clear. The

"Amazing! It is no different from our home atmosphere."

initiators are the fierce winds and the dusty atmosphere of the planet.

In the rarefied atmosphere of Mars, wind speeds, as high as 30 meter/sec to 60 meter/sec, are required to carry the grains. As there occurs no rain after the storms, the grains remain suspended in the air for weeks and months. It is due to them that Martian sky has a pinkish tint, just as our sky has blue. Sunlight scatters the dust to produce the tint. On a little prodding by the winds, the hanging dust causes dust storms. The game continues, on and on.

Apart from these earth-like local dust storms, storms on a global scale also occur on Mars. It is claimed that this phenomenon generally occurs once in a Martian year when the planet is closest to the sun in its elliptical orbit. The increased solar energy then falling on the planet causes it. However, the Vikings suspect that these global storms are more frequent.

The channels

The most baffling signs on Mars are the channels and soil which look eroded by water. The only explanation offered for these markings is that once upon a time floods appeared on this planet. This seems unlikely, as estimates show that no water in such large amounts have ever been present on the planet. Nor is there any likelihood that the planet had a warmer climate in the past, which is necessary for floods.

Conway B. Leovy, Professor of Atmospheric Sciences at the University of Washington, U.S.A., has offered an explanation (*Scientific American*, July 77) which sounds plausible. He claims that Mars had once been covered with water ice. Cataclysmic events, such as volcanoes or falling meteorites, may have made water ice to evaporate. What immediately followed was torrential rains which caused floods. May be, such a thing also happened on earth before oceans came into existence.

DILIP M. SALWI

Bubble chamber

SOMETIMES atomic particles disintegrate by themselves into two or more particles which are more elementary in nature. The newly generated particles take divergent tracks. With a vapour-filled cloud chamber, this rare occurrence cannot be recorded, as the probability of collision of the particle with gas molecules is very small. The collision probability can be increased either by increasing the pressure of the enclosed gas, or by introducing a series of lead plates in the chamber at the cost of length of the track. Compared to cloud chamber, a particle has a much higher collision probability in photographic emulsion (*S.R.*, Jan. 1977) as the dense emulsion makes collision a frequent affair. However, the particle trajectory is so crooked that the exact effects of a magnetic field cannot be measured. Also, it is difficult to protect the photographic emulsion completely from the all-pervading cosmic radiation that masks much of the useful tracks. These difficulties called for a new device, better than both the cloud chamber and the photographic emulsion. In 1952, this demand was fulfilled satisfactorily by Donald A. Glaser of Michigan University, USA, with the invention of a new detector called 'Bubble chamber'. For his ingenious discovery, he was awarded the 1960 Nobel Prize in Physics.

Principle of bubble chamber

We know that at boiling temperature, a liquid boils with effervescence. If the liquid is subjected to high pressure of the order of a few hundred atmospheres, it does not boil at its normal boiling point. This is because the boiling point of a liquid usually increases with increase in pressure. (Fig. 1) If the pressure is suddenly reduced, the liquid does not boil immediately but remains quiescent for some time. The liquid at this moment is said to be superheated. The quiescent period de-

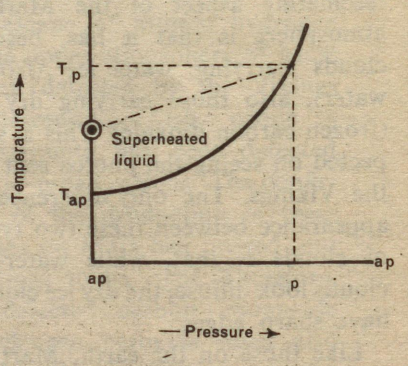


Fig. 1. ap-atmospheric pressure; P-superincumbent pressure: T_p-boiling point of liquid at p; T_{ap}-boiling point of the liquid at ap

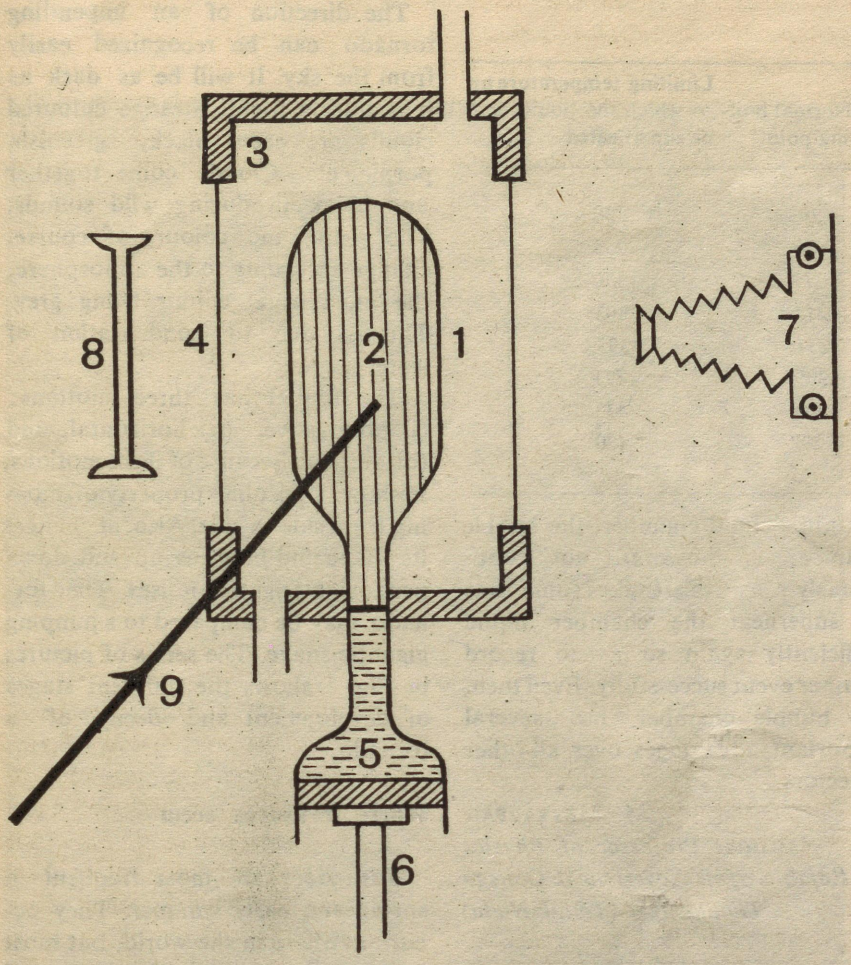


Fig. 2. Glass bulb (1); superheated liquid (2); oven (3); window (4); water (5); piston 6; camera (7); light source (8); ionizing radiation (9)

pends upon the nature of the liquid and the degree of superheating, i.e., the temperature above the normal boiling point. The greater the degree of superheating, the greater is this quiescent period. In a bubble chamber, this superheated liquid behaves like the super-saturated vapour in the cloud chamber.

Superheated liquids possess a sort of instability against bubble formation which is analogous to the instability of a supercooled vapour against drop formation. Glaser found that a charged particle triggers the formation of microscopic bubbles in a superheated liquid and it starts boiling. As a result, small bubbles form all along the path of the ionizing particle in the liquid. This produces a visible track. By illuminating the bubble tracks by photoflash, they can be photographed.

Structure of bubble chamber

A bubble chamber consists of a heavy-walled cylindrical pyrex bulb 3-4 cm long and 1-2 cm in diameter, which is filled with a suitable liquid. The liquid-filled chamber is immersed in a thermostat-controlled liquid bath (Fig. 2). By moving the piston, any desired amount of pressure can be applied to the liquid in the chamber to make it superheated. Generally, the liquid remains quiescent in this unstable state for several seconds, then violent boiling takes place. If during the quiescent period, an ionizing particle is allowed to pass through the chamber liquid, it leaves behind a string of bubbles. L. W. Alvarez of California University, USA, found that the performance of the bubble chamber is still better if the chamber volume is sufficiently large and the pressure of the compressed liquid is dropped rapidly.

Superheated liquids

The liquids used in bubble chamber must have certain specifications to get a clear record of the tracks. (1) The liquid should be non-conducting, so that the charge of ions is retained; (2) it should have low surface tension, so that the force tending to collapse a bubble is weak; (3) it should have high vapour pressure which would tend to enlarge each bubble formed in the liquid, and (4) it should be more or less transparent, so that the bubbles formed by the penetrating ion can be photographed or even seen with the naked eye. Many pure liquids and some solutions satisfy these conditions. The choice is usually made on the basis of the nature of ionizing particle and the target material for study. In general, for all types of works, diethyl ether and liquid propane and pentane are used, as they are easily available and operate at convenient temperatures and pressures.

Uncharged particles do not ionize the molecules of the liquid and so do not produce tracks. To study X-rays, gamma rays and uncharged particles like neutrons and neutral pions, a highly dense liquid must be used in which a definite collision reveals its presence and position. For this purpose, liquids like stannic chloride or methyl iodide dissolved in propane, tungsten hexafluoride and xenon are used.

The quiescent period of a superheated liquid is an important parameter. If it is higher, rare nuclear reactions can be studied.

Table 1

Liquid	Chemical formula	Normal boiling point	Limiting temperature up to which the liquid can be superheated
Hydrogen	H	20	30
Xenon	Xe	166	255
Nitrogen	N	77	170
Trifluro methyl bromide	CF_3Br	214	303
Propane	C_3H_8	231	333
Pentane	C_5H_{12}	309	393
Diethy lether	$C_4H_{10}O$	309	413
Dibromo difluro methane	CF_2Br_2	298	420

The measurements with bubble chamber yield promising results. Energies of particles can be deduced from the depth of penetration required to stop them in the dense liquid. The nature of the electrical charge of the particle and its momentum can be determined by applying a transverse magnetic field and finding the curvature of the track. From the density of bubbles along a track, the charge and speed of the particle can be estimated.

Unlike cloud chamber, the bubble chamber is, however, not continuously sensitive. It takes some time to superheat the chamber liquid sufficiently again so as to record another event successfully. Even then, the bubble chamber has several important advantages over all other detectors.

M. MEYYAPPAN
Assistant Professor of Physics
Rajah Serfoji Government College
Thanjavur-5 (Tamil Nadu)

What is a tornado?

IN nature, we see many violent phenomena, like volcanoes, earthquakes, landslides, storms etc. To these can be added the tornadoes, which are one of the most violent and devastating atmospheric phenomena known to man. Their characteristics are fantastic; results utterly drastic. A tornado can be distinguished by its funnel-shaped cloud which extends downwards from the base of a turbulent cloud layer. It moves in an unpredictable path with the lower end of the funnel moving back and forth causing distruction wherever it touches the ground.

When two air masses with different temperatures and moisture contents meet, violent convection currents are set up. They produce spiralling movement of the air known as vortex motion which is the characteristic of a tornado. The centrifugal force of the whirl reduces the pressure within the vortex and rarifies the air. This rarefaction causes cooling which in turn causes condensation of water vapour releasing enormous amounts of energy. The difference between the atmospheric pressure and the internal pressure of the vortex is an important factor.

The direction of an impending tornado can be recognized easily from the sky. It will be as dark as it is during night. Strange coloured clouds are seen—black, greenish, purple etc. Clouds come together and break producing wild sounds. The shape and colour, of course, change according to the atmosphere, the most usual colour being grey. This is due to condensation of water vapour.

The funnel has three motions: (i) progressive, (ii) horizontal, and (iii) vertical. Because of these motions, it shows a peculiar property of moving from side to side. Also, it changes its shape and bounces up and down producing frightful noises. The tornado may be compared to a jumping gigantic snake. The series of pictures in Fig. 1 shows the different stages of development and decay of a tornado.

Where tornadoes occur

Tornadoes are most frequent in spring and early summer. They occur anywhere in the world, but most frequently in the great plains and valleys of America, namely, Mississipi, Ohio, and Lower Missouri Valleys. In India, occurrence of tornadoes is rare. However, there are records of their occurrence near Moradabad, Mawana, Gunnam and Delhi.

Dimensions

A tornado whirls at a tremendous speed. The greatest velocities are reached at the centre of the funnel. According to the law of conservation of angular momentum, the outer air currents must tend to move faster as they approach the centre. The speeds cannot be measured directly because no instrument is capable of withstanding that power. So they are obtained from the after-effects. The range lies between 135m/sec-175 m/sec., though

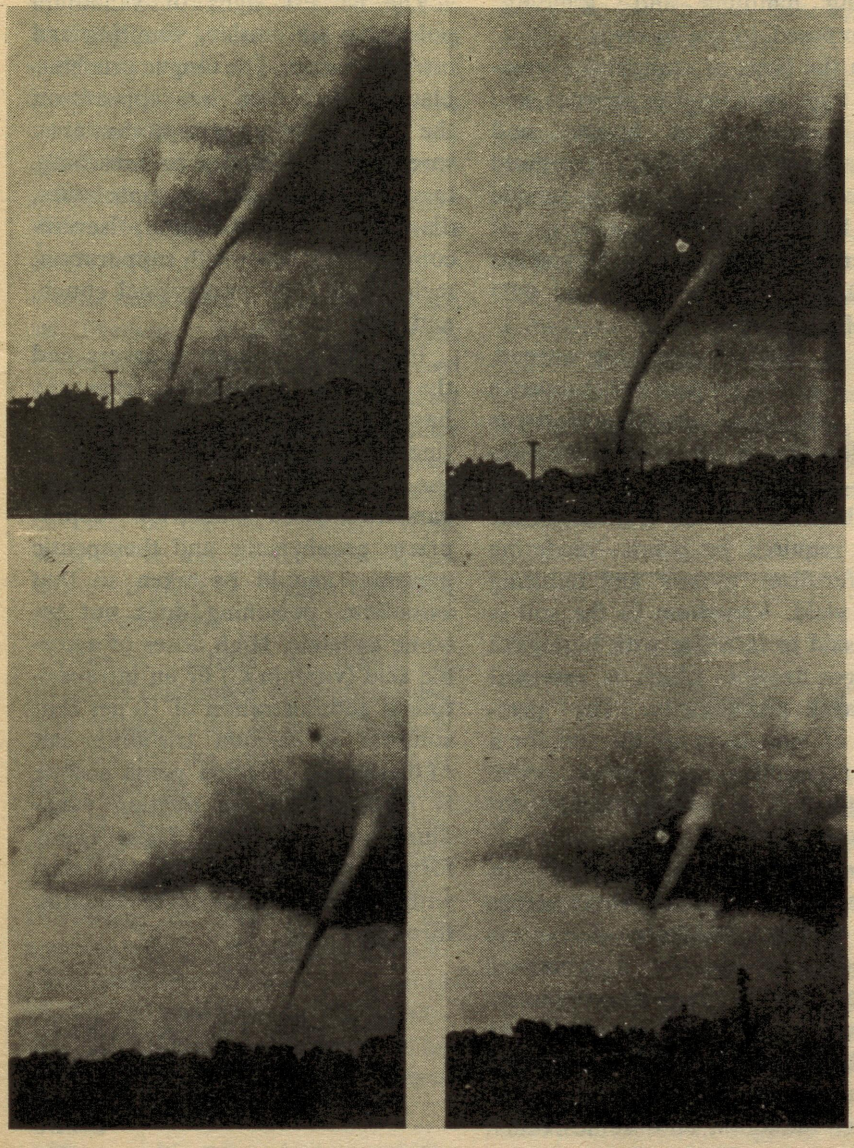


Fig. 1. Various stages of development and decay of a tornado near Manhalton, Kansas, U.S.A., May 31, 1949 (*Courtesy* : H. E. Dale and University of Oklahoma Press)

theoretical velocities above 880 m/sec. have been calculated. The length of the path of a tornado till it lasts varies between 250 meters-36,960 meters. The diameter of the funnel is usually a few hundred meters. The central pressure may be as low as 60%-80% of the normal atmospheric pressure, i.e., 600-800 milli bars. The central pressure has not yet been recorded directly as the centre rarely passes through a meteorological observation station.

To obtain the dynamics of the tornado, laboratory models have been developed, one of them by J. S. Turner of Woods Hole Oceanographic Institute, California, U.S.A. According to him, the whole of the vertical motion is confined to a cylinder around the axis. Near the axis is a region of up-flow and an annular ring surrounding this contains the compensating downward flow. In-flow takes place from the bottom of the funnel. The vortex is driven from place to place at the cloud region.

In order to study the vortex motion of the atmosphere, which is responsible for the formation of the tornado, modelling of vortex flows is being attempted. It has not yet been possible to identify the tornadoes by the use of radar pictur e. Research in this field is in progress.

N. C. V. N. CHAKRAVARTHY
Department of Geophysics
Andhra University
Waltair-530003 (A.P.)

Environmental hazards of vanadium

ENVIRONMENTAL experts have recently issued a warning on the use of vanadium which according to them may act as a potentially dangerous pollutant and may adversely affect the productivity of farms and forest land. These experts, belonging to the Monitoring and Assessment Research Centre (MARC) at Chelsea College, London, have placed vanadium along with other potential environmental hazards like mercury, lead, cadmium and DDT. Some of them have already been included in the list of priority chemicals and are constantly being monitored by

the Centre for any possible environmental damage.

Widespread interest in vanadium toxicity has been spurred by the recent discovery of high concentration of vanadium compounds in fly ash from combustion of residual petroleum products and coal from some parts of the world. In the United States alone, the atmospheric concentration of vanadium is reported to be about a million times higher than in south polar air.

The concentration of vanadium in coal and crude petroleum oil is low but appears to vary widely among different sources of coal or petroleum and within a particular oil or coal field. Vanadium is also present in certain lignites, shales, fireclays, asphalts, terrestrial plants, sea water and marine muds.

It also occurs in the blood of certain sea squirts and sea cucumbers where it forms upto 10 per cent of the blood cell pigment. Vanadium concentration in these animals is often 10,000 times that in the sea water in which they live. These creatures lie fixed to sea rocks and their fossilized remains account for the presence of vanadium in petroleum in some parts of the world.

The ores of vanadium are distributed mainly in Peru, Colorado, Utah, South-West Africa and Zambia. In India, substantial quantities of vanadium can be recovered as byproduct in the alumina plants during processing of bauxite.

Exposure

With the increasing production and use of vanadium, the handling of its different compounds has become an industrial health problem in many countries. Workers engaged in the manufacture of vanadium pentoxide from vanadium concentrated slag and ferro-vanadium in pelletizing plants, in the cleaning of oil and gas fired boilers, in refinery operations using vanadium as a catalyst, in glass and ceramic industry, in electronics and in smaller plant operations involving handling and grinding are exposed to the hazards.

On the basis of available information, from industrial experience and from experimental human and animal studies, the threshold values for vanadium pentoxide fixed by the American Conference of Governmental Industrial Hygienists are 0.5 mg/M^3 (for dust) and 0.05 mg/M^3 (for fumes).

As the MARC report has warned, there is a clear evidence that even a small amount of vanadium destroys soil fertility. It prevents mineralisation—a process by which nutrients are liberated from the fertilizer in the form required by plants—rendering the fertilizer useless and reducing crop yield. Vanadium in the soil is also said to interfere with biological nitrogen fixation which is essential for farm productivity. The presence of vanadium in the soil for a longer period may, therefore, prove catastrophic for agricultural production.

The presence of vanadium in atmosphere in metropolitan cities leads to high incidence of cancer, next only to smoking. A survey of air pollutants and smoking habits of persons in six European cities and North Wales revealed that incidence of lung cancer was due to cigarette smoke, vanadium and some other metals present in the air.

Symptoms

The earliest signs of vanadium poisoning are nausea, vomiting and intensive cough. The tongue gets blue-black and a blue line appears on the gums. Other symptoms are : sore throat, difficulty in breathing, loss of appetite, anaemia, emaciation, diarrhoea, blurred vision, severe-conjunctivitis often with suppuration, melancholia, dry paroxysmal cough, and albuminuria.

In order to protect workers and the general population from the hazards of vanadium pollution, routine of screening should be done of the population living in and around vanadium-based industries. Appropriate prophylactic and therapeutic measures should be taken so that vanadium poisoning does not become endemic. High doses of ascorbic acid (vitamin C) or an intraperitoneal administration of 10 per cent solution of calcium trisodium salt of diethylene triamine penta acetate is recommended in treating vanadium poisoning cases. These agents form soluble complexes (chelates) with vanadium and excrete the latter through urine.

R. R. KHAN
Scientist
Industrial Toxicology Research Centre
Lucknow-226001

Indium, the "chewing gum" metal

THE first consignment of the ultra high purity indium produced at the Special Materials Plant of the Nuclear Fuel Complex, Hyderabad has been exported to West Germany. This is a part of an export order for 150 kg worth Rs. 3.5 lakhs.

The Special Materials Plant was set up at the Nuclear Fuel Complex, primarilly for producing ultra pure materials needed for the electronics

industry. Ultra high purity indium is used in the manufacture of germanium transistors. It is also used in the manufacture of flux-free, low melting soft solder. The process of production of this material from crude indium, developed initially at the Chemistry Division of the Bhabha Atomic Research Centre, was adopted at the Special Materials Plant for regular production on a large scale.

The metal which Ferdinand Reich of Freiberg School of Mines, Germany and his assistant discovered in 1863 remains one of the rarest of the elements, although the price has fallen from the $40,000 valuation which its discoverers placed on each of the two pencil sized samples. It was named indium because it gives an indigo coloured line in spectrum.

Usually, indium is found in zinc ores associated or compounded with another rare metal, gallium. It is extracted as hydroxide which is then reduced to obtain metallic indium. Ultra high purity indium is made from this by a special process. It involves multistage electrorefining of crude indium in an aqueous solution of indium sulphate. Electrorefining is done by using anodes of crude indium and cathodes of highly pure indium. The cathode deposit so obtained is cast into ingots under vacuum.

The metal is soft and silvery white. It is lighter than zinc, more lustrous and less tarnishable than silver; melts in a match flame at a temperature of 155°C and is so soft that you can dent it with your thumbnail. In fact, pure indium can be chewed like chewing gum—if you have good strong teeth.

The indigo metal entered industry in the form of a dental alloy. Indium-gold alloy inlays have greater strength and ductility, and also more resistance to tarnishing than any other alloy known to dentists.

Indium was used in special bearings for making propellers of aeroplanes in World War II. These steelsilver-lead-indium bearings also performed excellently in tanks, jeeps and other mobile equipment which are assigned heavy duty. Zinc-indium coating on hollow steel propeller blades of ships protect them from rust.

Large amounts of this metal added to gold produce a blue gold. The colouring is accompanied by a desirable hardening of gold.

Pure silver that has slight amount of indium diffused into its surface resists blackening or tarnishing when exposed to sulphur bearing atmosphere present in homes that use coal as a fuel.

Added to silver solders and other brazing alloys in quantities as small as 1 or 2 per cent, indium produces a harder, stronger brazing material. Moreover, these indium solders have a high degree of wettability, so much so, in fact, that they can be used to solder metals to glass.

Indium takes a very high polish and for this reason it has been used in plating special mirrors.

Ultra high purity indium is used for p-doping in semiconductor technology (particularly germanium transistors) and in the manufacture of flux-free low melting soft solders in the electronics industry.

G. V. JOSHI
Oil and Natural Gas Commission
Bombay

Role of zinc in plants

ZINC is well-known to us as a mineral micronutrient (partially mobile) essential for normal growth of plants. However, our knowledge of its role in plant physiology and metabolism is far from satisfactory. As early as 1869, J. Raulin (France) suggested that traces of zinc were necessary for the growth of the fungus *Aspergillus niger*. Definite evidence in support of zinc requirement for higher plants was first provided in 1941 by P. Maze of Pasteur Research Institute, Paris, who showed that without addition of zinc, normal growth of maize plant would not occur. In 1928, A. L. Sommer of the University of California proved the necessity of zinc for several higher plants including barley, sunflower, broad beans, kidney beans and buck wheat.

Effect of zinc on growth

R. T. Policarpochkina and E. E. Khavkin of Sibirskii Institute, Irkutsk (U.S.S.R) reported in 1971 that inadequate supply of zinc inhibited growth of roots and leaves in maize plants, formation of lateral roots (isolated from maize plant), and reproduction of tobacco tissue cells in suspension culture, confirming the necessity of zinc for cell division. Increase in the dry matter production in maize plants with the application of zinc has also been observed. Sommer's earlier experiments on bean plants demonstrated that zinc was essential for reproductive processes. Delay in flowering due to zinc deficiency in maize plants has also been noticed. E. Polar (1975) at Cemece Nuclear Research Centre, Turkey, suggested that zinc in pollen grains plays an important role during fertilization. A reduction in yield of many crops like beans, paddy, wheat and maize has been found due to zinc deficiency.

Plant metabolism

Zinc is involved in several metabolic functions of plant including auxin metabolism, protein synthesis, nucleic acid metabolism, carbohydrate metabolism, etc. Chlorophyll content decreases under zinc deficiency. It might be due to the accumulation of δ-ALA (a precursor of chlorophyll biosynthesis) or non-availability of Mg^{++} at the site of chlorophyll synthesis. It has also been found that $^{14}CO_2$ fixation rate is reduced under zinc deficiency, which might be due to the inhibition of some enzymatic activities in the dark reaction of photosynthesis. Not only CO_2 fixation but also the intermediates of the carbon assimilation cycle are affected. For instance, there is an increase in glucose, fructose, and sugar phosphates on the one hand and decrease of sucrose contents on the other. This suggests that zinc has some role in sucrose biosynthesis as well. There is decrease in the rate of RNA formation just prior to the onset of growth inhibition under zinc deficiency.

The cytoplasmic ribosomes of *Euglena gracilis* contain a significant amount of zinc and these organelles become extremely unstable in zinc deficient conditions. A decreased incorporation of ^{32}P in nucleic acids in rice plants, increase in amide, total amino nitrogen compounds and amino acids have been reported under zinc deficiency. This increase in amino-acids is usually accompanied by a decrease in the protein content of the plant. Prof. C. Tsui at the University of Wisconsin (USA) suggested in 1948 that zinc is required for the synthesis of tryptophan which is a precursor to auxin (a plant hormone) biosynthesis. Additional support for the role of zinc in tryptophan synthesis has been provided by the report that the activity of enzyme tryptophan synthetase is markedly reduced in *Neurospora* grown under Zndeficiency. The action of gibberellic acid increases by zinc in bean internodes.

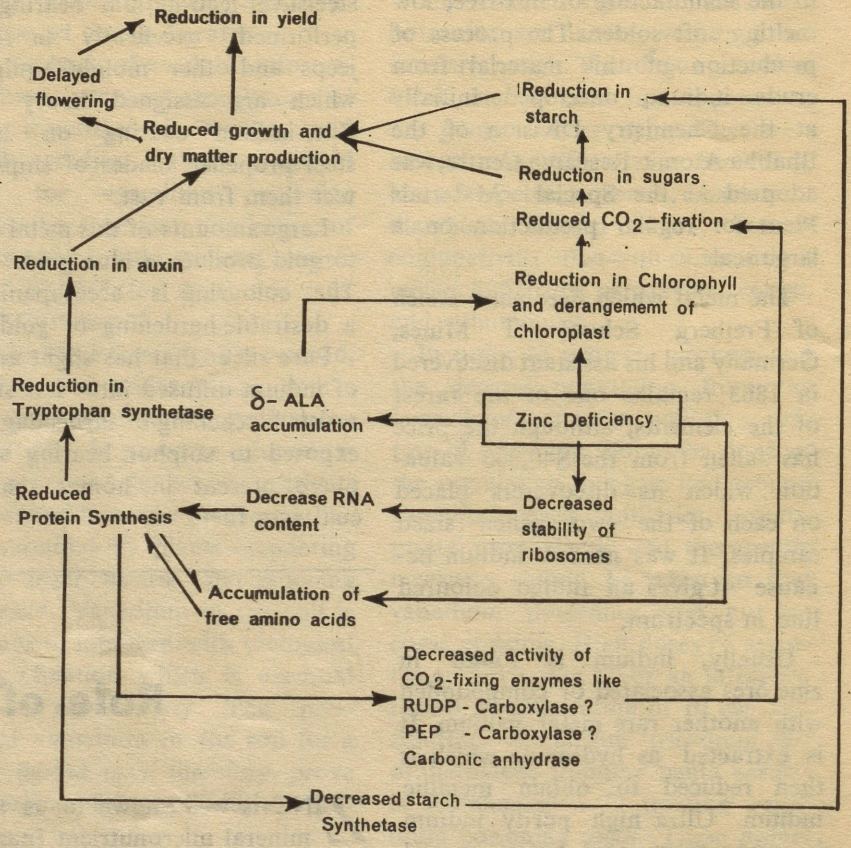


Fig. 1. Effect of zinc deficiency on growth, yield and metabolic changes in plants

A number of zinc metalloproteins have been identified in i higher plants, algae, fungi, bactera and animals. All zinc-dependent enzymes are metallo-proteins—the metal being firmly or covalently bonded to the protein.

Histological effects

In zinc deficient plants, the palisade and mesophyll tissue in leaves become abnormally compact, the number of palisade cells decreases and the cell becomes 12-16 times larger than the normal cells. The number and size of chloroplasts are reduced. The root-tip cells accumulate tannins, calcium oxalate crystals and oil globules. In maize, the mesophyll chloroplasts become swollen and the bundle sheath chloroplasts become "comma shaped" and devoid of starch grains.

Deficiency symptoms

Lack of zinc produces indistinctive symptoms in plants, associated with retardation of normal growth and lack of chlorophyll. The effect of zinc deficiency on crop plants has been variously described as "little leaf" of lemon, "sickle leaf" of cocoa, "bronzing" of tung, "little leaf" and "rosette" of apple, "white bud"

of maize, and "dieback" of citrus. Among the most characteristic symptoms are shortening of internodes, reduction of leaf size to 5%-10% of normal size and various forms of chlorosis. Root growth also decreases and produces irregular swellings behind the root apex where root hairs normally develop. The symptoms have been observed to appear first in older leaves in tobacco, tomato, peas and french beans, while in maize, both young and old leaves may show the symptoms. Initial symptoms are a light interveinal chlorosis of older leaves, which rapidly progresses to form a broad bleached stripe, severe stunting of plant follows and pollination is poor.

C. K. SHROTRI
Radiotracer Lab.
College of Basic Sciences
and Humanities
Pantnagar-263145 (U.P.)

They are not all mosses

MOSS is the common name given to lower green non-vascular plants belonging to the class musci, a sub-division of Bryophyta. These plants usually form thick greenish carpet on earth surface, walls, woods or even on rocks. But the term "moss' is loosely applied to a number of unrelated organisms which show only certain superficial resemblances. The following are some of the false mosses of the plant kingdom.

Algal mosses

Mosses are formed by algae. The blue green algal organism, Protococcus, sometimes forms a greenish film called "moss" on tree trunks, posts and stones. It is interesting that these algae grow only on the north side of the trunk. It is not known why it is so.

The *Carragheen moss* or Irish moss of commerce is represented by the red alga, *Chondrus crispus* (Fig. 1a). It is the best known and most widely used food alga in western Europe. When mixed with cold milk, seasoned with vanilla or fruit, it turns into a delicious food known as Blancmanges in Europe. Carrageenin is extracted from this "sea moss."

The moss often associated with reindeer covers large areas in northern Europe and America. It is a lichen formed by the combination of two unrelated organisms, the algae and fungi. A typical example is *Cladonia rangiferina.* The reindeer principally depends on these plants and hence the name.

Scale mosses

Scale mosses are leafy liver-worts belonging to hepaticae of Bryophyta. Under the class hepaticae there are both thalloid and leafy forms. *Takakia* (Fig. 1b), which is considered to be very primitive, has leaves compo-

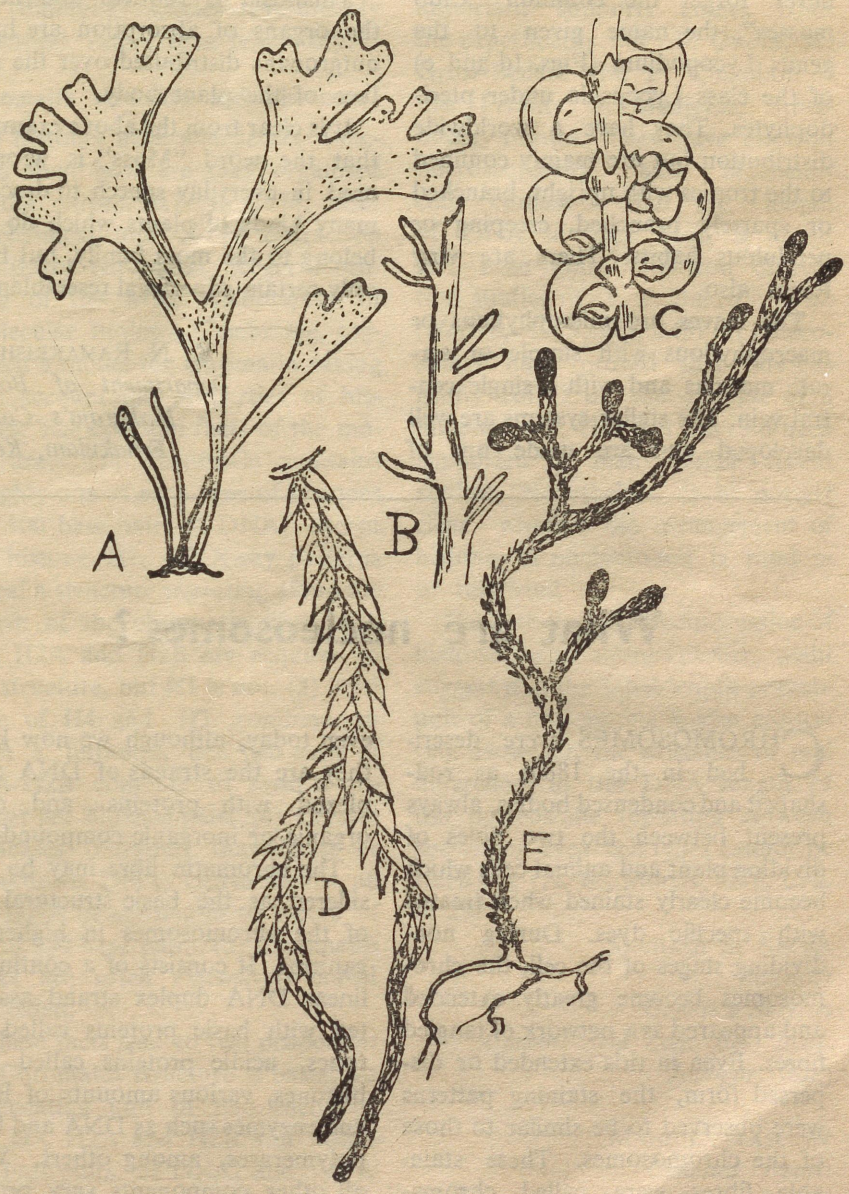


Fig. 1. (a) *Chondrus crispus:* (b) Takakia; (c) Frullamia; (d & e) club mosses

sed of two hair-like segments. The leafy members are usually recognised by the presence of two rows of leaves. In certain cases it may show three rows; two rows composed of large leaves and one row of small leaves. In *Frullania*, the plant has a small pouch-like lobe bent up behind the main portion of the leaf (Fig. 3). The leaves have entire or serrate margins.

Club mosses

Those who study botany can never forget the common "Club mosses", the name given to the genus Lycopodium (Figs. 1d and e) of the class Lycopsida under pteridophytes. They have a worldwide distribution but are mainly confined to the tropics with upright, branched or sparsely branched, creeping or pendulous habits. There are viny forms also.

The leaves are microphyllous or macrophyllous with simple or serrate margins and with a single central vein. The stellar systems are well developed and are made up of tracheids. The gametophyte in club mosses is often associated with an endophytic fungus. Because of their peculiar size and snake-like appearance, these mosses are called the reptiles of the plant world.

Spanish moss

The Spanish moss is an Angiosperm living strictly as an epiphyte on various substrata. *Tillandsia usneoides* is a typical example which shows extreme epiphytism by attaching itself even to telephone wires.

Tillandsia is rootless and hence the organs of absorption are hairy outgrowths distributed over the surface of the plant body.

It is clear from the above examples that the word "Moss" is wrongly used in everyday speech to describe many kinds of plants which do not belong to the moss family, but have only certain superficial resemblances.

K. N. RAMAKRISHNAN
Department of Botany
Maharaja's College
Ernakulam, Kerala

What are nucleosomes?

CHROMOSOMES were described in the 1880s as rod-shaped and condensed bodies, always present between the two poles of dividing plant and animal cells which become clearly stained when treated with specific dyes. During non-dividing stages of the cell, the chromosomes become greatly extended and appeared as a network of tangled fibres. Even in this extended or dispersed form, the staining patterns were observed to be similar to those of the chromosomes. These stainable fibres were called chromatin. This term continues to be used even today, although we now know they are the strands of DNA complexed with proteins and other organic or inorganic compounds.

The chromatin fibre may be considered as the basic structural unit of the chromosomes in higher organisms. It consists of a continuous linear DNA duplex strand associated with basic proteins called histones, acidic proteins called non-histones, various amounts of RNA, and enzymes such as DNA and RNA polymerases, among others. While all other components vary proportionately histones occur in an equal proportion, by weight, to DNA in the chromatin fibre.

Histones

Histones were discovered in the late 19th century, but it was not before 1943 that Edgar Stedman and Ellen Stedman of the University of Edinburgh specified some role to them. Their calculations of the histone contents of cells suggested that actively growing tissues contain less histones than the non-growing tissues. They concluded that histones function as inhibitors of biological activity. According to their data, they were correct in postulating an inhibitory function for histones, but as we know now, their measurements of histone contents were inaccurate—the histone contents of active and inactive cells do not vary. The bio- found in the nucleus. But when more DNA was added to the system, inhibition was reversed. This suggested that the histones blocked transcription (the RNA synthesis on DNA template) by binding to DNA and not by inhibiting the activity of RNA polymerase (the enzyme that catalyses RNA synthesis). At about the same time Vincent Allfery and Alfred Mirsky of the Rockefeller University, showed that when histones were removed selectively from isolated nucleus, the rate of RNA synthesis increased. Both types of experiments led to the conclusion that histones normally function as chemical evidence of the inhibiting role of histones came in 1962 from the experiments of Ru-Chih Huang and James Bonner of the California Institute of Technology, California. They showed that adding histones to a test-tube system, in which all ingredients of RNA synthesis are provided, inhibited RNA synthesis. They further proved that maximal inhibition of RNA synthesis was observed when a histone-to-DNA ratio becomes 1:1, a ratio in which histone and DNA are normally

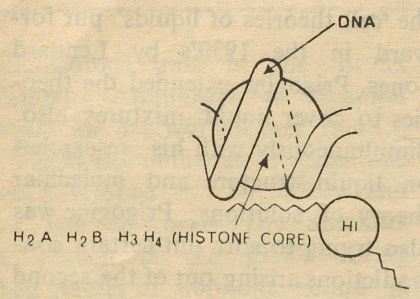


Fig. 1. A "nucleosome" formed from two molecules each of the histone H2A, H2B, H3 and H4. The 200 base pairs of DNA coils round the histone bead which had a diameter of about 106 angstrom. Separate nucleosomes are linked by histones H1. (After R., Lewin. 1976, *New Scientist*, 17 June, p.623). Each nucleosome is a spherical particle of about 115 angstrom diameter

regulatory molecules to inhibit the capacity of genes to synthesize RNA.

The histones, however, can be best defined by their chemical characteristics : they are proteins, rich in the basic amino acids arginine and lysine, but completely lacking the amino acid tryptophan. Because of their basic nature they can readily be extracted with acids like dilute hydrochloric acid and sulphuric acid. They can be fractionated into five principal classes, H1 (H5), H2A, H2B, H3 and H4 (Bradbury, E. M. 1975, *Ciba Foundation Symposium* 28, American Elsevier. N. Y.), most of which are present in the cells of all higher organisms. These five classes of histones fall into three groups on the basis of their relative contents of basic amino acids lysine and arginine. The three groups are: (1) Lysine-rich (H1), (2) Slightly lysine-rich (H2A and H2B), and (3) Arginine-rich (H3 and H4).

The lysine-rich histone class H1 displays microheterogenecity, that is, it can be fractionated into four components, each having a similar amino acid sequence composition and about the same molecular weight. This class is least tightly bound to the chromatin and therefore may be concerned with the surface properties (Lewin, B., 1974, *Gene Expression*, Vol. II, Wiley-Interscience). The two classes of slightly lysine-rich histones, H2A and H2B, show some conservation between different species. On the other hand, the two classes of arginine-rich histones, H3 and H4, show extensive conservation because of the practically identical amino acids sequence. They show conservation in organisms as unrelated as cow and carp (H3) and cow and pea seedlings (H4). Such a conservation mechanism of histones suggests a function common to different species—presumably structural, rather than regulatory.

Chromatin structure and histones

If histones have a structural function, then how are they organised in the chromatin? In 1974, after biochemical and X-ray diffraction studies of chromatin, Roger Kornberg of the MRC Laboratory of Molecular Biology, Cambridge, suggested a model for chromatin taking into account the properties of histones. The essential facts of the model are: (1) Chromatin contains roughly one of each type of histones per 100 base pairs of DNA, except for histone H1. (2) X-ray patterns reveal a structure repeating along the length of the chromatin fiber; H4, H3, H2A and H2B are required in the structure, but H1 is not. (3) Two each of H4 and H3 combine to form a tetramer, and two each of H2A-H2B combine to form a oligomer per 200 base pairs. (4) Certain nucleases (enzymes that digest or breakdown DNA) cleave almost all the DNA in chromatin to pieces of about 200 base pairs. (5) Chromatin fibres are often extensively coiled or folded.

These facts lead to two proposals: (1) Chromatin structure is based on a repeating unit of two each of H4, H3, H2A and H2B and about 200 base pairs of DNA, and (2) A chromatin fiber consists of many such units forming a flexibly joined chain.

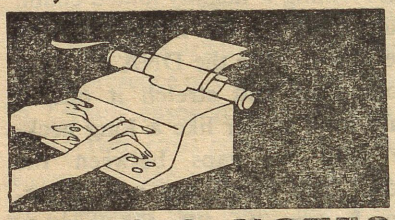
According to the model "If one were able to take the DNA out of a chromosome and stretch it out, it would look rather like a long necklace with no gaps between the beads." The beads are now popularly known as "Particles on-a-string" or "nu" bodies (A. L. Olins, and D. E. Olins, 1974, *Science*, 183, 330) or nucleosomes (P. Oudet, *et al.*, 1975, *Cell*, 4, 281) (Fig. 1).

Various electron microscopic, biochemical and nuclease digestion experiments have supported Kornberg's model. One of the most important supports comes from the experiments of P. Oudet, M. Gross-Bellard and P. Chambon of the Faculty of Medicine, Strasbourg, France. They have electron microscopically and biochemically confirmed that the length of DNA in each bead is about 200 base pairs. Neutron diffraction studies of J. P. Baldwin *et al.* (*Nature*, 1975, **253**, 245) on nucleosomes have proved that DNA is gently coiled on the outside of a histone core. This fact has also been supported by many other recent studies. Nonetheless, it is not yet clear whether the arrangement of histones in nucleosomes is random or restricted.

The high degree of conservation of histones, as mentioned earlier, might suggest that the DNA length per subunit of a nucleosome is also conserved. However, the existence of real differences in the DNA length of the nucleosome repeating between species or even cell types cannot be ruled out (N. R., Morris, 1976, *Cell*, **8**, 257).

SUBHASH S. ARORA
Scientist
Genetics Section
Central Arid Zone Res. Instt.
Jodhpur (Raj.)

MANJULA VASUDEV
Genetics Deptt.
Haryana Agri. Univ., Hissar-125004



NEWS & NOTES

Nobel prizes 1977

Physics

THREE scientists share this year's physics Nobel prize for their researches in solid state physics. They are Sir Nevill F. Mott, 72, of the Cavendish laboratory, Cambridge, Prof. John H. Van Vleck, 78, of Harvard University and Dr. Philip Anderson, 55, of Princeton University.

Sir Neville's early work at Cambridge related to quantum mechanical effects on the scattering of alpha particles and atomic collisions. In 1930's, after he moved to Bristol, his interest turned to the solid state. There he made notable contributions to the theory of crystal dislocations, theory of fracture and other aspects of the structure of solids and also developed a theory of ionic crystals. One of Mott's outstanding contributions was the discovery of 'Mott transition' which explained why a material shows metallic or non-metallic property in the crystalline state.

Back in Cambridge, Mott invited Philip Anderson to Cavendish laboratory in 1961, and over the subsequent years they did pioneering experiments on the electronic structure of amorphous substances. Their new theories led to the development of devices such as semiconductor switches and opened up possibilities of making cheap solar cells from non-crystalline materials.

Philip Anderson started his research career with studies on magnetism under Prof. Van Vleck at Harvard. In the 1940's he developed a new theory of the antiferromagnetic state of metals. During his stay at Cambridge, Anderson also did fundamental studies on helium-3 and on the application of the solid state theory to astrophysics. But it was his work on the electronic structure of amorphous substances and on magnetism which earned him the Nobel prize.

Prof. John Van Vleck, known as the "father of magnetism", was the first to extend in the early 1930's the quantum theory to explain magnetic phenomena. His work on the nature of chemical bond, particularly in relation to magnetic properties, helped in devoloping the ligand or crystal field theory of molecular bonding. In 1932 he published the first edition of his *Theory of Electronic and Magnetic Susceptibility* that set out "in a completeness and clarity which quite belie the date" the modern theory of magnetism. Subsequently he developed and clarified many aspects of the electromagnetic nature of crystals and also made important contributions to microwave and resonance spectroscopy.

Chemistry

Prof. Ilya Prigogine, 60, of the Universite Libre of Brussels gets this year's Nobel prize for chemistry for research on statistical and non-equilibrium thermodynamics. (Thermodynamics is the study of the laws governing processes which involve heat changes and the conservation of energy.)

Born in Moscow, Prigogine emigrated to Belgium at an early age, and has spent his whole career there. His early research work was based on some scientific papers on the 'cell theories of liquids' put forward in the 1930's by Lennard Jones. Prigogine extended the theories to cover liquid mixtures also. Simultaneously with his researches on liquid structure and molecular theory of solutions, Prigogine was also trying to sort out certain contradictions arising out of the second law of thermodynamics when applied to open systems. (The laws of thermodynamics are generally applicable only to closed systems in equilibrium such as a gas enclosed in a cylinder and are true only for reversible processes. In case of an 'open' system, like a living cell, these laws do not hold true.) Prigogine developed thermodynamic theories to explain such non-equilibrium or irreversible systems. His theories have added a new dimension to our understanding of the physical world and will no doubt have far-reaching impact on the development of biological sciences as well.

Physiology and Medicine

The award for physiology and medicine is shared by three American endocrinologists. Dr. Rosalyn Talow, 56, of new York's Bronx Veterans Administration Hospital gets half of the $ 145,000 prize for developing the technique of radioimmunoassay for estimation of hormones in blood. The other half is shared by Dr. Roger Guillemin, 53, Director of the Salk Institute San Diego, California and Dr. Andrew Schally, 50, of Veterans Administration Hospital, New Orleans, for isolating, characterising and synthesising three polypeptides involved in the control of the anterior pituitary gland in brain.

Although basically trained as a physicist (she has a Ph. D. in that subject), Dr. Yalow was among the pioneers in the application of radioisotopes to clinical medicine. In 1947, she joined the newly formed

radioisotope unit of the Bronx Veterans Administration Hospital where she has worked ever since.

The radioimmunoassay technique was developed by Dr. Yalow and her late co-worker Dr. Solomon A. Berson in the 1950's during their studies of hormone action in blood. The introduction of the new technique for the estimation of insulin concentration in human blood plasma started a revolution in endocrinology. It soon found use in other fields like clinical pharmacology, enzymology, oncology, virology, haematology and immunology. It could be used not only for assay of insulin in blood but also for other peptide hormones including growth hormone, parathyroid hormone adrenocorticotropins and gastrin. It was soon extended to other non-hormonal substances like enzymes, viruses, and several drugs including antibiotics, morphine, LSD and barbiturates.

The radioimmunoassay method is based on the binding reaction between antigens (e.g., polypeptide hormone, enzyme, etc.) and specific antibodies. Labelling of an antigen with a radioisotope makes it possible to measure its binding with a limited amount of specific antibody having a known inhibitory effect. The unknown concentration of the antigenic substance in a sample can then be found out by comparison.

The works of Drs. Guillemin and Schally, though done independently, concerned the same problem, namely, the function of peptide hormones in the brain. It was known earlier that the action of the anterior pituitary gland is mediated by a neurohormonal mechanism involving transport of chemical substances from the hypothalamus (an organ located in the centre of the brain). Guillemin and Schally succeeded in isolating, characterising and synthesising three of the polypeptides involved, namely thyrotrophin releasing factor (TRF), gonadotrophin releasing factor (GnRF) and somatostatin (or somatotrophin release inhibiting factor, SRIF).

The discoveries of Guillemin and Schally have already proved significant for clinical and basic medical sciences. Synthetic TRF and GnRF are now widely used in the investigation of thyroid dysfunction and infertility, respectively.

BIMAN BASU

Obituary

Lord Adrian

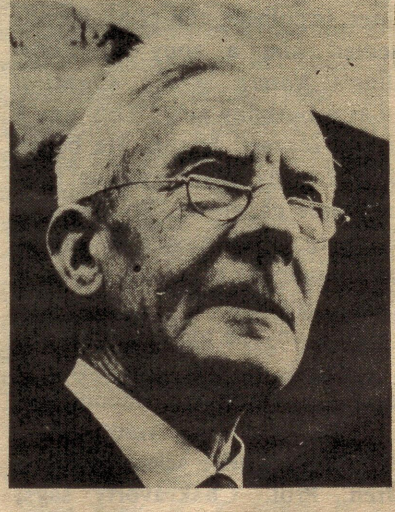
LORD Adrian, who shared the 1932 Nobel Prize for physiology or medicine with Sir Charles Sherrington "for their discoveries regarding the functions of neurons" died in London on August 5, 1977 at the age of 87. While Lord Adrian worked and taught at Cambridge University, Sir Charles did so at Oxford. As in the case of most of the Nobel-winning scientists, his research work will continue to illumine the path of researchers.

Lord Adrian is remembered for amplification of nerve impulses by radio-type amplifiers (a technique evolved first by Gasser and Erlanger who won the 1944 Nobel Prize for physiology or medicine). During the 1920's, Lord Adrian, in collaboration with Dr. Yotterman, divided the muscle of a frog until it contained just one sense organ and submitted it to an external stimulus, and amplified and recorded the sound in response to the stimulus. Contrary to the previous belief, they came to the conclusion that the more pronounced the stretching of the muscle, the more frequent were the impulses. Another of Lord Adrian's discoveries was that sense organs can and do adjust to a prolonged change in stimulus.

After 1934, Lord Adrian devoted himself to a study of the electrical activity in the brain. His work in this direction provided new leads in the understanding and treatment of epilepsy and in the location of cerebral lesions.

Born on November 30, 1889 in London, Lord Adrian studied at the Westminster School and Trinity College of Cambridge University with which he was associated most of his working life in one capacity or another, earning his master's degree in medicine in 1915. He then rendered medical service during World War I. For sometime, he also worked at St. Bartholomew's Hospital.

Lord Adrian started his academic career as a Lecturer in Physiology at Cambridge University (1920-29), later became Foulertin Professor of Physiology at Cambridge (1937-51). Thereafter, he served as Chancellor of the University of Leicester but returned to his *alma mater*, Cambridge, in the same



Lord Adrian

capacity. He was raised to peerage as the First Baron of Cambridge in 1955 and was appointed a trustee of the Rockefeller Institute, New York in 1962. He was elected a Fellow of the Royal Society as early as 1923 and was awarded the Order of Merit in 1942.

He is author of three books, *The Basis of Sensation* (1927/28), *The Mechanism of Nervous Action* (1932), and *The Physical Background of Perception.*

R. C. DHINGRA
Principal, National College
Sirsa 125055 (Haryana)

An Interview

Prof. Chakravorty

Prof. Chakravorty

SOMETIMES, it is fascinating to know how a now reputed scientist became interested in science in his childhood. Besides, we also get to know what most interests a child in science. How his interest can be sustained so that he blooms into a top ranking scientist.

Prof. Animesh Chakravorty, who won the 1975 S. S. Bhatnagar Award for his researches in chemical sciences, tells something about his childhood which should be an eye opener to our school teachers. "I vividly remember", he says, "how excited I was when our science teacher told us that matter is molecular in nature". That the three states of matter indicate different arrangements and different mobilities of molecules thrilled him. This sowed in him the seeds of science.

Later, in college, one of his friends presented him a copy of Linus Pauling's *Nature of the Chemical Bond* as a birthday gift. "This was a gold mine for me", he says. He began to do self-study in the exciting field of inorganic chemistry. So when in 1950s, inorganic chemistry was emerging as a discipline based on powerful unifying principles—a renaissance was almost on—he took up research in it. Besides, parents, teachers and colleagues constantly encouraged him to continue his research.

We can popularise science among children, Prof. Chakravorty says, through museums, well-equipped laboratories in primary and secondary schools and through colourful illustrated inexpensive books. "Can we not do this?" he asks.

Born on June 30, 1935, at Mymensingh (now Bangladesh), he grew up in an environment of science. His father was a reputed eye specialist. He had his early education in Mymensingh and Calcutta, and later did M.Sc. and D.Phil. from Calcutta University. He is presently Head, Department of Chemistry, I.I.T., Kanpur.

Prof. Chakravorty's major research is on the structure and properties of molecules in which a metal ion is surrounded by organic or inorganic groups. Such groups are called ligands and the entire molecule is called a complex compound. The molecules of such compounds have sometimes fixed shapes, but at times, the shape changes back and forth between two or more alternatives. The electrons in such molecules may be very mobile and may undulate back and forth between the metal ion and the surrounding ligands. On occasions, it is possible to add or subtract one or more electrons to such molecules. This process is called "redox".

In some cases the same molecule may contain more than one metal ion. When this happens, the electrons of one metal ion often interact with the electrons of another metal ion. This produces peculiarities in magnetic properties. Using many techniques, Prof. Chakravorty has studied these varied phenomena. He and his team have made many new molecules and have also fabricated necessary equipment from indigenous components for their studies.

Prof. Chakravorty has been impressed by the methodology of research in the U.S.A. "The most important propellant is," he says, "hard work in laboratories and cross fertilization of ideas in meetings and seminars." The single-minded devotion to work that he saw in the West, he claims, is yet to pervade in our country. "We need to import this creed of hard work," he says.

DILIP M. SALWI

XV International Congress of Paediatrics

THE XV International Congress of Paediatrics was held recently in New Delhi. The Congress was attended by about four thousand

delegates from eighty-five countries, including those from different parts of India. It was the largest gathering of international experts ever held in India. Among the distinguished scientists who attended the Congress were Dr. Frederick C. Robbins, a Nobel laureate from the United States, Dr. A. Ihsan Dogramaci, President of the International Paediatric Association from Ankara, Turkey, and Prof. Andrea Prader of Switzerland.

The theme of the congress was "Breast feeding with love leads to better child health", a theme most appropriate for a setting like India where breast feeding has been advocated and practised since time immemorial.

Considerable time was devoted to the topic of breast feeding which in recent time has been established to be of great importance in preventing the new born against infections. Dr. L. A. Hanson of the Deparment of Immunology, Institute of Medical Microbiology, University of Goteborg, Sweden, said that several components of human milk, viz., lactoferrin, lysozymes, bifidus factor, phagocytes, T and B cells and antibodies play an important role in protecting the human neonate from infection. Immunoglobulin antibodies (IgA) consitute the dominant secretory antibodies in the human milk. They are constantly secreted throughout lactation. The secretary IgA antibodies are presumably locally produced in the mammary gland. He also presented evidence on the presence of antibodies against food protein in the human milk which possibly may help prevention of allergy in a baby. Dr. A. E. Olszyna Marzys of the Institute of Nutrition of Central America and Panama, Guatemala City, reported that his studies reveal high levels of DDT, dieldrin and heptachlor epoxide in human milk. This he said was due to environmental contamination.

Dr. Dogramaci said that three quarters of the world's child population suffer from hunger and lack both preventive and curative medical care. He cited that in Punjab the mortality rate is 72 times greater than in Sweden for 1 to 2 years old children. Of the over 80 million children born every year in the developing world, five million die of diphtheria, whooping cough, tetanus, polio, measles and TB while twice as many are disabled through brain damage, paralysis, stunted growth, deafness or blindness. Dr. Dogramaci pointed out that proper use of vaccines could have eliminated many of these diseases as has been achieved in many developed countries.

Among the topics for symposia were, in general, those covering nutrition, metabolism, infections, gastrointestinal disorders, cardiovascular systems, neurology, psychiatry, oncology, medical education, growth and development, endocrinology, etc.

ZAKA IMAM

Biochemist Bodansky passes away

DR. Oscar Bodansky, a pioneer in the use of biochemistry for the detection of various diseases, especially cancer, died on August 21 in New York. He was Chief of the Division of Biochemistry and a Vice-President of the Sloan-Kettering Institute for Cancer Research from 1966 to 1971 when he retired. Author of *The Biochemistry of Diseases*, a 1281-page text book, first published in 1940 and of *Biochemistry of Human Cancer*, published in 1975, Dr. Bodansky made many important and lasting contributions. His original and imaginative investigations on enzymes, their relations to, alterations during, and usefulness in the diagnosis of various diseases earned him a wide and well-deserved reputation as a distinguished medical researcher. His contributions to biochemistry and its application for diagnostic purposes were recognized in 1962 when he was awarded the Aloan Foundation Award. He also received the Van Slyke Award in clinical chemistry in 1965 and the Lucy Wortham James Award for clinical investigation in cancer in 1973.

Born in Elizabethgrad, Russia on August 21, 1901, young Bodansky came to the U. S. A., received his Ph.D. degree from Columbia University in 1925 and M. D. from the University of Chicago Medical School in 1938. He taught various subjects in Columbia University, University of California, University of Texas, New York University, and Cornell University. During the World War II he served as Chief of the biological section of the medical division of the Army's Chemical Warfare Service (1942-45) and as Director of medical research of the service's medical division (1945-56). He joined the Sloan-Kettering Institute in 1948.

R. K. DATTA
Beth Israel Medical Center
New York, N. Y. 10003, U. S. A.

Seminar on restructuring of practicals relevant to theory

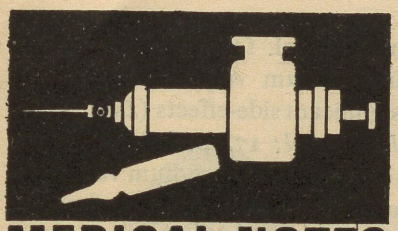
A U. G. C. sponsored seminar on restructuring of chemistry practicals relevant to theory was held at Andhra Loyola College in Vijayawada from 8-15 October, 1977. Over 40 participants from all over India participated in the seminar. The aim of the seminar was to acquaint experts with the actual laboratory techniques and experiments in modern branches of chemistry.

The topics covered modern fields of chemistry like chemical engineering, biochemistry, industrial chemistry, ion exchange, chromatography, drugs, pesticides, perfumes, etc.

The general opinion was that lectures should be reduced to a minimum and chemistry should be taught through more laboratory experiments. Greater stress should be given to practicals relating to everyday life, so that students realise the extent to which chemistry affects our life. Experiments on preparation of plastics, analysis of grass, milk, ion exchange and chromatography were included in the seminar.

The seminar brought out the need for introducing open-ended experiments, where neither the teacher nor the student knows the results of the practicals, thus making theory available through discussion at the end of the practicals. This would require a change in the evaluation methods so that the students are evaluated not on the basis of results of the experiments but on the basis of their theoretical knowledge and their capacity to apply it in the laboratory.

R. K. TRIKHA
Chemistry Department
Hans Raj College, Delhi-7



MEDICAL NOTES

Is "Caulerpol" Vitamin A_3 ?

IT is a well-known fact that vitamin A_1 or retinol is obtained exclusively from such animal products as butter, egg fat, blood, and fish liver oil, etc. Paul Karrer and R. Morf (1931-1933) were the first to characterize and elucidate the structure of vitamin A_1. Later, J. G. Baxter and C. D. Robeson (1940-1942) were able to obtain it in pure crystalline form. Vitamin A_2 (2-dehydrovitamin A_1) was discovered by M. Shantz in 1948 from pike livers.

Prof. A. J. Blackman of Department of Chemistry, Tasmania University, Hobart, (Australia), and Dr. R. J. Wells of Roche Research Institute of Marine Pharmacology, Dee Why, N. S. W. (Australia) have, in 1976, jointly isolated and characterized a new diterpene alcohol, very closely related to vitamin A, from a marine algae *Caulerpa brownii*. The new substance isolated by them is a colourless oil, b.p. 120°C (0.1 mm), and has been named *Caulerpol* (*Tetrahedron Lett.*, No. 31, 2729-2730, July 1976). Caulerpol is a tetrahydro derivative of retinol; it is therefore, as is apparent from its structure, 7, 8, 11, 12-tetrahydrovitamin A_1 (Fig. 1).

It is interesting to note that whereas vitamins A_1 and A_2 occur in nature only in animal organisms, caulerpol would appear to be the first compound reported with the same carbon skeleton from plant sources. A compound of this structure is quite natural on biosynthetic basis and is so closely related to vitamins A_1 and A_2 that it is likely to be declared vitamin A_3. Moreover, like vitamins A_1 and A_2 the configuration of conjugated double bonds in caulerpol is also *trans*.

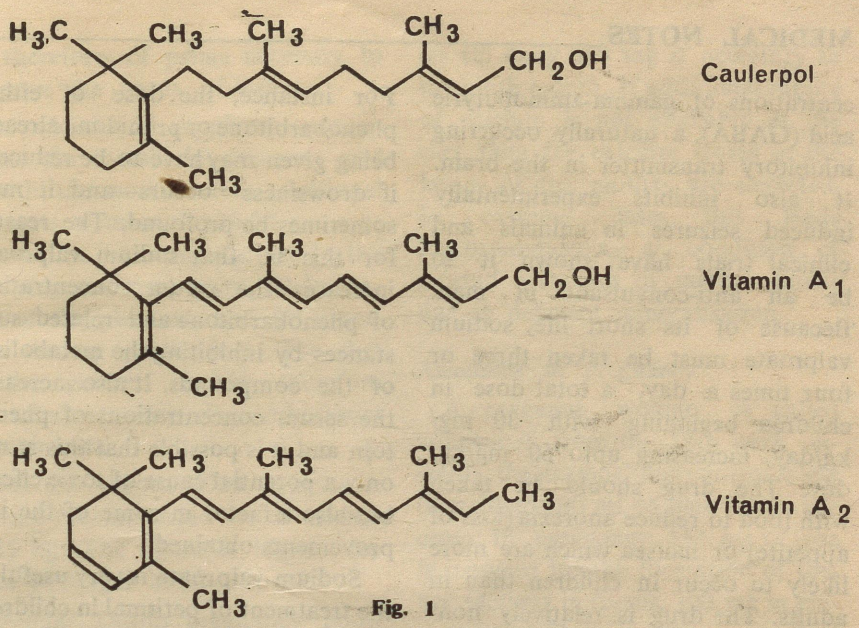


Fig. 1

Previously, several *Caulerpa* species (Chlorophyta) were investigated by various workers and shown to contain triterpenes, xanthophylls, and certain nitrogen-containing compounds, but the isolation of caulerpol—a diterpene alcohol of vitamin A family—is undoubtedly of great significance. For the isolation of caulerpol, Blackman and Wells collected *Caulerpa brownii* algae from Cook's Corner, Freycinet Peninsula, East Coast of Tasmania, and subjected it to exhaustive extraction at 0°C with a mixture of chloroform and methanol (1:1, v/v). The concentrated extract was partitioned between hexane and aqueous methanol. The material from hexane solution was purified by dry column chromatography on silica gel eluted with hexane-chloroform mixture. In this way a 9.5% yield of caulerpol (based on dry weight of algae) was obtained. Interestingly, a small amount of caulerpol acetate was also recovered along with free caulerpol.

The physiological and pharmacological properties of caulerpol are yet to be invesigated. Only when this is done it would be possible to declare precisely, if caulerpol is vitamin A_3.

G. S. JOHAR
Department of Chemistry
Vikramajit Singh Sanatan Dharma College, Kanpur-208002

A new antiepileptic drug for children

SODIUM valproate represents a new approach to the therapy of epilepsy. It is useful for children whose epilepsy has not been controlled with conventional drugs. Sodium valproate raises the con-

centrations of gamma-aminobutyric acid (GABA), a naturally occurring inhibitory transmitter in the brain. It also inhibits experimentally induced seizures in animals and clinical trials have shown it to be an anti-convulsant in man. Because of its short life, sodium valproate must be taken three or four times a day, a total dose in children beginning with 30 mg/kg/day, increasing upto 50 mg/kg/day. The drug should be taken with food to reduce anorexia (loss of appetite) or nausea which are more likely to occur in children than in adults. The drug is relatively non-toxic and its unwanted side-effects are very mild even at higher doses.

It was observed that apparent side-effects, if any, are usually due to potentiation of the side-effects of other anti-convulsants given. For instance, the dose of either phenobarbitone or primidone already being given may have to be reduced, if drowsiness occurs—and it may sometimes be profound. The reason for this is, that sodium valproate increases the serum concentration of phenobarbitone and related substances by inhibiting the metabolism of the compounds. It also increases the serum concentrations of phenytoin and it is possible that this is not only a potential cause of toxic effects but also a factor in some of the improvements obtained.

Sodium valproate is very useful in the treatment of petitmal in children. In a study with ten children having petitmal, only one failed to improve. The other nine achieved complete control, seven of them having been treated unsuccessfully with other drugs. Six of them remained free from petitmal for two years while taking sodium valproate and had no significant side-effects (*Dev. Med. Child. Neurol;* **17**, p. 743, 1975). It was also found that sodium valproate along with the treatment of children with intractable epilepsy reduced the frequency of fits; children most helped are those with grand-mal or petitmal. In addition, children who got relief from epilepsy from this drug also showed improved alertness and school performance. The drug has to be given regularly, atleast at eight-hour intervals; preferably at six hour intervals, because of its short halflife.

U. N. Das
Immunogenetics Laboratory
Department of Genetics
Osmania University
Hyderabad-500307 (A. P.)

FOR HER (*Continued from page* 795)

practice, 5 mg folic acid supplement ensures adequate supply.

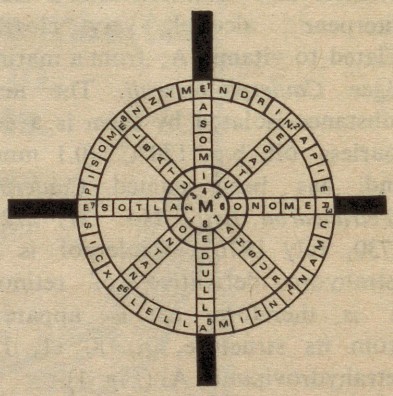
Anaemia due to vitamin B_{12} deficiency in pregnancy is comparatively uncommon. The mean vitamin B_{12} level in the serum of the mother during parturition normally is 190 micrograms per ml, while it is 390 micrograms per ml in the infant's serum. A single injection of 40 micrograms of vitamin B_{12} is enough to produce maximum response in 10 days in mothers who are deficient in it, but usually larger therapeutic doses are recommended.

Subhash C. Datta
Nabanita Sengupta
Biochemistry Deptt.
University College of Sciences
Calcutta-700019

SCIENCE FOR THE YOUNG (*Continued from page* 799)

are made up of a network of threads of almost invisible fineness, along which are minute loops made up of special cells arranged in a ring. When an unsuspecting eelworm crawls into one of these rings, the cells of the loop instantly expand, and tighten on the worm, gripping it firmly. The more the worm struggles to free itself, the tighter the loop becomes. When the worm is finally exhausted, the fungus sends in special branches which then suck nutrients from its body leaving only the skin, like a shell.

Indira Rajagopal
Department of Botany
University of Delhi
Delhi-110007



(Solution to wheelword puzzle on page 798)

FOR HER

Nutrition of a pregnant woman

PREGNANCY is a remarkable anabolic process (synthesis by living tissues of complex molecules from simpler ones) whereby out of food, vitamins, minerals and hormones, a 3.2 kg infant with 300 ml blood, 500 gm proteins, 30 gm calcium, 15 gm phosphorus and 300 mg-400 mg iron takes shape in nine months. If nutrition of the mother is inadequate, the constituents required are drawn from her body reserves and she becomes weak. The incidence of premature births rises with a decrease in the nutritional status of pregnant women. Low birth weights, low vitality and more early deaths are frequent among infants born to poorly nourished mothers. Improvement in the nutrition of the mother is, therefore, of prime necessity to improve the status of infants.

In addition to supplying requirements for foetal development and growth, the mother needs additional nutrients to meet; (1) 20-25 per cent increase in basal metabolism in the later stages of pregnancy, (2) formation of the placenta, and (3) blood loss during parturition. The diet of the mother should therefore be adequate for the additional requirements.

Calories. About 2000 calories a day are recommended for a mother of 45 kg. The figure is higher for those of larger build.

Proteins. During pregnancy, additional protein requirement of the foetus, placenta, etc., is about 950 gm., roughly estimated at 0.5, 3.0, 4.5 and 5.7 gm daily during each successive 10-week period. In order to convert this amount of tissue protein, an additional daily 10-12 gm of mixed protein allowance for the mother is necessary. Lactating women produce daily 850 ml-1000 ml of milk. Assuming 1 per cent protein in human milk, the daily excretion is 10 gm. Therefore, about 25 gm extra protein per day is recommended for the mother.

Carbohydrates and fats. Carbohydrates and fats should be supplied as in ordinary diet to provide necessary calories.

Vitamins and minerals. For the infant to be born with adequate stores, vitamin deficiency should not be allowed to occur during pregnancy. Ideally, the diet should supply all the vitamins (Table 1), but since this is not always feasible, one tablet of a multivitamin preparation should be administered daily.

Calcium. The calcium requirement increases particularly during the last 3 months of pregnancy when bones of the foetus are ossifying. About 25 mg of calcium is required daily by the foetus during the third month. But the demand gradually increases till daily 300 mg is necessary in the ninth month. If additional supply of calcium is not available in the diet then the calcium stores in the bones of the mother are depleted. In extreme cases, this leads to osteomalacia, a condition of morbid softening of mature bones due to deficient mineralization.

Anaemias in pregnancy

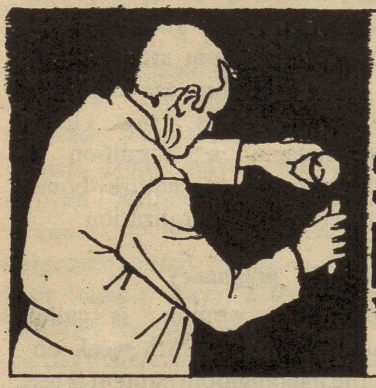
A pregnant woman is called anaemic if, from the 28th week onwards, the haemoglobin content is less than 10gm/100 ml of blood (70 per cent). In pregnancy, 550 mg of iron is required for the formation of foetus (400 mg in foetus, 100 mg in placenta, and 50 mg in uterine muscles.) About 175 mg is lost during parturition and 180 mg is excreted in the milk during lactation. On the other hand, there is also a saving of about 225 mg of iron which would have been lost during nine menstrual cycles. Thus the total loss of iron to the mother during each pregnancy is about 680 mg if the infant is breast fed and 500 mg if it is not.

The demand for folic acid or folate (a member of vitamin B group) increases because of increased cellular proliferation. Premature infants are sometimes born to folate-deficient mothers but the incidence is reduced with folic acid supplements. The requirement of 'free folate' is 300 microgram during pregnancy and 400 microgram during lactation. In

(*Continued on page* 794)

Table 1. Requirements during pregnancy and lactation

Calories	2000-2500
Proteins	70-90 gm
Vitamin A	6000 units
Vitamin B_1	1.5 mg
Riboflavine	2.0 mg
Nicotinic acid	15.0 mg
Folic acid	5-10 mg
Vitamin C	45 mg
Vitamin D	4000 units
Calcium	1.5 gm
Iron	15 mg



SCIENCE FOR THE YOUNG

The mermaid mystery

THE might and majesty of the oceans have attracted the attention of man through the ages. Many legends are associated with it. The ocean is credited to have counterparts of animals and man living on land. Though highly evolved groups of animals inhabit the seas, it is certain that it has none resembling humans. The poetic fancy however invented mermaids and mermen living in depths of the ocean. It is interesting to look into the facts leading to the origin of this myth.

In ancient times, sailors used to narrate stories of mysterious creatures they encountered while on sea voyage. People were fascinated by these stories, because of the exaggerated versions of the observed phenomena. Many secrets of the oceans were not known to science at that time. The origin of mermaid myth is an example of fact intertwined with fancy.

Sea cows, *Dugong* (Fig. 1), are marine mammals belonging to the group *Sirenia*. They feed on sea weeds at the bottom and only occasionally come to surface waters to breathe. These animals have the habit of holding their calves in between their forelimbs while nursing. This appears like a woman breast-feeding her infant, especially when viewed from a moving ship at a distance. It becomes evident however that such a resemblance does not hold good when the animal is watched from close quarters. The other marine mammals that give an appearance of human face are sea lions, walruses and seals. But unlike the members of the *Sirenia* group, they do not possess fish-like tails.

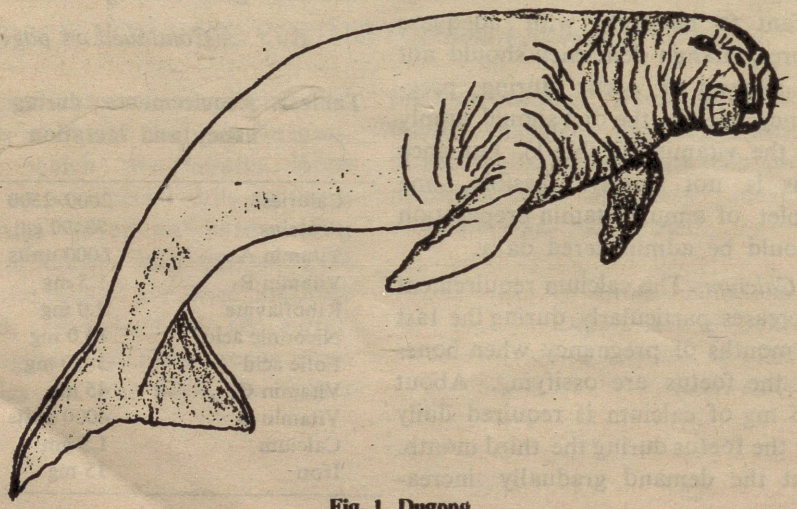


Fig. 1 Dugong

M. ARAVINDAKSHAN
Central Marine Fisheries Res. Sub-Station, Bombay

How does your kite fly ?

BACK in the dim ages of the past, man looked up at the birds and yearned to emulate them. His ambition to imitate the birds soaring in the sky gave him enough courage to use wings made of feathers and jump from a height. The early attempts failed, but nevertheless, aviation history started from these events. The next step to satisfy man's ego was his invention of the kite. Flying a kite is now enjoyed both by youngsters and older people. In some parts of our country it occupies a social status in fairs and festivals. Flight of a kite is based on sound scientific principles.

Let us see how a kite flies. Forces acting on a flying kite are: the thrust due to wind, the tension of the string and its own weight.

Thrust due to wind striking a flying kite at an angle acts on all parts of the undersurface of the kite, but the total effect is equivalent to a single thrust acting at a point (Fig. 1). This single thrust can be taken

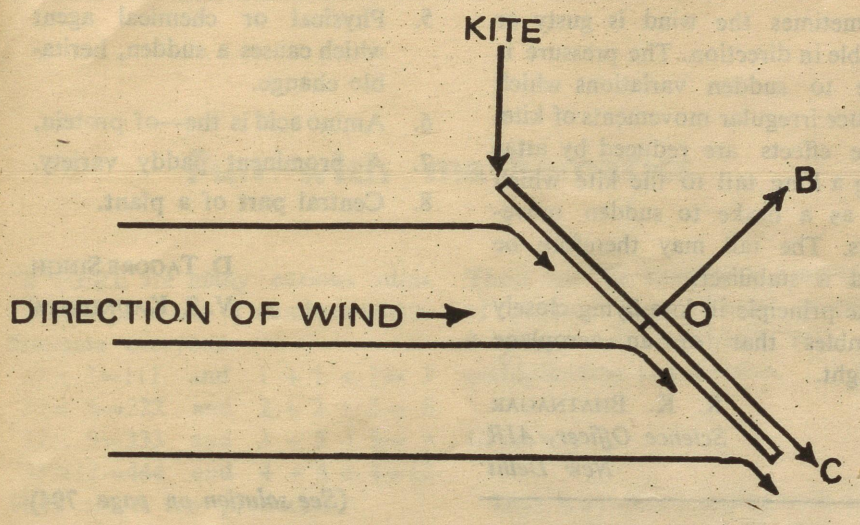


Fig 1

as equivalent to two components, viz., thrust acting along the surface of the kite (OC) and normal thrust (OB). The first component acting along the surface of the kite has no effect on its stability. Therefore, the only effective component of wind thrust is the normal thrust which is responsible for the lift given to the kite. This normal thrust too can be considered to be equivalent to a vertical component which provides lift to the kite in the upward direction, and a horizontal effect that may drag the kite in horizontal direction (Fig. 2).

Normal thrust depends on the relative velocity between wind and kite and also on the angle of inclination of the kite to wind direction. In other words, a strong wind blowing against the surface of the kite will produce the same effect as that when air

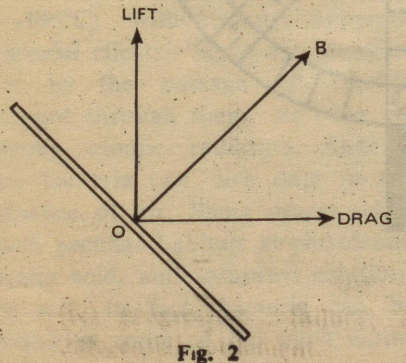


Fig. 2

is still and the kite is moved with a large velocity. Children know this. That is why when the air is still, they run along the ground with the end of the string in their hand. This provides lift to the kite. Another method adopted by them is: one of the playmates takes the kite to a sufficient distance and releases it when it is pulled fast from the other end. As a result, the kite gets a lift.

Thrust is an essential condition of the flight. To get 'lift', there must be 'thrust'. There is yet another condition which is important. The kite must have its nose up and tail down so that its surface is at an angle to the flow of air. The angle (angle of incidence) is produced by adding weight to the kite's tail. Movement of air under the kite, which has its nose up and tail down, would force it upwards. Owing to the angle of incidence, the air cannot blow upon the top surface as it blows against the under-part. As the top is partly shielded from the air flow, at a spot a short distance away from the nose of the kite, there is actually a partial vacuum with practically no air at all. Nature, however, cannot stand even a partial vacuum and its instant efforts to fill it causes the kite move upwards. This suction has been found to be about twice as powerful as the upward pressure of the air underneath. Because of this pressure the kite is lifted high in the air.

The second force is the weight of the kite acting vertically downwards. Weight is the force that retards lift. To keep the weight light, kites are made of thin sheets of paper.

Tension is the third force acting on the kite. The string of a flying kite remains under tension. Tension of the string also acts in two directions, viz., vertical and horizontal. The vertical component of the tension acts downwards and tries to pull the kite vertically downwards. The horizontal component balances the horizontal effect of thrust due to drag of wind.

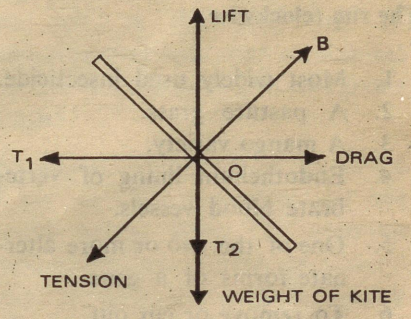


Fig. 3

When the kite is stable in air, lift-thrust acting on the kite is equal to the weight of the kite and the vertical downward tension in the string. Similarly, the force which makes the kite drift horizontally is neutralized by the horizontal component of the tension of the string acting in the direction opposite to that of the drift force.

If the string is pulled, the kite rises. This is because pulling of thread increases the wind velocity relative to the kite. Consequently, the lift force, which depends on the relative velocity between wind and

kite, increases and may exceed the downward force, viz., the weight of the kite and the downward vertical component of tension acting on the kite. This excess of lift force over the vertical downward force raises the kite high.

If the thread is loosened, the kite moves farther away. This is because when the thread is released, tension decreases and consequently its horizontal component also decreases. Under these conditions, drag-thrust dominates and pulls the kite horizontally.

Sometimes the wind is gusty or variable in direction. The pressure is liable to sudden variations which produce irregular movements of kite. These effects are reduced by attaching a long tail to the kite which acts as a brake to sudden movements. The tail may therefore be called a stabiliser.

The principle in kite flying closely resembles that of an aeroplane in flight.

R. K. BHATNAGAR
Science Officer, AIR
New Delhi

5. Physical or chemical agent which causes a sudden, heritable change.
6. Amino acid is the—of protein.
7. A prominent paddy variety.
8. Central part of a plant.

D. TAGORE SINGH
V. R. KAUNDINYA

(*See solution on page* 794)

Science wheelword puzzle

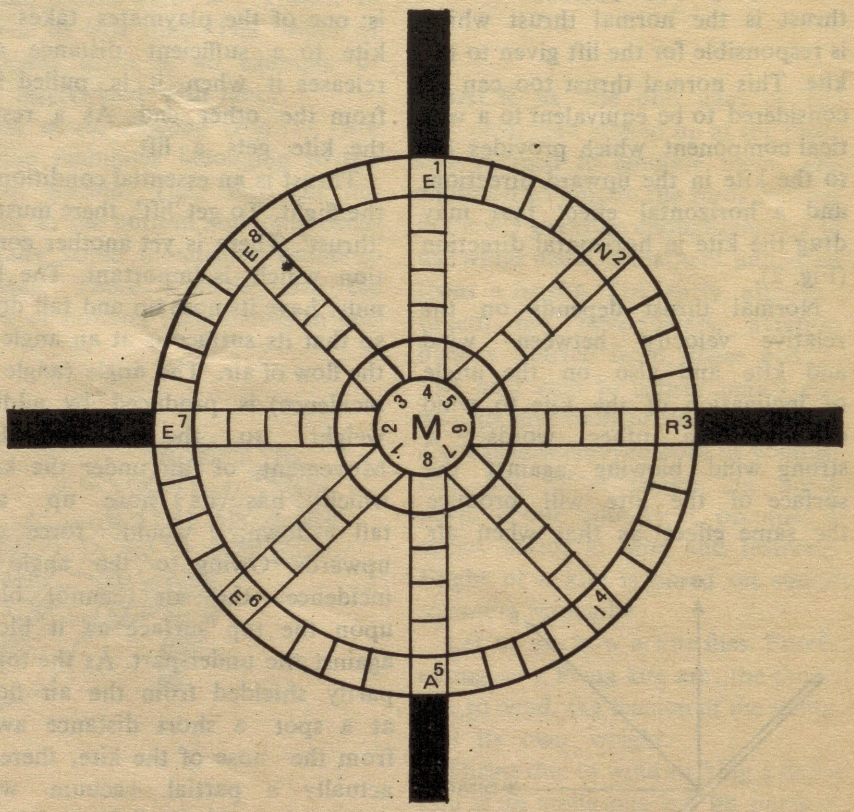
CLUES

The rim (clockwise)

1. Most widely used insecticide.
2. A pasture grass.
3. A mango variety.
4. Endothelium lining of vertebrate blood vessels.
5. One of the two or more alternate forms of a gene.
6. To remove or cut out.
7. A genetic element that can exist either free or as a part of the normal cellular chromosome.
8. An organic catalyst.

The spokes (Axlewise : The words begin from the common axle M)

1. Pertaining to the fauna and flora of the mountains.
2. Sugar formed as a result of starch breakdown.
3. Having the capacity of undergoing a sudden, heritable change.
4. A sub-family to which "Touch-me-not" belongs.



Fun with mathematics

THERE are many curious sums and products of numbers which fascinate everyone.

37× 3=111 and 1 + 1 + 1= 3
37× 6=222 and 2 + 2 + 2= 6
37× 9=333 and 3 + 3 + 3= 9
37×12=444 and 4 + 4 + 4=12

Here are a few products:

1×8 + 1=9
12×8 + 2=98
123×8 + 3=987
1234×8 + 4=9876, and so on.

Also

1×9 + 2=11
12×9 + 3=111
123×9 + 4=1111
1234×9 + 5=11111, and so on.

And

9×9 + 7=88
98×9 + 6=888
987×9 + 5=8888, and so on.

These are the interesting properties of number nine. Thus number 9 plays an important role in multiplication and division.

Guess why

Here is another amusing trick with numbers. Write down any three digit number. Repeat the digits in the same order and make a six digit number (e.g. 312312). Divide the number by seven and take the quotient. Do not worry about the remainder, for there will be none. Divide the result by 11 and then by 13 and we have the original number. Can you guess why ?

V. PURNA CHANDRA RAO
Deptt. of Mathematics
I.I.T., Kharagpur

Science oddities

NO other living organism on earth can perhaps match the virtual indestructibility and wide distribution of bacteria. Bacteria can be freeze-dried or kept at the temperature of liquid nitrogen (—195°C) without any apparent harmful effects. Some are unaffected by the passage of electric current through them, or even by strong atomic radiation. Anaerobic bacteria can live only in the absence of air. Some others relish such peculiar habitats as petroleum, acetic acid, and saturated solutions of salt. In fact, bacteria can be found in some of the most extraordinary surroundings that you can think of. While some of them live and breed happily in hot water springs, where temperatures are between 90°C and 100°C; others are found thirty meters below the ice at South Pole.

A man standing still at a point on the equator would certainly be astonished if someone told him that he was rotating, revolving, and gyrating at top speed, as well as taking part in several other movements. But this is actually true, for, the earth under him is moving at a speed of 1680 km per hour around its axis, while at the same time it is revolving around the sun at 105, 600 kmph. What's more, it is moving with the sun at about 68,400 kmph towards the star Vega, while it follows the sun around the hub of the Milky Way galaxy at nearly 864,000 kmph. And, of course, it is moving with the Milky Way, in the galaxy's own motion, but no one knows yet, at what speed, or in which direction.

A cobweb, dusted away by the flick of a duster, may give the impression of a small mat of fine, delicate strands. But, for all its apparent delicacy, spider silk is one of the strongest material in nature. It has been estimated that the tensile strength of spider thread is "second only to that of fused quartz." The natives of Papua, who had for centuries known the strength of spider silk, get their fishing nets made by spiders. A bamboo strip, bent like a tennis racquet, was left in the bush to be converted overnight into a hand-net that could hold upto two kilograms of fish!

IF anyone claimed that he could see around a corner, no one would believe him, for everyone knows that light travels in straight lines. However, this is not as impossible as it sounds, for light can now be made to travel along a curved path by the use of special glass fibres. These extremely fine fibres of glass are flexible. They are so constructed that light entering one end of the fibre is reflected by total internal reflection along the inner walls till it reaches the other end. Using such fibres, it is possible to see around a corner.

QUITE a few plants feed on insects and other small creatures. But the tiny predacious fungi that live on eelworms are a class by themselves, for these weird plants actually set up noose snares to catch their prey. Their bodies

(*Continued on page* 794)

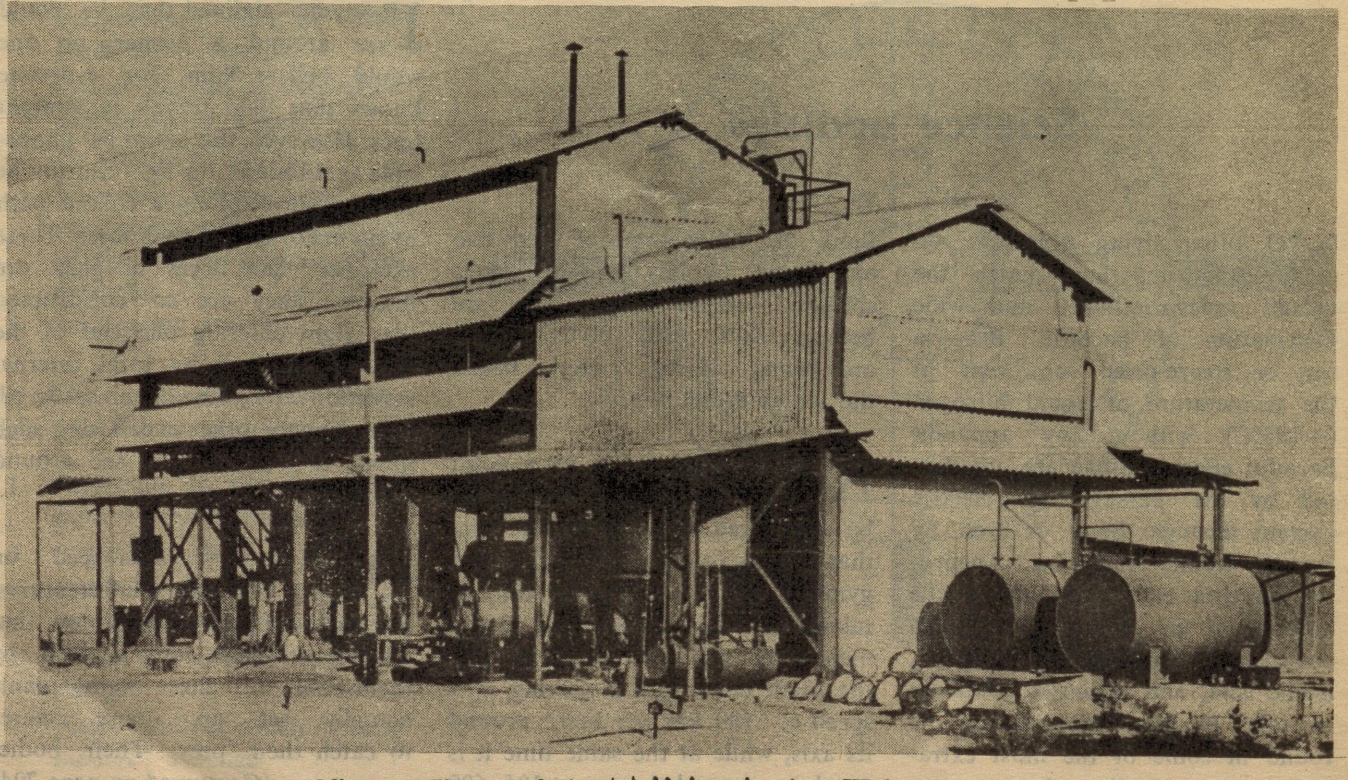
Science in Industry

Export of micro-waxes

FOR the first time in the country, microcrystalline waxes based on Indian Institute of Petroleum (IIP) know-how are being exported by Oil & Natural Gas Commission (ONGC) to various developed countries such as U.S.A., U.K., etc. ONGC has recently exported the first consignment of 20 tonnes of microwax to a firm in Los Angeles through the State Chemicals and Pharmaceutical Corporation, earning foreign exchange to the tune of one lac rupees. Orders for export of microwax to other developed countries such as U.K., Germany, Japan, etc., have also been secured. ONGC has set up a plant at Ankleshwar, costing about Rs. 20 lacs and with a production capacity of 20 tonnes per month. They are planning to step up its capacity in view of the increased demand abroad. It is interesting to note that microwax is being produced from tank bottom sediment of the Ankleshwar crude oil, which had so far been considered 'just waste'. These waxes have 90°C-93°C melting point, and are used in the manufacture of polishes, rust preventives, electrical insulation, paper coating, leather treatment, etc. IIP scientists K. M. Agarwal and Y. Kumar recently visited the Ankleshwar plant at the request of ONGC to help in improving the quality of the product.

The process developed by IIP from pilot plant studies of Ankleshwar tank sediments in its laboratories at Dehra Dun involves recovering and purifying microcrystalline wax from the bottom sediment accumulated in the crude oil storage tanks. This is a waste product obtained during the production and pumping out crude oil.

The accumulations in tank bottoms are melted, thereby removing water and sediment by setting. The lighter fractions like naphtha, kerosene and gas oil are removed by distillation under vacuum, and then the residue is treated with sulphuric acid to remove asphaltic matter. After removing the acid sludge, the acidified wax is treated with sodium carbonate and activated charcoal for neutralisation and decolorisation, and finally filtered through a pressure filter. The molten wax is then passed through flaking machine and microcrystalline wax is obtained in the form of flakes.



Microcrystalline wax plant at Ankleshwar based on IIP knowhow

Manufacture of special charcoal blocks

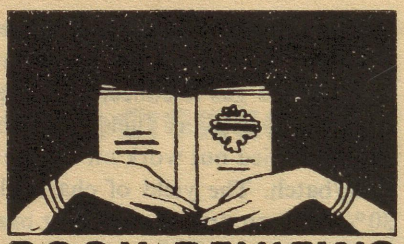
A process for the manufacture of special charcoal blocks from indigenous raw materials for polishing metal surfaces has been developed by the Central Fuel Research Institute (CFRI), Dhanbad. The main product is the charcoal block and the byproducts are wood tar, liquor and gases. The charcoal block produced by this process is of a special nature and is suitable for polishing metal surfaces. From the liquid products, a number of chemicals, viz., wood preservatives, methyl alcohol and acetic acid, can be made. The gas can be used as a fuel.

About 650 charcoal blocks were consumed during 1975-76. At present the entire demand is being met by imports. The demand is expected to go up.

The wood available indigenously is cut to desired size according to the requirements of the consumer. The wood pieces are carbonized in externally heated metal retorts, the heating being done either by gas or electricity. The gases evolved are cooled in a condenser to separate the liquid products, namely tar and liquor, and the stripped gas is collected in a gas holder and used as fuel. The laboratory carried out work on a scale of 4 kg/batch. The yield of charcoal is 30%-33% on dry wood weight basis. Kail variety of pine wood grown in high altitudes (Kashmir, Himachal Pradesh, Kumaon and Bhutan) is raw material for the process.

The equipment required are: machines for sizing the wood as per requirements, a furnace capable of giving the desired heating schedule; and mild steel retort assembly. All these are available indigenously.

It is suggested that a plant carbonizing 800 kg of wood per annum (300 working days) will be economical. The estimated capital investment for such a plant would be around Rs. 20,000 and the cost of production, Rs. 19 per block.



BOOK REVIEWS

LUNAR SCIENCE: A POST APOLLO VIEW *by* Stuart Ross Taylor, *Pergamon Press*, Headington Hill Hall, Oxford, OX3 OBW, England, $19.

THIS book is a readily assimilable digest of the vast amount of new knowledge—much of it barely four years old—about our nearest celestial neighbour, the moon. It is remarkable how little, relatively speaking, we knew about this natural satellite of earth barely twenty years ago. At that time there was no way of even viewing one half of moon's surface because it presents the same face towards the earth. The first camera that looked at the moon's averted hemisphere was put into an orbit passing behind the moon in October 1959 by the USSR. Its useful photography was confined to some 70 per cent of the visible hemisphere lit by a high sun, and both the picture quality and the resolution were poor by the standards of earth-based telescopic photography. Useful far-side photographs were obtained from another Soviet space vehicle which completed the lunar far-side coverage in July 1965, and, from a hird,which provided higher resolution coverage of a limited portion of the far-side. A number of craters were readily identifiable, but the most surprising observation was that most of the far-side of the moon contained no maria—the so-called lunar "seas". Major crater chains, upto 1000 kilometres long, were found.

This Soviet contribution to selenology, the science concerned with the physical nature of the moon, is only a minor prelude to the avalanche of knowledge let loose by the Apollo manned landings on the moon by the Americans. There were in all six such lunar landings—the first on July 20, 1969 and the last on December 11, 1972. As a result of these manned landings, a total of 2,196 samples weighing in all 382 kg was collected on the moon. The book under review is a bird's eye view of the scientific return from this amount of material in terms of our understanding of the geology, topography, origin and evolution of the moon as a full-fledged denizen of the solar system. The book consists of seven chapters each one of which, bar the first introductory one, deals with an aspect of lunar science: like Chapter 2 with lunar geology; Chapter 3 selenology; Chapter 4 the "maria"; Chapter 5 the Highlands, Chapter- 6 the interior of the moon; and Chapter 7 the origin and the evolution of the moon.

There is no space here to describe the diverse aspects of lunar science dealt with in the book. But there is no doubt that the new knowledge yielded by the analysis of lunar rock samples brought by the manned Apollo missions has provided many scientific surprises. Indeed, each mission was a surprise as the author's own summary recorded at the outset clearly shows:

"Apollo 11 provided unusual chemistry and ancient rocks. Apollo 12 revealed the existence of an extremely fractionated rock type, labeled KREEP, Apollo 14 yielded a plethora of breccias; a peculiar green glass of primitive composition appeared at Apollo 15; Apollo 16, expected by some to sample volcanic rocks found none; while Apollo 17 looking for Cinder Cones, found old orange glasses. The moral, reinforced by our observations on Mars, is that geological processes are different on other planets and that the value of terrestrial analogies and experience is limited."

One consequence of Apollo mission is definite settlement of some old controversies while revealing new aspects of others. A case in point of the first kind is the clear-cut decision that lunar rocks are *not* of volcanic origin but are of "impact" origin, that is, they are caused by the impact of meteorites. An instance of the latter is the origin and evolution of the moon. The new constraints spelled by the Apollo missions have shed new light on the older "classical" theories of the origin of the moon. These "classical" theories of lunar origin are of three main types: (a) Single-shot origin, that is, formation along with the earth as a double planetary system; (b) fission from the earth; and (c) capture by the earth of a body formed elsewhere in the solar system.

None of these three types of theories has survived completely unscathed from their encounter with the Apollo data. But some have been hurt more than others. The biggest injury was suffered by the first type. It was immediately realized from the earliest results that a new set of chemical constraints had appeared to reinforce the formidable dynamical and density problems posed by the existence of the earth's unique natural satellite. Apollo mission data seem to have all but knocked out the first theory because neither the lunar density nor its orbital inclination is in accord with actual findings. It has also been not favourable to the fission hypothesis because it infringes both the geochemical and dynamical constraints. The dynamical objections to it have been known ever since George Darwin first proposed the hypothesis in 1896. But the geochemical constraints are the outcome of Apollo

mission data. As for the capture hypothesis, the Apollo data have shown that the moon was not a sample of the primitive solar nebula, as once hoped. Nevertheless, it remains a strong contender. These and other topics in newly arisen moon science have been lucidly dealt with in this book. It is an indispensable acquisition for all who wish to remain *an fait* with the proliferating lunar research of today.

JAGJIT SINGH

COSMIC RAYS *by* A. M. Hillas, *Pergamon Press* (address as above), Pp. 297, $ 12.00.

THE subject of cosmic rays usually deals with the study of the nature and origin of high energy particles (or rays) which reach the earth's surface/atmosphere from above. Beginning with the use of a crude apparatus like the gold-leaf-electroscope in the early part of the present century, it grew into one of the most sought-after fields of physics in the late forties and the fifties when interest in high-energy physics was at it's peak. In the process it led to the discovery and development of many advanced techniques for detection of cosmic ray particles; the nuclear emulsion technique and the bubble chamber, as well as the setting up of some very high energy machines like the "Cosmotron" and the "Bevatron", to mention a few. Cosmic rays can now claim the credit for the discovery of dozens of elementary particles, and still provide the highest energy particles available to man. The subject has wide applications in many branches of physics. It is natural that such a wide and important field should attract the attention of a large number of capable writers. The present volume is written by a Reader in cosmic physic at Leeds University, U.K.

The book is divided into two parts. The first part is of nine chapters covered in about 135 pages. It traces the development of the subject from the very beginning upto the point where the origin and variation of primary cosmic rays became understood. In essence, it appears to be a "commentary" on the way the subject grew with time. The second part, of about 160 pages, contains a reprint of sixteen key research papers. It allows the reader to have a close look at some of the turning points in the history of the subject.

The style of the book is essentially non-mathematical with plenty of historical details on the development of the subject. The reader is frequently advised to go through the relevant research paper at the end of the book. In the reviewer's opinion, more emphasis has been laid on topics like the origin of cosmic rays and their variational behaviour than on the composition and properties of the particles themselves. Illustrations depicting shower production are completely absent. Discussion on the techniques of detecting cosmic ray particles is also not given. But, still, the book on the whole is well written and contains plenty of information for the newcomer. Some original research papers included in the second half of the book (like the one of Hess describing his famous experiments of 1912 with high-rising balloons) instil a thrill in the reader for the subject. Some of these papers are not even easily available in our research libraries. Teachers and researchers interested in cosmic rays would find the book quite useful. It would also be of use to those interested in subjects like radio-astronomy, space physics and astrophysics. Though in India, it cannot be recommended as a textbook for any class, it's addition to college and university libraries would be welcomed.

NARESH KUMAR

PHYSICS IN INDUSTRY *Ed. by* E. O'Mongain and C. P. O'Toole, *Pergamon Press* (address as above) (1976), Pp. 595, $ 30.

HISTORICALLY, physics was relatively slow to enter industry compared with chemistry. Unlike chemistry, where industrial applications go hand in hand, researchers in physics have established only a weak link with industrial technology. Industry needs people with many diverse scientific skills evolved from initial training in physics, because engineering skills alone are not sufficient to provide the innovation rate needed for continued economic success. The book under review, which is an outcome of a recent international conference held at Dublin organized by the International Union of Pure and Applied Physics and the Irish National Committee for Physics, not only emphasises the importance of studying physics applied to industry but also describes several areas of such applications and distinguishes clearly between the academic physics and industrial physics. Generally, physics students, while being trained in basic physics, miss the opportunity of knowing this aspect of the subject.

The major areas covered are communications and data processing, energy, acoustics, biological applications and the new technologies. The social aspects of the problem are also given due attention. Although based on the proceedings of a conference, where generally the stress on any area is proportional to the number of delegates in that area and not necessarily proportional to the importance of the field, the textbook-like style is maintained by the introductory articles and presidential addresses in each area. They introduce and develop the subject and justify the importance of the field. A beginner will also find it interesting.

In addition to scientific contents, various social and philosophical aspects of the problem have been discussed in the plenary papers of the conference. They include the role of the universities and their interaction with the industry, applied physics in developing countries and its role in the improvement of their economic status. Although most contributors on the latter subject are from other developing countries, the only contributor from India in this conference has presented an analysis of socio-economic problems of education for optimizing creative potential of physics for industry. He has emphasized the need for the development of new teaching methods for physicists opting for industry.

As it happens with most conferences, some papers are included even if they have only a distant relation with the basic theme of the conference. Some papers, such as those on measurements of various physical quantities or some modifications in measuring techniques, fit in more in a scientific journal than in a book of this kind. They may be of interest to only those who are directly involved in those fields.

In spite of these minor shortcomings, one would find that the book is a useful information manual for those who have interest in this field or who are directly involved in the industries in the mentioned areas or those who are policy planners for scientific research.

A. K. GUPTA

INVERTEBRATES *by* R. L. Kotpal, S. K. Agarwal and R. P. Khetarpal, *Rastogi Publications*, Meerut 250002, Pp.660, Rs. 17.50

QUITE a number of books on zoology are available for students of high-school standards as well as of college level, but most of them are written by foreign authors. They deal with animals many of which are not found in India. The basic principles of zoological science, like those of any other science, do not vary with nations; but when we get down to details and specifications, differences arise. Students would like to know more about the animals around them. The authors have taken care to deal with animals specially in India. The value of this book is thus enhanced.

It is a well printed publication, profusely illustrated to make understanding simple. The type sizes are large for easy reading and the language has been kept simple. All these add to the readability of the book. Students of both high-school and college levels will find it useful.

A MANUAL OF VIRUS DISEASES OF TROPICAL PLANTS *by* S. P. Raychaudhury, *The Macmillan Company of India Ltd.*, 2/10, Ansari Road, N. Delhi-110002 (1977), Pp. 299, Rs. 44.25.

THE author is internationally known in the field of phytopathology, particularly virus diseases of plants. It is his persistent interest of three decades that has culminated in this book. The publisher claims it to be the first comprehensive account of virus diseases that affect the plants in the tropics. To some extent it is correct to say so. As the principles of virology can be found in other books, they have been purposely omitted here. The author has described about 250 virus diseases of plants. Using common English names, he has tactfully avoided the controversial nomenclature system.

The first part of the book under review consists of nine chapters spread over 86 pages. In this part interesting aspects are as follows: Some viruses cause morphological aberrations so that the disease caused is recognizable, while others do not. The latter can then be detected by the presence of crystalline or amorphous inclusions in the cells. The viral diseases can be transmitted just by touching, or when plants are grafted, or by the insects that feed on them. Viruses are also transmitted by pollen from the infected plants and by the seeds produced by the diseased plants.

The latest methods of separation of viruses from plant material and their purification, such as differential centrifugation and electrophoresis are described. The serological tests, such as precipitin test, complement fixation test, and electrophoresis described here will be useful for those who are interested in identifying the different viruses. Fluorescent antibody technique used by the author has been helpful in determination of viral infections.

The book also informs the reader how viruses can be controlled. It is interesting to note that by culturing the rapidly growing shoot apices of diseased plants and embryos, one can obtain a disease-free plant. Tissue culture methods also serve as a means of propagating the viruses.

The second part of the book has 15 chapters and deals with infections of the various plants grown in the tropics. Some of the important plants dealt are rice, wheat, maize, sugarcane, cotton, jute, sandal, banana, groundnut, mustard, coconut, cardamom, tea and coffee. From the viewpoint of India's commerce and trade, these plants are very important and it becomes imperative to know about the diseases caused by viruses and their control. The author has devoted the last chapter of this part to infections caused by mycoplasma and rickketsia-like organisms.

Each chapter of the book is followed by references, and a subject index concludes the book.

The 109 black and white photographs of the plates have been satisfactorily reproduced, except for the inversion of one of the plates. However, the colour plates are poorly reproduced. The author—quite surprisingly—seems to have forgotten to give any reference to all these plates in the text. Though the book is subsidised by the Government of India, it is priced high.

As virus diseases cause various degrees of damage to economic plants in India as well as abroad, there is a great need for intensive research. The description and photographs included in the book will be of immense help to anyone interested in identifying virus diseases and knowing ways of their control in the tropical regions.

M. ILYAS

FOOD SCIENCE - A chemical approach *by* Brian A. Fox and Allan C. Cameron, *Hodder and Stoughton*, London; Indian Representative: *B. I. Publications*, 359, D. N. Road, Bombay 400001, Pp. 380, Rs. 39.20.

WE eat several times a day. It is, therefore, important that we know what our food contains, what its various important constituents are, what happens to them, especially the nutrients, during cooking, and so on. Scientifically, our food is nothing but a combination of complex compounds that undergo chemical changes during cooking, processing and digestion.

Proteins, carbohydrates, fats, vitamins and minerals are the main constituents, important from nutritional point of view. But their amounts differ widely in various foods. So there is need to combine various items so that the meal is nutritionally balanced. But how much of what should one take? There is also the problem of spoilage. Why do some foods keep better than others? What is the principle of preservation? What are food additives? Are they harmful? The answer to these questions and many others can be found in the fourteen chapters of this book.

Food Science is basically a book of biochemistry, but with a difference. Unlike standard textbooks on the subject, here the treatment of the various topics is concise, yet easily understandable. The various food constituents like carbohydrates, proteins, oils and fats, etc., are dealt with in separate chapters while full chapters are devoted to general topics like basic chemistry, food and its functions, cooking and diet, food spoilage and preservation, etc.

There it a lot of interesting bits of information on topics like food values, proper cooking method (from nutritional point of view, of course), dieting (or slimming), food hygine, etc., which the housewife may find useful. Apart from suggestions for further reading at the end of each chapter, there is a general reading list at the end which will be of help to the serious reader.

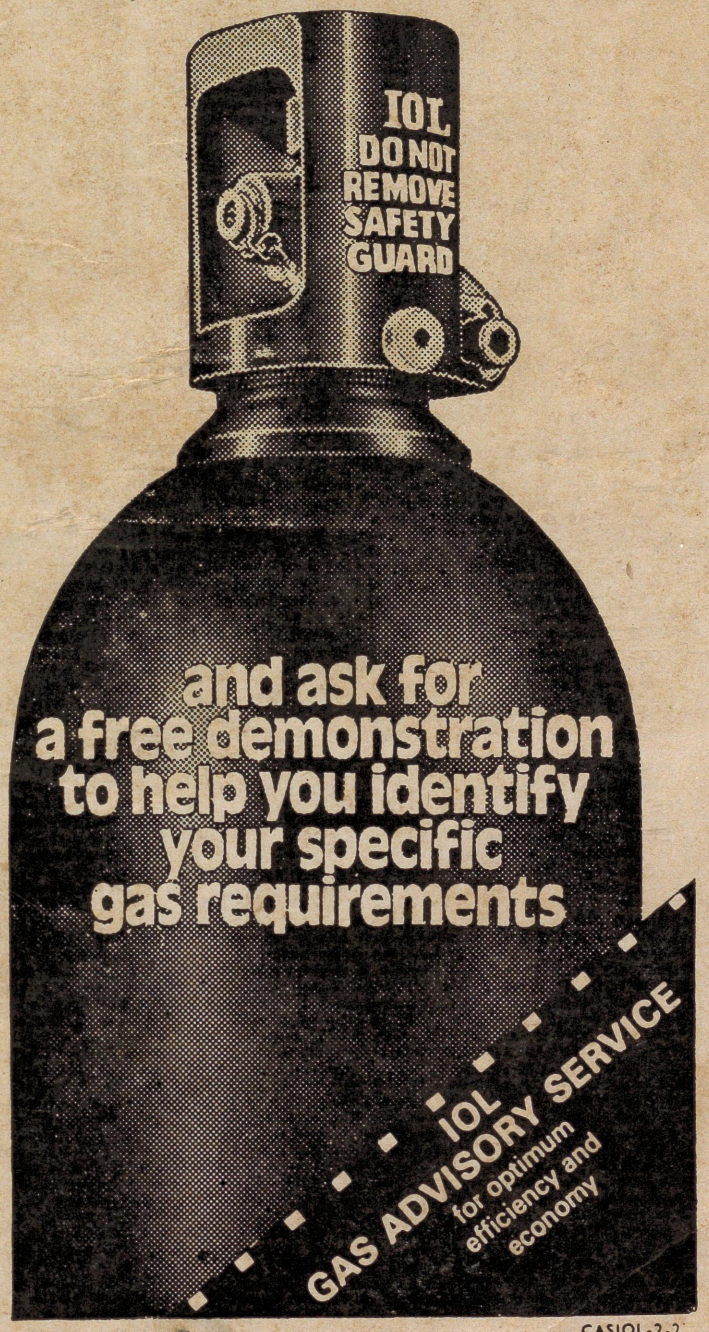
BIMAN BASU

Books Received

1. **MATHEMATICAL ANALYSIS** by V. Ganapathy Iyer, *Tata McGraw-Hill Publishing Co. Ltd.*, 12/4, Asaf Ali Road, 3rd Floor, New Delhi, 110002, Pp. 360, Rs. 21.00.
2. **ELECTRONIC PRINCIPLES AND CIRCUITS** by A. K. Kama & N. K. D. Choudhury, *Nem Chand & Bros*, Civil Lines, Roorkee-24667, Pp. 686, Rs. 32.50.
3. **ENGINEERING FLUID MECHANICS** by R. J. Garde & A. G. Mirajgaoker, *Nem Chand & Co.*, Pp. 591, Rs. 27.50.
4. **MECHANICAL VIBRATIONS** by G. K. Grover, *Nem Chand & Co.*, Pp. 462, Rs. 20.00.
5. **FORTRAN-IV & ENGINEERING APPLICATIONS** by Satya Prakash Garg, *Nem Chand & Co.*, Pp. 552, Rs. 22.50.
6. **HIGHWAY MATERIAL TESTING (Laboratory Manual)** by S. K. Khanna & C. E. G. Justo, *Nem Chand & Co.*, Pp. 135, Rs. 8.75.
7. **OPTICS** by F. G. Smith & J. N. Thomson, *E.L.B.S. & John Wiley & Sons Ltd.*, C/o British Council Division, 21, Jor Bagh, New Delhi-110003, Pp. 350, £ 1.30.

With every IOL Special Gases cylinder comes international technology.

Call an IOL gas expert to work on your high-purity gas application systems for the optimum results.



Accurate selection of your specific gas requirements, study of your applications, advice on gas handling systems and problems by IOL experts can help optimise efficiency and economy. A free demonstration will clearly indicate the advantages of using an IOL high-purity gas—now in 3 new grades for ease of selection and economy:

IOLAR-1
IOLAR-2
IOLAR-3

IOL gas experts will visit your plant, work with your engineers or technicians, and organise a trial run to demonstrate the advantages of the IOL range. You thus avail of the finest gas technology in the country—backed by the expertise of the worldwide BOC Group. And each IOL cylinder, individually tested, carries a certificate guaranteeing levels of controlled impurities.

IOL
SPECIAL GASES

Special Gases Centre
Indian Oxygen Limited
Lal Bahadur Shastri Marg
Ghatkopar West, Bombay 400 086.

CASIOL-2-2

Registered with Registrar of Newspapers : R.N. 7440/64

Printed and Published by S.P. Ambasta, Council of Scientific and Industrial Research, Rafi Marg, New Delhi-110001
at the Delhi Press, Jhandewalan Extn., New Delhi-110055
Regd. No. D-(C)-66.