SCIENCE REPORTER

MARCH 1977

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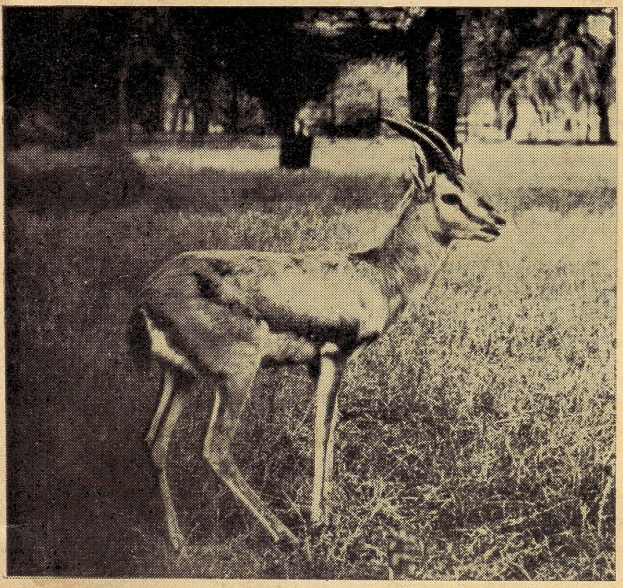

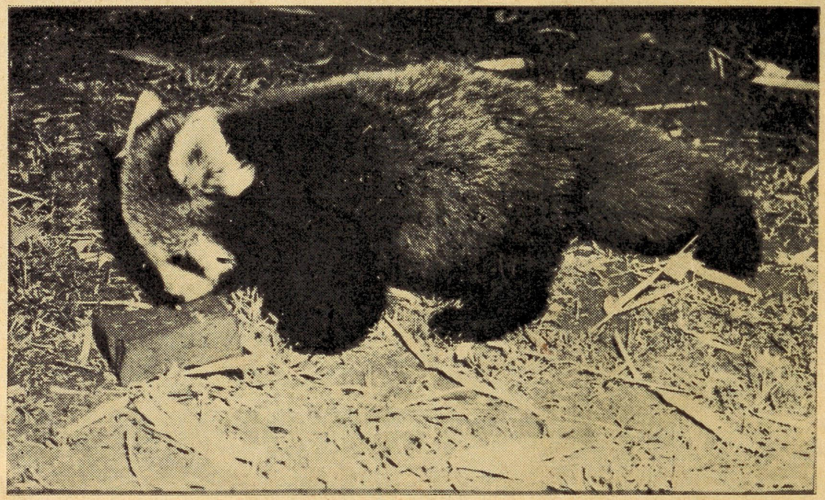

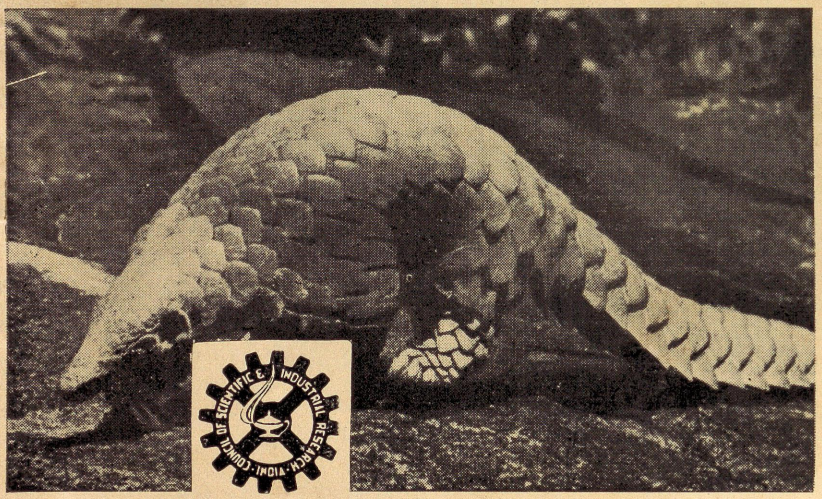

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LETTERS

Retinal detachment

Sir, **Retinal detachment can cause blindness** (*S.R.*, Aug. and Sept. 1976) was very interesting. Please let me know about the aetiology of the detachment of retina. Why does retina get detached from the choroid? What is the pathogenesis of the case and why is retina detached from the upper fundus more frequently than lower fundus?

Ramendranath Dalal
Calcutta-700030

The immediate cause of retinal detachment is the development of retinal breaks or holes, through which the degenerated fluid vitreous flows under the retina lifting it and causing a retinal detachment (Fig. 5). How and why are retinal breaks caused has been a subject of great interest to ophthalmologists for decades. In my article **Retinal detachment can cause blindness** (*S.R.*, August 1976), I have described the most accepted concept under the headings; "Causes of retinal tears" and "Vitreous in the mechanism of development of retinal tears". In short, the degenerated shrunken vitreous pulls on the retina (where it finds abnormal attachments) during sudden change in motion to cause retinal breaks. The vitreous degeneration and its abnormal attachment to the retina is determined by certain genetic defects and is closely related to short-sightedness or myopia.

Since gravity aids formation of retinal tears by downward shift of vitreous and also facilitates accumulation of fluid behind the retina leading to retinal detachment, not only the tears are more commonly formed in the upper quadrant, but once formed they quickly and easily lead to retinal detachment.

Dr. B. Patnaik
Asstt. Prof. of Ophthalmology
(Retina Care)
M.A. Medical College
New Delhi

Explosions of the galactic nucleus

Sir, Drs. S.B. Karanjai and S.K. Barman (*S.R.*, Jan. 1977) have mentioned that the formation of the 3 kiloparsec arm is due to an explosion at the centre of the galaxy, perhaps 10^7 years ago. According to K. Ishida (*Supp. Prog. Theo. Phy.*, **31**, 116-130, 1964) the 3 kpc arm, which is believed by J. H. Oort and others (*M.N.R.A.S.*, 118, 379-389, 1958) to be a fullfledged spiral arm and which is moving towards us with an outward radial velocity of 50 km per sec, is the result of an explosion at the centre of the galaxy $\sim 2 \times 10^7$ years ago.

The flowing of gas at the solar neighbourhood, from the halo, has been suggested by K. Ishida in terms of an explosion $\sim 5 \times 10^7$ years ago and the presence of large scale galactic halo to an explosion of the galactic nucleus 10^8–10^9 years ago.

Besides our galaxy, there are unambiguous proofs of explosive activities in extra-galactic objects. This phenomenon is considered to be fairly common. According to K. Ishida "all normal galaxies must have experienced enormous explosions 1-10 times in 10^{10} years". Seyfert and radio galaxies are believed to be caused by the explosion of the nucleus. G.R. Lynds and A. R. Sandage (*Ap. J.*, 137, 1008-1021, 1963) have reported evidences of an explosion in the central region of *Messier 82*. This is regarded as the most direct evidence of an explosion of the nucleus of the galaxy. E. M. Burbidge *et al.* (*Ap. J.*, 140(3), 942, 1008, Oct. 1964) have arrived at the same conclusion, of the explosive activity of *M 82*, from a study of the velocity field in that galaxy and K. Aizy *et al.* (*Supp. Prog. Theo. Phy.* 31,, 35-61, 1964, have even proposed the Pile Theory to explain the mechanism of the explosion.

S. K. Gurtu
Defence Science Laboratory
Metcalfe House
Delhi-110054

The riddle of gravitation

Sir, I thank you for the article **The riddle of gavitation** (*S.R.*, July 1976). However, there is one important point which the authors seem to have overlooked. The Theory of Relativity does not say that no physical object can move with velocity greater than that of light, it just says that no physical object can travel *at the speed of light*. This small but vital difference has given rise to Prof. Gerald Feinberd's papers *On the possibility of faster than light particles* (Ref : *Promise of Space* by A. C. Clarke). Herein lies a vague distant hope of smashing the light barrier without violating the relativity principle.

S. C. Mahagaoker
B. H. U., I T
Varanasi

The statement of the first postulate of the Special Theory of Relativity mentioned in our article is indeed faulty. It was an oversight and we highly regret this error. At the same time the statement given by Shri Mahagaoker that "no physical object can travel at the speed of light" is also incorrect. The correct statement is that the velocity of light (in vacuum) is a universal constant, independent of the motion of the source and the observer. The observation that no physical object can travel at a speed greater than that of light is a consequence of the postulates, within the framework of the special theory of relativity. Photons and neutrons do travel at the speed of light, and they are physical objects. In fact, according to quantum electrodynamics every massless particle must travel exactly at the speed of light. We would not like to comment, at this stage about particles travelling faster than light.

A. W. JOSHI
S. S. CHOUDHARY
Deptt. of Physics
Meerut University, Meerut

Variable stars

Sir, Variable stars have been classified into four types by Dilip M. Salwi, **The stars that pulsate**, (*S.R.*, Aug. 1976). In one type , there are hotter or colder regions, according to the author, whose rotations cause light variation. Now almost all the stars are rotating with hotter (photosphere) or colder (starspots) regions. So, we should expect the stars to fluctuate in brightness. This is not so. The sun, for example, has an almost constant radiation output, though there are sunspots on the surface participating in the general rotation with lesser temperature than the surrounding photosphere.

Surprisingly, Mira type variables and flare stars have not found a place in the author's classification.

S. K. GURTU
Defence Science Laboratory
Metcalfe House
Delhi-110054

Light

Sir, In **The riddle of gravitation** (*S.R.*, July 1976) by A. W. Joshi and S. S. Chaudhury the quotation by Alexander Pope reads :

Nature and Nature's laws lay
hid in night,
God said 'Let Newton be'
And all was right.

Here a slight error has crept in. It should have read "Nature .... And all was **light.**" One letter either wrongly printed or misquoted makes the quotation dubious. Newton's work on light is unforgetable contribution to science.

GEORGE POLSON
Alangadan House
M.G. Road
Ernakulam, Cochin-682016

Gravitation

Sir, In *S.R.*, July 1976, A.W. Joshi and S.S. Chowdhury have given a very interesting and informative review of the various theories of gravitation including the latest one put forward by K. P. Sinha and Sivaram. But it is unfortunate that there is no mention of Hoyle-Narlikar theory, which at one time attracted the attention of all. They based their theory on Mach's principle of action at a distance. According to them, mass of a body is not its inherent property but is dependent on the entire mass of the universe. This theory also explains why there is always attraction and no repulsion in gravitation.

A. K. DAS GUPTA
Calcutta-700033

Heavy metals

Sir, **The heavy metals** by Sunil P. Pande (*S. R.*, May 1976) was quite interesting. Selenium does not belong to the class of metals. Arsenic, antimony and selenium are better known as metalloids. Selenium displaces sulphur from sulphur-containing proteins. Excess selenium in the soil causes formation of protein-selenium compounds in crops. Drinking water contaminated with selenium is one of the causes of formation of protein-selenium compound in the body of the animals. Alkali diseases of the cattle result from the protein-selenium compounds formed in the body.

Presence of a little selenium in rats is essential. Lack of selenium destroys the action of glutathion peroxidase in blood of the rats. This results into hepatic necrosis in rats. Growth of sheep is retarded by lack of selenium. Administering selenium compound to cattle and pigs rescues them from hepatic dystrophy.

The enzyme, glutathion peroxidase, contains selenium. It prevents unwanted oxidation by peroxide in cells of rats.

LALITA PATTREA
Lecturer in chemistry
Vidyasagar College of Women
Calcutta-700006

Nodulation in plants

Sir, I read the article **Nodulation in plants** by Sukumar Chatterjee (*S. R.*, January 1977) with interest. The author is not correct when he writes "Strangely, the bacteria cannot fix nitrogen outside the nodules when they are artificially cultured in the laboratory".

In fact, recently Pagan *et al.* (*Nature*, July 31, 256 : 406) have shown that a strain of *Rhizobium* 32H 1 could fix nitrogen when they were artificially cultured in a defined medium, in absence of plant cells. A key factor in the culture medium proved to be a carbon source, a pentose sugar such as xylose a arabinose, as well as a dicarboxylic acid such as succinate.

MANTU BASAK
Division of Microbiology
Indian Agril. Res. Instt.
New Delhi-110012

Articles

Sir, We thank you for publishing useful articles in *Science Reporter* every month. The articles increase our knowledge about the latest developments in science and technology.

We request you to publish more articles on health problems (common diseases, causes, possible remedies, etc., with illustrations) and also topics on various small scale industries for the unemployed youth (finance, raw material, technology, marketing, etc.).

V. NIRANJAN SASTRY AND COLLEAGUES
Department of Chemistry
Atomic Energy Central School
Hyderabad-500762

Suggestions

Sir, I have been a subscriber to *S. R.* for the past one year. It is of great help to students, appearing in competitive examinations, especially to the students appearing for the National Science Talent Search Examination of NCERT.

I would like you to publish articles on topics such as detergents, biopolymers, biological clocks, etc. These articles will be of great use to science students.

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

II

Sir, I am subscribing to *S. R.* regularly since January 1970. I made all the back numbers into bound volumes. The magazine helps immensely the teaching and student communities in understanding the recent developments in various branches of science. I utilise articles on biology in my classroom for the benefit of students. I wish you greater success in the years to come.

S. GHULAM MAHMOOD
Asstt. Professor of Zoology
Government Arts College
Ootacamund-643002

III

Sir, I have read *S.R.* of January 1977. In every article I found certain words above the standard of a common reader. I would therefore suggest that a vocabulary of the difficult words and abbreviations (if any) be given at the end of each article.

Besides, I would like you to publish articles on human psychology and psychological diseases every month if possible.

S. A. AHMED
12-Poloview
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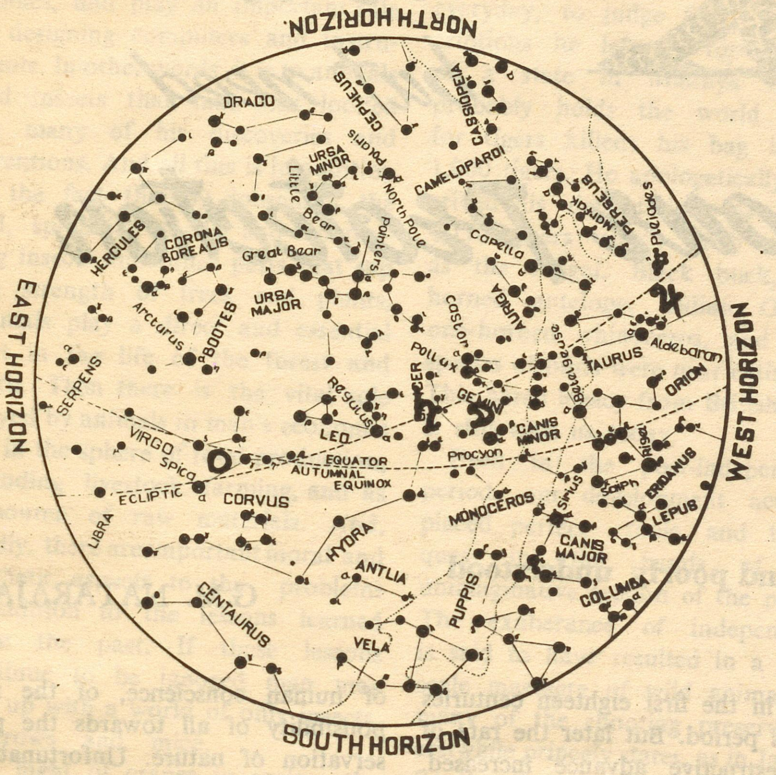
Planets and their positions

APRIL 1977



MAGNITUDES

-1 0 +1 +2 +3 +4 +5

PLANETS

♃ JUPITER

♄ SATURN

MOON

O FULL MOON 4TH

☽ FIRST QUARTER 26TH

FULL moon occurs on 4th at 9-39 a.m. and new moon on 18th at 4-05 p.m. I.S.T. The moon passes about four and a half degrees north of Mars on 15th and same amount south of Venus on 17th, five degrees south of Mercury on 19th, about three degrees south of Jupiter on 21st and six degrees south of Saturn on 27th. The lunar crescent becomes first visible after the new moon day in the evening of 19th.

The moon is at perigee or nearest to the earth on 6th and at apogee or farthest from it on 21st.

There will be a partial eclipse of the moon on 4th, but it will not be visible in India.

There will also be an annular eclipse of the sun on 18th. The eclipse will be visible in India except in northern and north eastern parts before sunset as a partial solar eclipse.

The planets

Mercury (*Budha*), or the evening star sets, about an hour after sunset during the first three quarters of the month. Thereafter, it is too near the sun to be visible being in inferior conjunction on 30th. It is at the greatest eastern elongation of about 19 degrees from the sun on 10th and becomes retrograde on 20th. It is in Aries (*Mesha*). Its visual magnitude varies from -0.9 to +2.1.

Venus (*Sukra*) is too near the sun to be visible during the first quarter of the month being in inferior conjunction on 6th. Thereafter, it reappears as a morning star and rises about an hour before sunrise. It becomes direct on 27th. It is in pisces (*Mina*). Its visual magnitude varies from —3.1 to —4.1.

Mars (*Mangala*), visible in the morning sky, rises about one and a half hours before sunrise during the month. It moves from Aquarius (*Kumbha*) to Pisces (*Mina*). Its visual magnitude is about +1.4.

Jupiter (*Brihaspati*), an evening star, sets about three hours after sunset during the first half of the month and about two hours after it during the second half. It is in Taurus (*Vrisha*). Its visual magnitude is about —1.6.

Saturn (*Sani*), visible in the evening sky, sets about two hours after local midnight during the first half of the month and about an hour after it during the second half. It becomes direct on 11th. It is in Cancer (*Karkata*). Its visual magnitude is about +0.4.

Source: Nautical Almanac Unit of the Meteorological Office, P-546, Block 'N', New Alipore, Calcutta-53.

They are wild but need our Protection

Wild life conservation is vaguely and poorly understood in India

G.M. NATARAJAN

THE population of many animal species has been changing since prehistoric times. Many animals have died out and others have come close to extinction as a result of climatic and geographic changes. This process is still continuing, in fact, at a faster rate, because of the active interference of man. I will not enlarge here on man's savage and senseless treatment of the world's animal population. They are well-known and speak for themselves.

It is estimated that over the past two thousand years 106 species of animals and 139 species of birds have become extinct. Man's impact on nature was relatively slight in the first eighteen centuries of this period. But later the rate of his destructive advance increased. Last century seventy species of animals became extinct, and in the last fifty years forty species have vanished from the earth. At the present time annihilation has become even more intense.

The *Red Data Book*, introduced by scientists to record animal and bird species threatened with extinction and for whom remedial action is necessary, lists 600 species. The population of a number of species is well below one hundred, and in some cases it is less than ten. The *Red Data Book* can be seen as a document of human conscience, of the responsibility of all towards the preservation of nature. Unfortunately, there are still many people who do not consider the problem of wildlife conservation of any consequence. Why, they ask, should any man bother to preserve and protect the black buck or some small bird listed in the *Red Data Book* ? The answer is that there are many and compelling reasons why he should. Any species of wildlife, animal or bird, is a unique creation of nature with its own specialised mode of life, organic structure, and individual behaviour. One can reconstruct a temple, a palace or a machine by a plan or description,

Shri Natarajan teaches zoology at Rajah Serfoji Govt. College, Thanjavur (Tamil Nadu) 613005

but it is impossible to reconstruct an extinct life form.

And, has man realised all the economics and other possibilities of living nature? For example, the bodies of animals have long served man as models for his development of various instruments and machines. The principles employed in converting external stimuli into biological receptors have formed the basis of a new science—bionics, and play an important role in designing computers and instruments. In other words, it is to animals and insects that man has looked for many of his discoveries and inventions. And all this is in addition to the fact that by loosening the soil, spreading seeds and controlling insects and other pests that sap the strength of trees and plants, animals play a direct and essential part in the life of the forest and earth. Then there is the vital role played by animals in man's economic life in the sphere of food production, including livestock farming, and as a source of raw materials. And, finally, there are important moral and aesthetic aspects to the problems in addition to the lessons learned from the past. If these lessons continue to be ignored man may end up with a world of only insects, sparrows and mice.

A flight of cranes in spring, the song of cuckoo, the mighty tiger in the forest, do something for our spirit, bring us joy.

Today, six hundred animal species are on the endangered list, which means that these animals will disappear unless urgent measures are taken over the next thirty years. Meanwhile, other species are being added to the list. Can these threatened species be saved ? Experience in India in the field of wildlife protection gives an encouraging answer to this question.

India has about 500 species of mammals, 2060 species of birds, 748 species of reptiles, and 29,700 or more species of insects. A mere enumeration of animals living in one state of India would fill a number of pages.

The mad destruction of animals occured during British rule in India also. As a result many animal species, especially lions, tigers and cheetahs were almost wiped out. In Assam, Colonel Pollock—a military engineer, shot a rhino or a buffalo for breakfast almost everyday, to judge from the descriptions he left. A former Raja of a state in Madhya Pradesh probably holds the world record for tigers killed; his bag is over 1,000 tigers. He apologetically described his depredation as "killed 1,170 tigers only". Such animals as the Nilgai, Black buck, four-horned antelope, Indian Gazelle, one-horned rhinoceros, and many species of birds were near extinction. This harsh legacy from British times is still with us today.

Even in the post-independence period, our development activities placed perfect tools and techniques in the hands of vast unimaginative section of the people. The exuberance of independence is said to have resulted in a large-scale massacre of wild animals, in many of the shooting preserves of erstwhile princely states, as in Janjira, South of Bombay, where villagers went out and killed 200 cheetahs and paraded their kill on the streets in celebration of Independence Day! What was worse, the forest departments of the states in which the princely states merged, disbanded the game departments of the latter and relegated game protection to a secondary place. For quite sometime, the wildlife lost even the dubious protection it had enjoyed in the princely states.

Paradoxically in no other country is life valued in theory so much as in India and many people would even hesitate to destroy the meanest or the most harmful of animals. Ashoka's third century B.C. pillar edict gives the names of birds, beasts, fishes, and probably even insects that are to be afforded protection in his empire. Kalidasa's hunting deer, Kamban's Hanuman and Kautilya's "Abhayaranya" are some of the other important references to our wild life.

India was probably the first country to enact a Wild Life Protection Act. The Wild Birds and Animals Protection Act was passed in 1887 and was repealed in 1912. The Forest Act XVI of 1927 dealt with game protection in the states. Various states, notably the Punjab and Bengal, also enacted their own laws. In 1952, the Government of India, by a resolution constituted the Indian Board for Wild Life. Based on the recommendations of the Board, the status of several animals and birds in the country was classified into: (a) those that are threatened, (b) those that are of special category needing protection, and (c) big game and small game and Vermins.

By the new Wildlife Protection Act of 1972, the threatened species are absolutely protected and the rest are afforded graded protection as they appear down in the classification. Under this Act possession, trapping, shooting of wildlife alive or dead, serving their meat in eating houses, their transport and export are all controlled and watched by special staff namely the Chief Wildlife Warden and the authorised officers.

Chapter III of this Act prohibits hunting of females and young ones except that of Vermin.

However, to prohibit hunting of animals is only one step in the work of protecting them. It is also necessary to know about them. For instance, the lion-tailed macaque is an interesting object for study. It is usually moving in troops of 12 to 20 animals. Sometimes lone males or courting couples may be seen. The sex ratio of male and female is 1 : 3 and the reproduction and

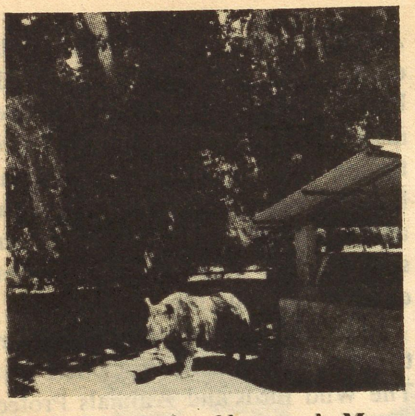


Fig. 1. Great Indian rhinoceros in Mysore zoo

population increase is yet to be studied. The longevity and mortality is not known. And the remarkable antagonistic behaviour of the troops remains an enigma to scientists to this day. On the initiative of the Tamil Nadu Government the entire Kalakkadu Reserve Forest in Tirunelveli district has become a sanctuary and a research programme has been launched to study the behaviour of these animals extensively.

Tiger is a good example of what can be done with scientifically-based and rational measures for the protection of wildlife. By the end of 19th century, the tiger had been all but destroyed in India, especially in central and eastern regions. In 1973 the Government of India launched the "Project Tiger". A total prohibition on poaching and hunting of tiger was imposed. As a result of the measures taken by the government the tiger population has grown considerably and the area of its habitat has expanded.

When an animal or bird species appears on the critical list the government's first and most effective measure is to impose a total ban on hunting. The hunting of the now rare birds such as the flamingo, pelican, bustard, great white crane, openbilled stork, grey heron, pink headed duck and mountain quail is prohibited. Limited hunting may be allowed at some future date, but never near the mating sites of the birds or where they gather during the mating season. Other measures include the establishment of reserves, the provision of feeding stations along migration routes and in the wintering places of birds, the protection of seashore colonies of birds, and the introduction of water-fowl to new reservoirs.

Good progress has been made in protecting Gir lions. The protection of Gir lions is of great national significance. Despite succession of drought years, Gujarat Government has taken all possible steps to increase the number of animals. A 48 lakh rupees scheme launched earlier by the Gujarat Government to protect the Gir lions will be completed soon.

With regard to enforcement of regulations every Indian state has its own wildlife wing in the Forest Department and additional field staff for effective enforcement of the Wild life (Protection) Act.

In India the first reserve to be established was the Manas in Assam and the second, the Kaziranga. The Kaziranga sanctuary shelters the one horned rhinoceros, one of the world's rarest and peculiar present day monsters. At present the Indian sub-continent has more than fifty sanctuaries which occupy a total area of about 12950 km.

Sanctuaries in India include such natural features as unique landscapes, broad-leaved forests, mountain forests, virgin bushlands in deltas of big rivers, all of which give a fairly clear idea of what the country looked like in the past, together with its rare animals and plants, etc., The sanctuaries also serve cultural and educational purposes, and are visited by scientists school and college students and tourists.

In addition to the sanctuaries, India has national parks, protected areas and reserves. The national parks are for public recreation and tourism. The number of national parks in India is steadily growing. Every year there is establishment of new reserves also.

Despite all these measures taken by the Government to protect the fauna and flora of our country, it is really distressing to know that India has lost about 200 animal and bird species since the beginning of Christian era; and the rate of loss of wild animals alone was, according to one estimate one for every 55 years upto the last century and since then, at a staggering rate of one animal for every one and half years. 250 other species are now about to be lost. In fact, it can be said that, with very few exceptions, most of our wild animals today are balancing precariously over the precipice of extinction.

In India, the setting up of nature protection reserves has received special attention. In the last century the necessity was realised of providing birds and animals with places

"Is it available to our home life too, Dear?"

About the extinct!

THERE was a time in the past when giant dinosaurs had ruled the earth. Ghastly looking as they were, the only evidence of their past existance is fossils which were preserved in nature. While everybody would be happy that the dinosaurs vanished, the biologists may, however, repent that they did not get one to study its behaviour and physiology. Biologists have been speculating about the various physiological aspects of the extinct dinosaurs by relating their height and hydrostatic pressures in the vascular system. Why is there an interest in those extinct animals? Naturally, it is important from the biological point of view. But one wonders if we are really interested in the wildlife because a number of species are threatened with extinction. Would we be able to save enough living specimens of today's endangered species so that our future generations do not hold us responsible for depriving them of this natural heritage?

Z. I.

of refuge—sanctuaries—where they would be fully protected by law. That is how nature reserves came into being. However, their purpose is not only confined to protection of animals but much wider.

In many parts of our planet nature has been modified and distorted by the impact of man. But to study nature it is necessary to have areas of truly virgin pristine landscape where animals, plants, the soil, etc., are in their natural state. This is the primary aim behind the setting up of nature reserves and parks, preserving, as far as possible, a true criterion of nature.

Nowhere in the world had destruction of the natural wilderness, the habitat of wildlife proceeded with such speed and totality as in the Indian sub-continent. It has been the most decisive factor in the catastrophic diminution of India's wildlife within and outside the sanctuaries in the last 25 years.

The decline of the wildlife of India also stems from the demands of our exploding population not only on forest products but on the forest land itself. With the extension of cultivation into the forest it has now become a question of survival for many species like the Blackbuck, the Chinkara and the Indian wolf, to mention only a few. They exist only in precarious survival pockets and their assured existence depends on the success of the conservation movement. The swampdeer and the Nilgai have made their last stand on the periphery of the forest. Their further retreat is limited by a hostile habitat and their survival is in balance. When forest disturbance is universal and the forest canopies resound with material quests, where is the animal to breed, and where to rear its young ?

Human predation also continues unabated. The illegal fur trade is still rampant inspite of export bans. Wildlife conservation is but vaguely and poorly understood in India, and the public feeling for the animals is entirely indiffer nt. Tribal hunters in certain favoured areas increased in numbers. Forest-based tribes also have in recent years successfully destroyed every vestige of wildlife.

The forest department is only a commercial organisation and all its efforts are directed towards increasing revenue. Heavy cattle grazing and timber exploitation take place in parks and sanctuaries with the adverse effect on wildlife reproduction. So far as India is concerned, the proliferation of the cattle population is the greatest menace threatening wildlife. Domestic cattle, many of which are diseased, transmit their parasites to the wild animals particularly ungulates, in addition to competing with them for food in the over-grazed forests.

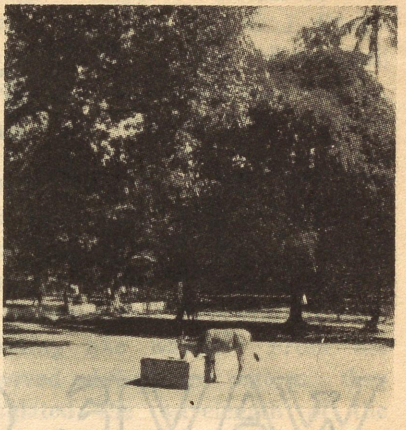


Fig. 2 Feeding Station in a Reserve Forest

Many people believe that Africa's wildlife is the richest in the world. But zoogeographical evidences point out that Africa's wildlife had its origin only in India. Unique forms of our country are antelopes, namely, Nilgai, black buck, four horned antelope and the Indian Gazelle. Black buck is found in no other country. Four horned antelope is the only antelope with four horns in the world today. But no other country has even these four forms of antelopes. Africa is rich in numbers, but India in variety and interest. Incredible as it may sound, there is no deer in Africa, India has several forms. Further, India shelters Gaur or the Indian bison, the biggest wild oxen living in the world today, which is not found in Africa. India is the only place in the world, next

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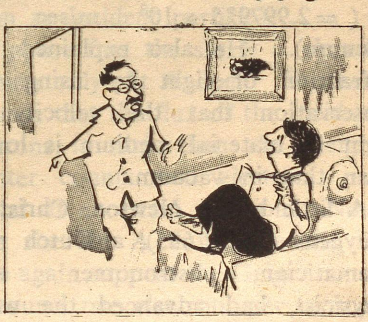

"But it is no more punishable to be wild, Dad"

DILEMMA IS WAVE OR PARTICLE?

A. W. JOSHI

Does every object in this universe, small or large, show the wave-particle duality? In principle, yes. But the wave properties of matter dominate only in the microscopic domain and become negligible in everyday objects

THE dilemma about the nature of light is an old one. The famous British scientist Sir Isaac Newton (1642-1727) was one of the pioneers who advanced a definite scientific theory of light. He suggested that light consists of particles or corpuscules which travel in straight lines and carry energy. By this simple theory, Newton easily explained the rectilinear propogation of light and its spectrum. According to him, corpuscules of light of different colours have different energies, though all of them travel with the same speed, the speed of light c ($= 2.997925 \times 10^8$ m/sec in vacuum). He also explained the refraction of light by using the observation that the velocity of light in material medium is lower than that in vacuum.

A little before Newton, Christian Huygens (1629-1695), a Dutch mathematician, astronomer and physicist, had advanced the wave theory of light. According to it, light is a wave travelling in an all-pervading medium named 'ether' just as sound travels in gases, liquids or solids. He also explained the phenomena of rectilinear propagation of light, reflection, refraction, double refraction, etc. He noticed the polarization of light but did not give any attention to it.

For about 100 years, not much advance was made in understanding light. The corpuscular theory and the wave theory continued to be the main rivals. Adherents of each theory tried to explain all phenomena of light in terms of their theory. For example, polarization of light was explained by the corpuscular theory on the ground that a ray of light may be more like a flat rod rather than a circular one. On the other hand, in the wave theory, it was explained by suggesting that light consists of transverse waves in ether.

The dawn of the nineteenth century saw the wave theory gaining a distinct lead over the corpuscular theory. In 1801, Thomas Young, a British physicist and physician, discovered the principle of interference and found that this spectacular phenomenon could be explained by the wave theory alone. In the latter part of the nineteenth century, another British physicist James Clerk Maxwell (1831-79) gave the first sound theoretical foundation for the electromagnetic phenomena and showed that light is a small part of the wide electromagnetic spectrum. The discovery of artificial production of electromagnetic waves and their reception, by the German physicist Heinrich Rudolf Hertz around 1885, was another milestone towards understanding the nature of electromagnetic radiation. So, at the end of the nineteenth century, there was no doubt among physicists that light, and electromagnetic radia-

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tion as a whole, consist of waves.

At the turn of the century, the German physicist Max Planck (1858-1947) once again revived the corpuscular idea and suggested that light consists of quanta of energy. In other words, light cannot possess a continuous spectrum of energy but a ray of light of frequency ν (nu) must have an energy in multiples of $h\nu$, where h is a constant, now known as the Planck's constant. Planck was studying the intensity versus wavelength variation of the radiation emitted by a black body and there was no good theory to explain this phenomenon, the black-body radiation. Planck found that with the quantum hypothesis his results agreed extremely well with observations. There was no other experimental observation to support the quantum hypothesis except that the formulas derived on this basis agreed with the observed spectrum of black-body radiation. Planck himself, however, was not happy with this hypothesis. He described it as an act of desparation, done because some theoretical justification had to be found.

Soon in 1905, Albert Einstein (1879-1955), another German physicist, used Planck's idea of quanta to explain the photoelectric effect successfully, providing a strong support to the corpuscular view of radiation. Later in 1923, Arthus Holly Compton, an American physicist, performed experiments on scattering of light from electrons and showed that the results could be explained only by assuming that light consists of quantized photons.

Although the corpuscular theory gained considerable support in the beginning of the present century, the fact remained that the phenomena of interference and diffraction could be explained only by assuming light in the form of waves. Faced with such facts, physicists began to believe that electromagnetic radiation is a complex phenomenon and shows the dual character; in some experiments it behaves like waves and in others like particles.

Wave-particle duality

Maurice de Broglie (1875-1960), a French experimental physicist, supported Compton's views on the particle nature of radiation. His brother, Louis de Broglie was studying history. Coming frequently in contact with his elder brother and his discussions with other physicists, Louis became interested in the dual nature of radiation. He thought that if radiation (which was supposed to be wave-like) shows particle properties, matter (which was supposed to be particle-like) should also possess wave properties. Believing strongly in the symmetry of nature, he left history for physics and in 1924 submitted his ideas in a thesis to the faculty of science of the University of Paris for the degree of Ph.D. In the thesis, he considered the relation between wavelength and linear momentum of a photon and argued that the same relation should also give the wavelength of a material particle. This relation, now known as the de Broglie relation, is $\lambda = h/mv$, where λ is the wavelength, h the Planck's constant, m the mass and v the velocity. Since wavelength is a wave characteristic and mass is a particle characteristic, the de Broglie equation relates the wave properties of an object to its particle properties.

The thoroughness and clarity of de Broglie's thesis impressed the academic world. His argument was philosophically correct and logically sound. However, owing to the lack of experimental evidence, it was thought that his idea of "matter waves" is merely an abstract idea and has no physical reality.

Then in 1927 came a dramatic and accidental confirmation of de Broglie's idea of matter waves. Sir George Paget Thomson, a British physicist, and C. J. Davisson and L. H. Germer of the Bell Telephone Laboratories, U.S.A., who were bombarding electron beams on crystals and observing electrons scatter in different directions, found that the results were identical to those of X-ray diffraction from crystals and could be explained only by assuming that the electrons were behaving like waves. From the observed diffraction pattern, they calculated the wavelength of the wave, and knowing the velocity of the incident electrons, found that it agrees exactly with the value predicted by the de Broglie relation. Soon it was found that atoms and molecules (and much later, neutrons) of suitable energy bombarded on crystals showed diffraction pattern, and in each case the wavelength obtained from experiments agreed with that given by the de Broglie relation. After this overwhelming confirmation of his ideas, Louis de Broglie became the first physicist to receive Nobel Prize in 1929 for the work he did for the doctoral degree.

Let us see a simple idealized experiment to understand the phenomenon of diffraction. Consider a diaphragm in which there are two parallel slits A and B as shown in Fig. 1. On one side of it, there is a source S of light or electrons, or atoms or neutrons or any suitable object. On the other side, there is a detector D or a photographic plate PQ. For electrons, a Geiger counter could be used as a detector. Consider the situation when electrons are taken as incident particles.

Suppose first the slit B is closed, keeping only slit A open. Further, suppose that the flux of the incident electrons is such that the Geiger counter counts two electrons per second at a certain position. Now close the slit A and open slit B. Once again suppose the Geiger counter counts two electrons per second. Now open both the slits. If electrons

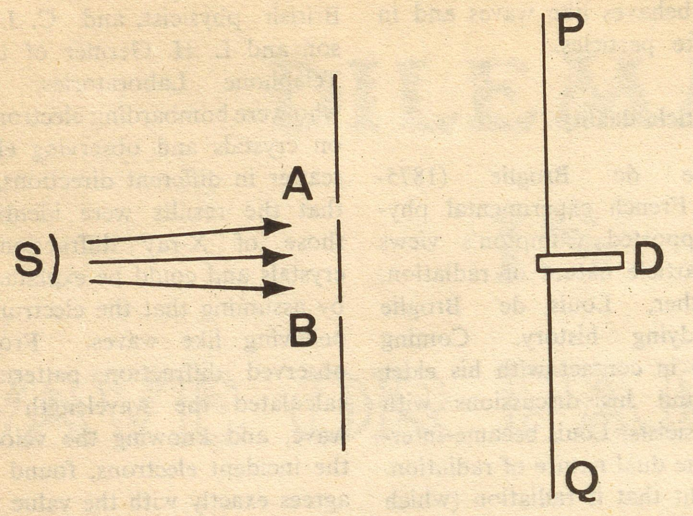

Fig. 1. Diffraction through a double slit

are particles, we expect to count four electrons per second. In reality, it is found that the count rate is anywhere between zero and eight, depending on the position of the detector D along the line PQ. If a photographic plate is used in the position PQ, a pattern of alternating bright and dark interference fringes will be seen. Dark fringes correspond to the regions which receive no electrons while bright fringes occur where a large number of electrons are incident. The observed intensity pattern along the line PQ would be as shown in Fig. 2. Essentially the same result would be obtained if a source of light or neutrons or atoms in place of electrons is used.

If electrons are particles, we could pin-point exactly through which of the slits each electron passes. Electrons passing through one slit should not be affected by closing or opening of the other slit. When both slits are open, the number of electrons arriving at any point on the screen PQ would be simply the sum of the numbers of electrons arriving when each slit is opened in turn. But if electrons are waves, each electron-wave would partly pass through both the slits and the passage of the wave through one slit would be affected by opening or closing of the other slit. When both slits are open, they act as coherent sources of waves and produce an interference pattern on a screen placed on one side of the diaphragm opposite to that of the source. (The number eight mentioned earlier in connection with the count of electrons per second comes from the sum of squares of individual slit counts; $2^2 + 2^2 = 8$). The wavelength of the incident wave can be calculated from the spacing between successive bright fringes, and it agrees with that given by the de Broglie relation.

It is interesting to note that Sir Joseph John Thomson (1856-1940), a British physicist, made the announcement in 1897 of the discovery of electron as a separate particle seen in cathode ray tubes, for which he was awarded the Nobel Prize in 1906. His son, Sir G. P. Thomson, shared the physics Nobel Prize with C. J. Davisson in 1937 for showing the wave character of the electron. The father and the son thus demonstrated two contradictory aspects of the electron.

Philosophical analysis

On first thought the revelation that electrons behave like waves sounds odd. The discovery of electron diffraction in 1927 surprised most physicists, not to speak of the man in the street. It appears all the more baffling that electrons and photons can sometimes behave like waves (in interference and diffraction experiments) and sometimes like particles (in scattering experiments).

To remove the puzzle, we have to analyse each and every word that has been used and look for loopholes in the classical theory of electrons and photons.

First, what is meant by a particle? It is believed that a particle has definite mass, size and shape. If it is kicked, it hurts the person. If it is thrown, it shoud follow a parabolic path under earth's gravity. When it is in motion, it has definite energy and linear momentum at every instant.

Now, what is understood by a wave? A wave is a disturbance in a medium. It is characterized by wavelength, frequency and velocity of propagation. It may or may not carry energy, depending on whether it is a travelling or a standing wave. When a wave travels in a medium, particles of the medium only oscillate about their mean position; it is the undulation of the medium which travels from one point to another. A wave has no definite shape.

In a sense, a particle and a wave are an antithesis of each other. Ideally, a particle is localized in space while a wave is extended in space by its very periodicity. Ideally, there cannot be two or more particles at a point in space-time; however, there can be any number of waves at a point. These are the ideas in our minds associated with the words "particle" and "wave". It may be said that the word "particle" is a set of certain ideas and associations. If an entity is found which does not have all the properties of a particle as defined above, it would not be called a particle. The same thing applies to the word "wave" also.

Once the particle and the wave have been analysed in this manner, the next hurdle is easy to cross. If an entity is found in this universe which has neither purely particle properties nor purely wave properties but has mixed properties such as mass, energy, wavelength, linear momentum, is sometimes localized and sometimes not localized in space, then it could be called neither a wave nor a particle. Something new has been discovered, and for the lack of a better name it is called a 'wave-particle duality'.

There is nothing logically wrong in the phenomenon of wave-particle duality. After all, the definitions of a particle and a wave given earlier are man-made and the mere definition of an entity does not guarantee the existence of the entity. For example, "unicorn" is a mythical animal which is supposed to be a horse with a horn on its forehead. So far as the definition goes there is nothing wrong with it, but it does not ensure the existence of a unicorn. And even if two entities defined by us exist, we have no reason to assume that the existence of a third entity with mixed properties is forbidden.

Once I was visiting the Cheetal Dear Park on the Khatauli-Muzaffarnagar road in Uttar Pradesh along with a group of friends. There, in a cage, we found some small animals which looked rather strange. They looked partly like rats and partly like rabbits, and we could not agree on what they were. After a prolonged debate, we decided to ask some personnel in the park and we were told that they were a cross-breed between a rat and a rabbit! In our conversation, we

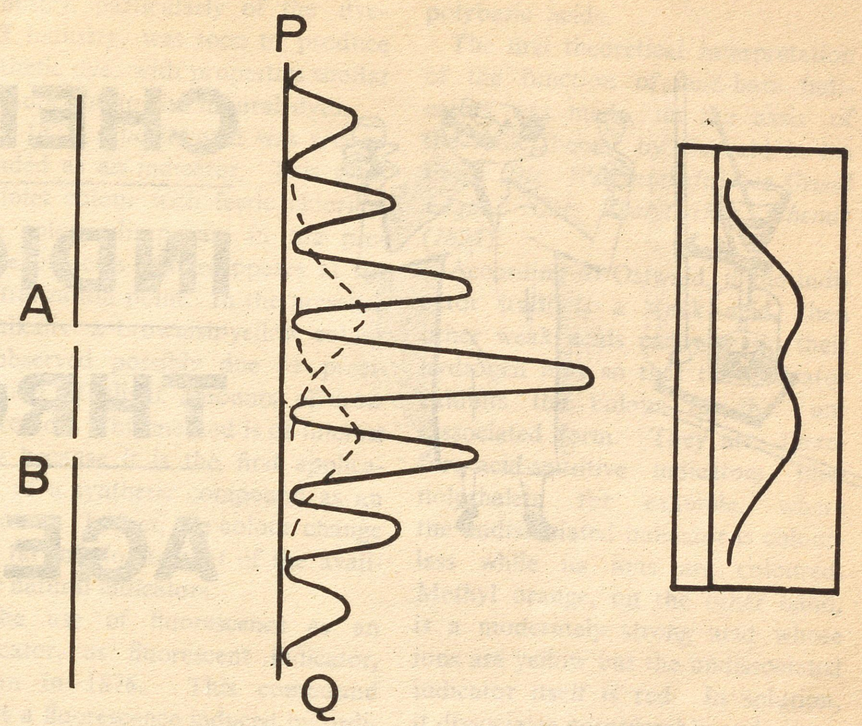

Fig. 2. The full curve shows the intensity of electrons diffracted from a double slit. Dotted lines show intensity distribution when only one slit is open at a time. Box shows intensity distribution according to classical theory, treating electrons as particles. This is just the sum of the dotted line distributions

had tacitly assumed that this world can contain only rats and rabbits. The revelation that a cross-breed can also exist cleared our clouded minds and showed a way towards real understanding.

Does every object in this universe, small or large, show the wave-particle duality? In principle, yes. But the wave properties of matter dominate only in the microscopic domain and become negligible in the domain of everyday objects. A simple numerical estimate is of great help in clarifying these concepts. The Planck's constant has the value $h=6 \times 10^{-27}$erg. sec. An electron has a mass of 9.1×10^{-28} gm. If it is travelling with a speed of about 6×10^{8} cm/sec, its wavelength according to de Broglie relation comes out to be about one Angstrom$=10^{-8}$ cm. This is nearly equal to the spacing between successive atoms in a crystal and therefore the electron is diffracted by the crystal. It should be noted that a wave can be diffracted from a grating only when the wavelength is of the same order as the grating constant. Now consider a small ball of mass one gm. When it is moving with a speed of one cm/sec, the de Broglie wavelength associated with it is about 6×10^{-27} cm, which is much too small in comparison to the grating constant of any artificial or natural grating. Hence its wave nature is totally suppressed and it acts almost like a particle. If it is desired to make the wavelength associated with the ball equal to 10^{-8} cm so that it can be diffracted by a crystal, its velocity would have to be reduced to about 6×10^{-19} cm./sec. If such a ball is initially kept at a distance of one cm from a crystal, it will take about 10^{18}

(*Continued on page* 156)

CHEMICAL INDICATORS THROUGH AGES

Advancements in the development of chemical indicators have contributed much to the progress made in volumetric analysis

S. AKHEEL AHMED

THE word "indicator" is derived from the Latin *indicare*, "to disclose", and might therefore be applied to every reaction or apparatus capable of providing information to the chemist. However, the word is, in analytical chemistry, used in a quite precise and restricted sense. Any titration requires an indicator to show that an equivalent quantity of titrant has been added to the other titrant. This indication can be given in a variety of ways :

(1) It may be a visible (or more generally, perceived by the senses) phenomenon arising naturally at the conclusion of the titration process itself.

(2) It may be some other modification within the titration system which can be made the subject of physical measurement, or

(3) It may be produced by some visible or perceivable change occurring at the equivalence point in some foreign substance. The foreign substance is then called an indicator. Indicators may be used not only to detect end-points but also for quantitative purposes (as in colorimetry) and for qualitative analyses.

Indicators in ancient history

It was no doubt known in ancient times that the extracts of some plants change colour when they are treated with certain substances. However, for the alchemistic classification of their materials this phenomenon was not of importance. It was not until the age of iatrochemistry, also known as medical chemistry (the period of rebirth of natural sciences), when classification of compounds into three main groups, i.e., acids, bases and salts, had begun and those phenomena were examined, and the mechanism whereby a substance changes the colour of an indicator investigated.

Robert Boyle (1627-1691), an English chemist, used plant extracts as indicators in a systematic method of qualitative tests. His work *Experiments on Colours* gives an account of these experiments. As indicators he used extracts of corn flower, cochineal (a bright red colouring matter made from the dried bodies of certain insects), litmus (blue colouring matter extracted from very small plant called lichens that turns red by acid and restores blue by alkali), brazilian-tree, blue-tree (name of the small trees) and curcuma (tuberous plants). It is interesting to note that Boyle attempted to estimate the strengths of acids with

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indicators. He carried out this experiment with blue colour extract of a tree called *Lignum nephriticum*. Later, he described experiments with ammonium hydroxide and urine with which the blue colour of the extract could be restored. The effect of potash on syrup of violets (small flowers having blue-red colour) was examined by him and his findings were that if the material to be tested changes the colour of the syrup to red it shows that acidic salts are in excess, but if the colour turns to green it shows that the material is of opposite nature. Boyle called such materials "alkali salts".

The use of plant extracts as indicators became widespread during the phlogiston period (started at the end of 16th century and lasted for about 100 years) in qualitative analysis. In the more specific field of titrimetric operations W. Lewis (1767), an English chemist, was the first to use litmus as an indicator in the determination of potash. After this, use of indicators for acid-base titrations slowly became accepted.

It was soon observed that various plant indicators do not react uniformly with acids, and that they require different amounts of acid to change their colours in different pH regions. Professor Felice Fontana (1730-1805) in 1775 noted that water containing carbonic acid changes blue litmus to red, but has no effect on the extract of violets. This, in fact, is the method of pH determinations by the use of indicators, but it was more than one hundred years before that this idea became practicable.

In the field of indicators there was no change for a considerable time. Although a large number of plant extracts were tested, litmus remained in extensive general use. Fredrich Mohr, the German chemist, in his book *Titrimethode* (1855) mentions the extracts of litmus, Pernambuk-tree, camphor tree and curcuma.

The rapid development of organic chemistry, particularly of the dyestuff industry, was soon to produce synthetic dyes with properties similar but superior to the natural dyes.

In 1875, salicylic acid was recommended as an indicator. This gives a violet colour with ferric chloride. The colour disappears in the presence of acids but reappears at the neutralization point. In the presence of alkalis a brownish-yellow colour is observed possibly due to precipitation of slight amounts of iron hydroxide. This method is of interest only because it is the first application of a synthetic compound as an indicator. In fact, the colour change was far inferior to that of the available natural indicators.

The use of fluorescence as an indicator, as fluorescent indicator, began in 1876. This compound emits a fluorescence induced by ordinary light in alkaline medium, but the fluorescence is destroyed by one drop of free acid. Carbon dioxide does not interfere with colour change of the indicator. It could also be used with analysis of coloured or turbid solutions. This indicator did not achieve much success.

Development of acid-base indicators

In 1877, an indicator which received worldwide application was phenolphthalein, but it was rapidly followed by tropeolin and methyl orange introduced by Georg Lunge, the German chemist, in 1878.

In the succeeding years many synthetic organic compounds were recommended for use as acid-base indicators. A paper published by Wilhelm Ostwald, a German chemist, in 1893, mentions 14 synthetic indicators. The colour changes of synthetic indicators differed more markedly than those of natural dyes. This soon led to a difference between acid-sensitive and base-sensitive indicators, and led to the introduction of differential determinations, for example, in the case of polybasic acids.

The first theoretical interpretation of the function of acid-base indicators was made, on the basis of the ionic theory, by Ostwald in his book *Die Wissenschaftlichen Grund Lagen Der Analytischen Chemie* (*1894*).

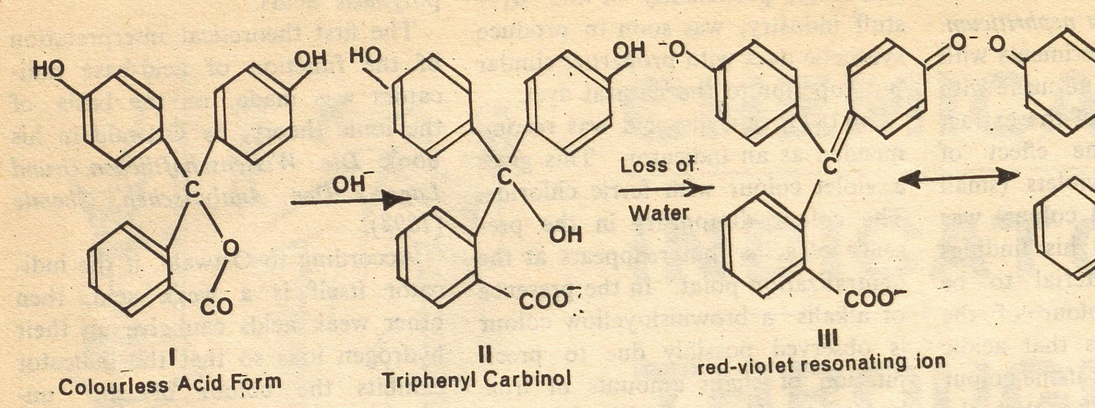
According to Ostwald, if the indicator itself is a weak acid, then other weak acids can give up their hydrogen ions so that the indicator exhibits the colour of the undissociated form. They are therefore acid-sensitive indicators, phenolpthalein for example, where the undissociated indicator is colourless while its ions are coloured. Methyl orange, on the other hand, is a moderately strong acid whose ions are yellow but the undissociated indicator itself is red In solution, it dissociates considerably and shows a mixed colour. When hydrogen ions are added the amount of dissociation decreases and the solution becomes red. A weaker acid, however, contains far fewer hydrogen ions capable of changing the equilibrium when passing through the neutralization point. Methyl orange is therefore more sensitive to bases.

The explanation of Ostwald is plain, simple and understandable. It is this interpretation which made clear and understandable a series of phenomena of chemistry that had hitherto seemed quite incomprehensible. It is probably no exaggeration to say that in both general and analytical chemistry everything appeared to be well ordered in Ostwaldian age; all the phenomena were explained and rationally understood.

Development and innovations in twentieth century

Ostwald's explanation, however, did not last long; various workers observed phenomena which did not agree with Ostwald's theories. One of the earliest problems to

PHENOLPHTHALEIN



METHYL ORANGE

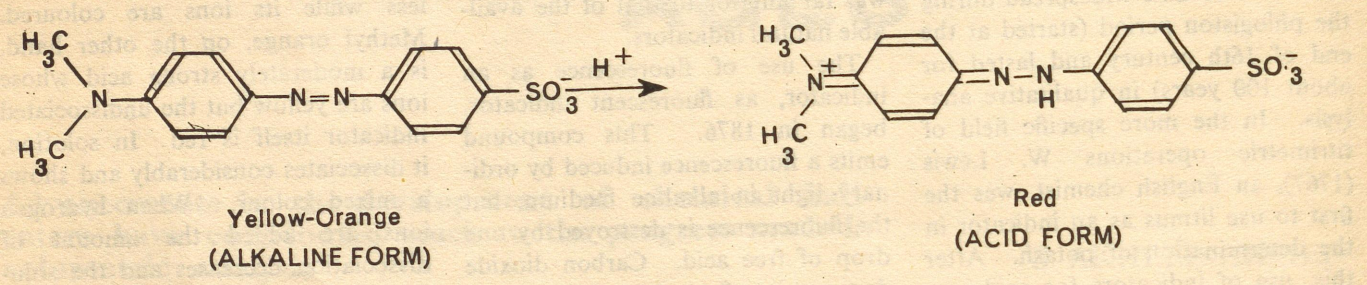


Fig.1

appear concerned the mechanism of indicator change. It arose when it was observed that the colour change is not instantaneous in many cases. It followed that some change in structure as well as the ion process too occurred. Arthur Rudolf Hantzch, a German chemist (1857-1935), in 1906 proposed his well-known chromophoric theory of indicators which interprets the colour change on the structural organic aspects. The colour change is caused by a structural change in which the inorganic form is evolved from the pseudo one. For example, phenolpthalein and methyl orange undergo structural changes (Fig. 1). This theory was received more favourably than Ostwald's by organic chemists. From analytical point of view it was not favoured, as it did not give an adequate interpretation of the quantitative aspects of the indicator change.

The two theories were reconciled by the contemporary American analytical chemist Izaac Maurits Kolthoff who devised a theory which retained the most useful parts of Ostwald theory. According to Kolthoff, the colour of the indicator is determined by the equilibrium between the pseudo and ionogenic forms as well as by the dissociation equilibrium of the latter. Recently, theoretical organic chemists have tried to interpret the colour change of indicators as being due to mesomeric phenomenon (some molecules, wherein redistribution of electrons is possible and which exist in the most stable or less energy state, are thought to be in mesomeric state). At the end of the last century it seemed as if scientists would give unambiguous answers to most of the major questions.

One of the most commonly used acid-base indicators today, methyl red, was introduced in 1908. Most of the sulphonapthaleins were prepared and introduced in 1915 and by using different sulphonapthaleins it was possible to develop the present colorimetric method for pH determination.

The first fluorescent indicator, fluorescein, was introduced before the dyestuff indicators appeared on the scene. The use of fluorescent indicators, which when illuminated emit fluorescence in alkaline or acid medium, is particularly advantageous when turbid or dark coloured solutions are titrated. Recently

Fredric Kenny, an American chemist, recommended the use of chemiluminescent acid-base indicators. The latter detect the end-point by emission of light. They have an advantage over ordinary fluorescent indicators in that the energy required to produce luminescence is obtained from the chemical reaction itself and not from an external energy source.

Redox indicators

Redox indicators constitute another important class of indicators. Most indicators in this class were developed after the acid-base indicators, particularly after the First World War. The French chemist J. L. Gay-Lussac (1778-1850) determined hypochlorite by titration with arsenious acid with a few drops of indigo solution as an indicator. The end-point was detected by decolourisation of the indigo. The indicator is not reversible in this case.

Chromatometric methods (use of potassium dichromate as an oxidant), although well-known from a very early period, were not widely used owing to lack of suitable indicators. In 1906 diphenylcarbazide was suggested as an indicator for the chromatometric determination of iron (II). This indicator gives a violet colour with an excess of chromate. The first reversible redox indicator was proposed in 1908 which was prepared by heating azobenzene with concentrated sulphuric acid. The molten mixture was then poured into a large volume of water imparting to it a deep red colour. (The name of the indicator is not found in literature, only its preparation is given).

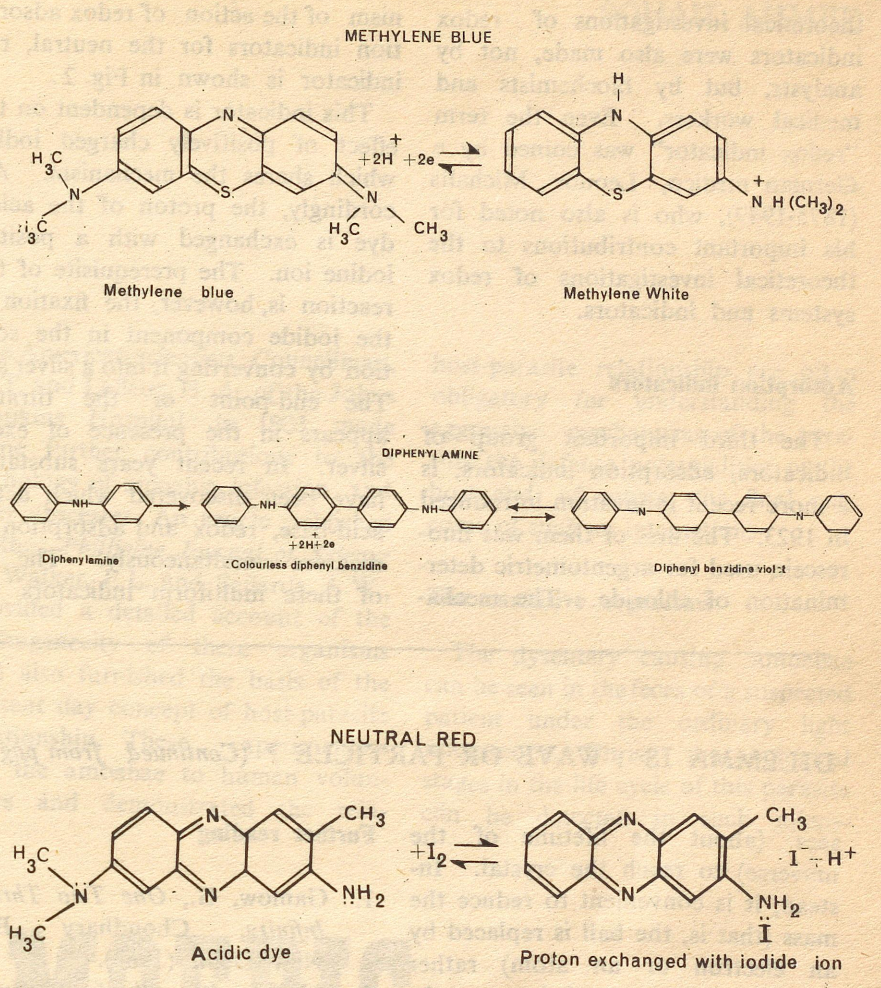
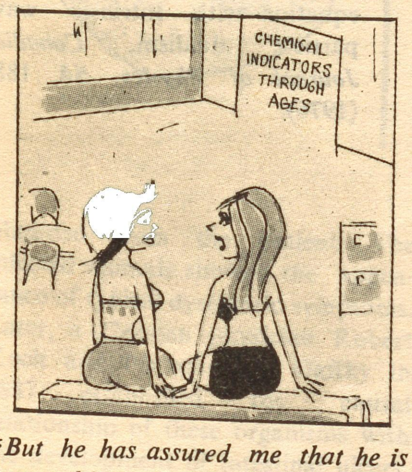


Fig. 2

The first definite redox indicator was diphenylamine introduced by J. Knop, a Czech chemist, in 1925. Knop and his wife Olga Kubelkova, over the next few years, discovered a large number of triaryl methane-type compounds which proved suitable as redox indicators. The mechanism of the redox behaviour of the methylene blue and diphenylamine is given in Fig. 2.

In addition to redox indicators which undergo a colour change, chemiluminescent redox indicators have also been recommended recently; for example, siloxene, luminole and lucigenine. Redox indicators which undergo a colour change, usually function in acid medium. However, the redox reactions which take place in alkaline medium have hitherto been seldom used for analytical purposes. Some of the more recent chemiluminescent indicators have the advantage in that they can also be used in alkaline medium. It is interesting to note that detailed practical and



"But he has assured me that he is not working on chemicals that could indicate our ages."

theoretical investigations of redox indicators were also made, not by analysts, but by biochemists and medical workers. Even the term "redox indicator" was coined by a German medico, Leonor Michalis (1875-1949), who is also noted for his important contributions to the theoretical investigations of redox systems and indicators.

Adsorption indicators

The third important group of indicators, adsorption indicators, is a more recent innovation introduced in 1923. The first of them was fluorescein used for argentometric determination of chloride. The mechanism of the action of redox adsorption indicators for the neutral, red indicator is shown in Fig. 2.

This indicator is dependent on the effect of positively charged iodine which shares the mechanism. Accordingly, the proton of the acidic dye is exchanged with a positive iodine ion. The prerequisite of this reaction is, however, the fixation of the iodide component in the solution by converting it into a silver salt. The end-point of the titration appears in the presence of excess silver. In recent years substances have been discovered which act as acid-base, redox and adsorption indicators simultaneously. The first of these multiform indicators was *p*-ethoxy chrisiodine.

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DILEMMA IS : WAVE OR PARTICLE ? (*Continued from page* 151)

secs (about the lifetime of the universe) to reach the crystal. Instead, it is convenient to reduce the mass (that is, the ball is replaced by an electron or an atom) rather than the velocity to bring out the wave nature of matter clearly.

Experiment and observation are the basis of all sciences and the evidence gathered from scientific experiments cannot be overlooked. In the light of the experimental evidence in favour of wave-particle duality the new concept should be accepted without hesitation.

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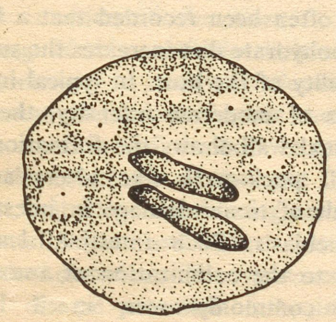
Intestinal amoebic infection is not only an affliction of the tropical countries, but colder regions of the world too.

SOHAIL AHMED

AMOEBIC DYSENTERY

A SERIOUS HEALTH PROBLEM



FOR the first time in 1873 a Russian scientist, Losch F., reported the presence of amoeba-like organisms in the feces of a patient who was having severe dysentery. Subsequently, he established the causal relationship of these organisms with dysentery by demonstrating their disease-producing ability in experimental dogs. The pathogenic potential of these organisms was easily confirmed by carrying out a simple experiment in which the test animals were fed with a small sample of the dysenteric stool obtained from the patient. The infected animals showed the appearance of typical dysenteric symptoms. Later, a German physician Robert Koch and his associate Gaffky in 1887 established the causal relationship of these organisms with the development of intestinal ulcers.

The American scientists, Councilman, W.T. and Lafleur, H. A. of the Johns Hopkins Hospital in 1903 made some further contributions to the pathology of amoebic infection and liver abscesses. An article published in the *Phillipine Journal of Science* by Walker, E.L. and Sellards, A.W., provided a detailed account of the pathogenecity of these organisms and also furnished the basis of the present day concept of host-parasite relationship. These experimenters fed the amoebae to human volunteers and demonstrated the relationship between amoebic infection and the appearance of typical amoebic dysentery symptoms. This was a conclusive evidence ever provided in human subjects that clinical symptoms of amoebic dysentery are caused as a result of intestinal amoebic infection. Such studies of the host-parasite relationship are often obligatory for understanding the aggressive mechanisms of the parasite, the defense potentialities of the host and, of course, the final outcome of such an interaction.

The causative organisms

The dysentery causing amoebae can be seen in the feces of a suspected patient under the ordinary light microscope. Three morphological stages in the life cycle of this parasite can be detected in such microscopic stool examinations : (a) the trophozoite—an actively motile, vegetative stage ; (b) The precystic stage—a transitory stage in between the trophozoite and the cyst; and (c) the cystic stage—a nonmotile infective stage having a tough outer coat. This stage is essential for

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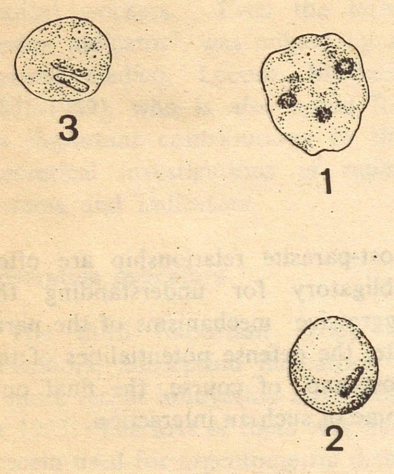

Fig. 1

the extracorporeal existence of the parasite.

The trophic or vegetative forms in microscopic examinations appear as blobs of actively motile organisms. They do not possess a definite shape, consist only of a tiny nucleus which is surrounded by a small amount of everchanging and flowing cytoplasm. The average size of an amoeba trophozoite varies from 15 microns to 40 microns (1 micron is equal to one millionth of a meter). Some other organelles like ectoplasm, endoplasm and the quick-forming feet, or pseudopodia, are easily discernible in a careful microscopic examination. But nucleus which is the most important organelle is not always detectable in ordinary slide preparation. The vegetative forms of the parasite are so fragile that they cannot survive for more than a few minutes outside the body of the host. These trophozoites are also killed by the action of the digestive juices and, as such, do not constitute an infection hazard even if swallowed.

The precystic stages are only of a transitory nature. They are found at the time when the cysts of this tiny parasite are getting ready to go out of the body of the host for the purpose of completing their life cycle. The life cycle is completed only when the cyst is ingested by another human host, usually through fecally-contaminated food and water. The cyst is the final stage in which it leaves the body of the host—for its sojourn into the outside world and to a new host, if possible. It is fully equipped to meet the unfavourable conditions which may be encountered during its hunt for a new host. The cysts are rounded and ovoid, not perfectly symmetrical. They have a tough and thick outer coat to ward off the anti-elements. The cysts also contain a liberal supply of food in the form of chromatoid bodies and glycogen granules. There are four nuclei within a cyst, each of which is capable of multiplying further. The cysts, after reaching the site of infection, release their nuclei by breaking apart the cyst wall. Soon after, each of the four nuclei divides once and doubles its number. Each cyst then releases eight daughter amoebae. The multiplication rate is therefore one to eight for this parasite.

The disease

The disease caused by these potentially pathogenic amoebae may include a wide range of pathogenic conditions or symptoms. A variety of vague, rather indefinite symptoms, often accompanying the amoebic infections are usually referred to as 'amoebiasis'. The symptomatology may often be described as according to the two types of infection ; (a) intestinal infection in which amoebae remain confined to the intestine, and (b) extraintestinal infection in which amoebae run out of the intestine, and colonize other organ systems, usually liver.

The disease producing abilities or the pathogenic mechanisms of amoebae may be regarded as a progressive cellular or lytic digestion (cell damage due to enzymic action of the parasite) of the infected tissue. This tissue-dissolving potential alongwith the ability of the parasite to penetrate mechanically into the cells, is responsible for invasion of the deeper tissue. Besides this, some kind of microbial inter-relationship (the involvement of other normally occurring intestinal bacteria) is believed to be involved not only in the survival of the amoebae but also in the successful establishment of the disease. The disease in its milder form is so innocuous that it may remain unnoticed in a large number of persons. Such symptomless subjects, in microbiological jargon, are referred to as asymptomatic carriers. But contrary to this, the disease in severe cases may even prove fatal. The severity of infection could therefore be anywhere in between the two extremes. A variety of factors like the general body resistance and the nutritional status of the host are some of the determining parameters for the severity of the infection. It has often been recorded that a high carbohydrate diet increases the susceptibility of the host. In typical infections of moderate intensity, the intestinal wall shows the formation of small pock-mark like ulcers as a result of tissue damage in intestinal amoebiasis. Such intestinal lesions due to the colonization of amoebae are commonly seen in a large number of clinical cases. The colonization is a common trait in parasites and in human beings—in fact, all forms of life must necessarily colonize. In more severe cases, the ulceration may be deeper and extend to the surrounding tissue, often causing extensive damage.

In extraintestinal amoebiasis, the organisms generally colonize in liver and other distantly placed organ systems. More often than not, such infections are usually located in liver, a very important and delicate organ. Such amoebic infections in the liver are responsible for causing typical lesions in the liver, usually referred to as amoebic liver abscesses. This form of infection is clinically known as hepatic amoebiasis. Amoebic liver abscesses generally appear as small, necrosed, rounded areas at the site of infection in the liver tissue.

Pathogenecity

The parasite is so well adapted to its natural habitat (the intestine) that sometimes even its disease causing ability appears to be somewhat doubtful. The parasites never really want to ruin the place where they live. Infact, no form of life would like to annihilate its habitat or environment. In some infected inbividuals the parasites remain in more or less perfect harmony with the host — an example of coexistence between forms of life whose aims and objects are obviously so diversified. But once in a while, however, this happy equilibrium is broken and the disease is caused by the parasitic invasion of the tissue. The losing of this particular balance in amoebiasis is somewhat dependent on many important factors such as the condition of the host in respect to the intactness of the gut wall, diet, nutrition, debilitating environmental factors and other acute intestinal disorders. The virulence or the disease potential of the invading amoebae is also an important factor to be considered.

Transmission

Dysentery is transmitted from person to person by the resistant cystic stages of the parasite. The infection is mainly transferred through fecally contaminated food, water and soil. Fecally contaminated objects like door knobs, towels and other objects of common use are also some of the important contact factors in the spread of the disease. The disease is established in a new individual by the ingestion of the cystic stages of the parasite. More frequently, the common source of infection is the ingestion of cysts through fecally contaminated raw vegetables. The food handlers in India constitute the biggest source of transmission of cysts from host to host. Fecal contamination of water, specially in rural areas, where proper water supply facilitie are lacking is

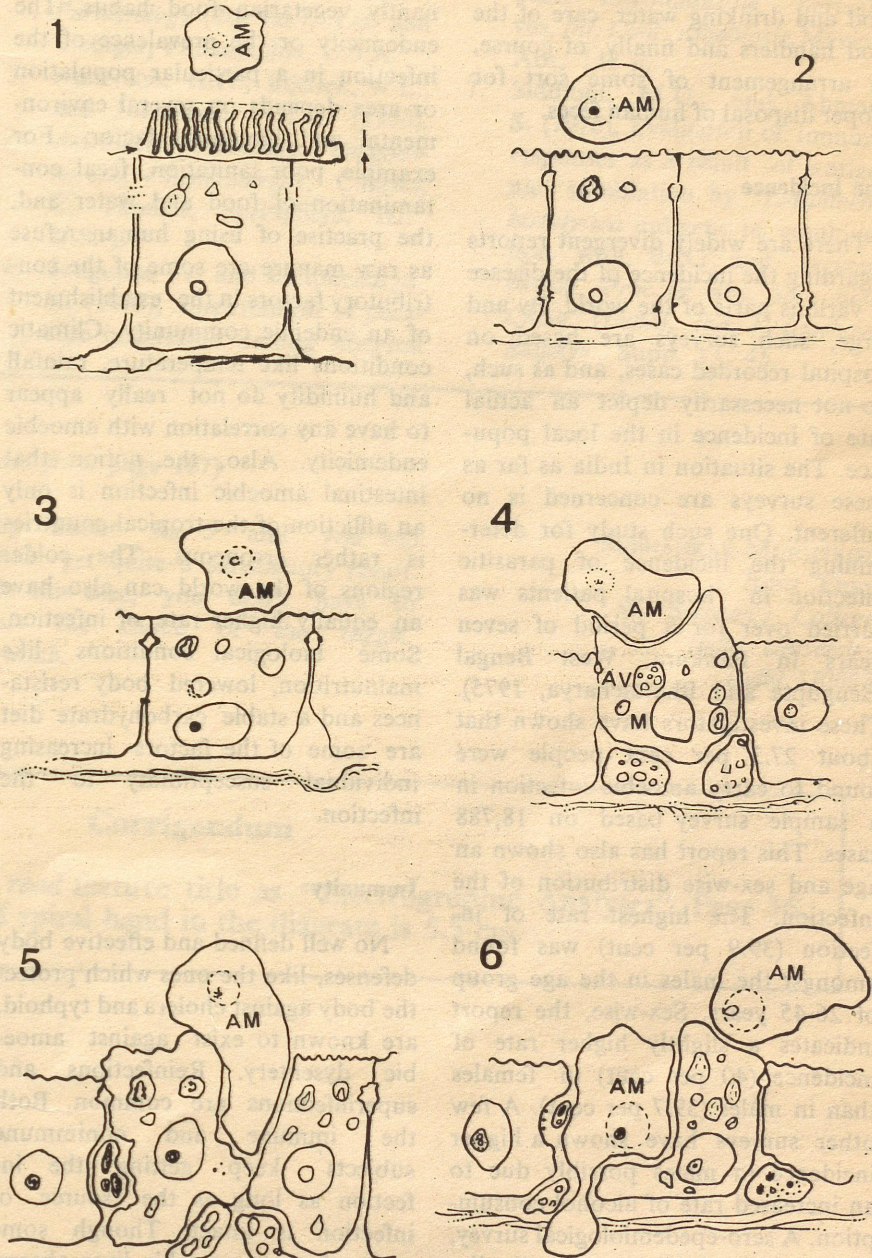

Fig. 2. A scheme based on the results of electron microscopic studies illustrating the penetration of cecal epithelium of guinea pigs AM : Amoeba (*Courtesy* : Akio Takeuchi and Brucc P. Phillips; *Am. J. Trop. Med. Hyg.*, 24: 34, 1975)

perhaps the greatest single source of infection. Transmission through the agency of dust, housefly and other such insects is yet another source of infection. Due care for saving oneself from the possible sources of infection should necessarily include the eating of properly washed vegetables, safe and uncontaminated food and drinking water, care of the food handlers and finally, of course, an arrangement of some sort for proper disposal of human feces.

The incidence

There are widely divergent reports regarding the incidence of the disease in various parts of the world. By and large, such surveys are based on hospital recorded cases, and as such, do not necessarily depict an actual rate of incidence in the local populace. The situation in India as far as these surveys are concerned is no different. One such study for determining the incidence of parasitic infection in hospital patients was carried over for a period of seven years in Bankura, West Bengal (Sengupta and Bhattacharya, 1975). These investigators have shown that about 27.3 per cent people were found to carry amoebic infection in a sample survey based on 18,788 cases. This report has also shown an age and sex-wise distribution of the infection. The highest rate of infection (39.9 per cent) was found amongst the males in the age group of 26-45 years. Sex-wise, the report indicates a slightly higher rate of incidence (40 per cent) in females than in males (39.7 per cent). A few other surveys have shown a higher incidence in males possibly due to an increased rate of alcohol consumption. A sero-epedemiological survey, based on the detection of antibodies in the serum of patients attending various out patients departments, was also carried out in the laboratory of the author. Its results have indicated that the prevalence of infection was higher in males belonging to a comparatively lower socio-economic group (monthly earnings Rs. 300/- or less). Areawise, the data break up in quantitative terms showed a higher incidence rate in urban population. Further, the carrier state of the infection was found slightly higher in the people with predominantly vegetarian food habits. The endemicity or the prevalence of the infection in a particular population or area depends on several environmental and biological factors. For example, poor sanitation, fecal contamination of food and water and, the practise of using human refuse as raw manure are some of the contributory factors in the establishment of an endemic community. Climatic conditions like temperature, rainfall and humidity do not really appear to have any correlation with amoebic endemicity. Also, the notion that intestinal amoebic infection is only an affliction of the tropical countries is rather erroneous. The colder regions of the world can also have an equally higher rate of infection. Some biological conditions like malnutrition, lowered body resistances and a stable carbohydrate diet are some of the factors increasing individual susceptibility to the infection.

Immunity

No well defined and effective body defenses, like the ones which protect the body against cholera and typhoid, are known to exist against amoebic dysentery. Reinfections and superinfections are common. Both the immune and nonimmune subjects keep getting the infection as long as the source of infection is intact. Though some cases of acute amoebic liver abscesses often rarely show a second infection. But milder infections are no safeguard against subsequent attacks. The reasons for not having a well defined protective immunity, as evidenced in other diseases, are not too well-known. Nevertheless, the possibility of enhancing the body resistances and obtaining a successful immune protection should not be taken as a lost cause. Recently, a few amoebiasis research workers have reported some partial success along these lines.

Effectiveness of various drugs

The amoebic cysts can be killed by a concentration of 1/2500 parts of mercuric chloride. Other cysticidal agents which can be effectively used for decontaminating purposes include 1 per cent phenol, 5 per cent formalin and 0.3 parts/million ozone. About 1 per cent potassium permanganate, which is commonly used for decontaminating water and raw vegetables, has been found ineffective against amoebic cysts. Chlorination of water and washing the vegetables with chlorine solution are quite effective for preventing an infection. Cooking utensils and other kitchenware can be easily decontaminated by washing with a large number of commercially available cationic detergents.

Therapeutically, sulfonamides (sulfa drugs) and antibiotics (the compounds usually effective against a large number of disease-causing agents) are ineffective against amoebic infections. Streptomycin (also an antibiotic) has been reported to reduce the rate of multiplication of amoebae, but such a treatment generally prolongs the survival rate of amoebae by inhibiting the normally occurring bacteria of the intestine. Moreover, such a treatment generally disturbs the healthy microbial balances within the intestine. Emetin, vioform and preparations containing para-aminobenzoic acid are some of the common amoebistatic (controlling) agents. As a result of a combined effort of a large number of laboratories around the world, a few more effective drugs against amoebic infections have recently been developed from certain metronidazole compounds. The inhibitory effects or effectiveness of some of these drugs have also been tested in India by Dr. U. K. Sheth of Clinical Pharmacology Unit, Seth G. S. Medical College, Bombay. He has reported that metronidazole and its other commercially available derivatives are quite effective drugs, possessing a considerably high chemotherapeutic activity against amoebic infections.

But a word of caution would not be out of place ; that all such drugs have a certain amount of residual toxicity. The golden rule for amoebic dysentery should, therefore, also be gleaned in the light of the old saying—'prevention is better than cure'.

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BATTERY ELIMINATOR (*Continued from page 197*)

somewhat less. Incidentally, you can also go in for the circuit that is given right at the beginning. Instead of BY 127, use a two pin rectifier (selenium). The cost will come down by about Rs. 5 and you will still get quite a satisfactory result. In this case, you don't have to use the choke or the toggle switch.

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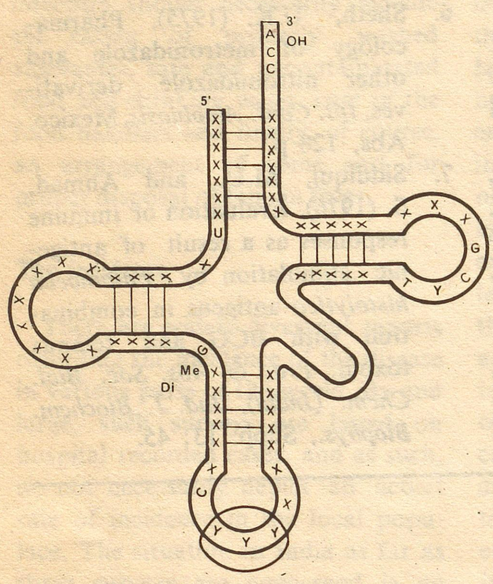
Corrigendum

Ref. S. R., Jan. 1977, page 35 *read* feature title as "Electrogrophic Analyser". Page 36, the dimension of the handle of spiral hand in the diagram is 5.5 cm.

By chemical synthesis of a biologically active gene, now made possible, a molecular geneticist can fabricate any DNA sequence he wants



Can MAN make a GENE?

SUBHASH S. ARORA
KAREN SANSI

EVERY organism on the earth has the ability to maintain its individuality and to produce offspring of the same kind. This self-preservation and self-reproduction depends on the presence and arrangement of various but essentially three types of giant molecules. They are polysaccharides, proteins, and nucleic acids (deoxyribonucleic acid, DNA; and ribonucleic acid, RNA).

The polysaccharides and their derivatives are used for maintenance and reproduction. These substances serve only to prolong the life span. Some viruses do not contain polysaccharides at all and are composed entirely of proteins and nucleic acids. Such viruses under appropriate conditions can reproduce, showing the lesser importance of polysaccharides. The proteins, on the other hand, play a more integral role in structure, maintenance and reproduction. Moreover, the uniqueness of each kind of organism is associated with a unique set of protein molecules it contains. Proteins are essential building blocks of membranes. They maintain the physical integrity of organisms. They are also enzymes which catalyse metabolic reactions. Therefore, protein molecules are important and play an important part in the bodies of plants and animals so much so that all organisms contain protein molecules.

The structure and metabolic activities of a cell are organized for its preservation. For this, the protein components are continually destroyed and replaced throughout the cell's existence. Consequently, organisms must possess the instructions for producing more proteins of correct kinds and quantities. It is equally important that these should be produced at the correct time and place. Such instructions should not only be preserved and replicated but also be transmitted to and maintained in its offspring. This type of information is contained in the genetic material. Which, then, is the genetic material—proteins, nucleic acids or both? Because of their simple

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chemical make up, viruses and bacteria were used for this study.

The experiments of F. Griffith of England in 1927 suggested that only DNA is the genetic material of the bacterium, *Diplococcus pneumoniae*. That the genetic material of T_2 virus is DNA was proved almost conclusively by the experiments performed by A.D. Hershey and H. Chase in 1952 at the Carnegie Institution, USA. Fraenkel Conart and his colleagues in 1958 at Virus Laboratory in Berkeley, University of California, proved that it is RNA that carries genetic information in tobacco mosaic virus (TMV). It is now certain that the genetic information of higher organisms is stored in DNA. It is now obvious that DNA and RNA contain the genetic information of almost all organisms and not the proteins (Fig. 1). However, the information for the structure and synthesis of polypeptides (or proteins) is stored in the polynucleotide chains (DNA or RNA).

DNA structure

The nucleic acid DNA is a substance that carries information from generation to generation. It is a long, double-stranded macromolecule. The two strands are coiled helically around each other forming a double helix. Each strand is made up of a chain of four kinds of nucleotides. A nucleotide is a complex structure composed of a phosphate group attached to a 5-carbon deoxyribose sugar linked to one of four different bases (Fig. 2). In a nucleotide the phosphate molecule can be linked with sugar molecule either at carbon number 5 or at carbon number 3. The former is known as 5′p3′OH nucleotide and the later 3′p5′OH nucleotide. Successive nucleotides can unite forming a phosphodiester bond between them to give rise to a polynucleotide chain. A polynucleotide chain written as 5′p3′OH would mean that there is a phosphate group at carbon number 5 at one end of the chain and at the opposite end there is —OH group at carbon number 3.

The bases are adenine (A), guanine (G), cytosine (C) and thymine (T). First two bases are purines and the last two pyrimidines. The purines and pyrimidines are nitrogen-containing closed ring organic compounds. The bases A and T, and G and C are "complementary bases" because for every A in one strand there is a T in the other and for every G there is a C in the other. This is called the complementary base pairing and sometimes termed as Watson-Crick pairing after its discoverers. Therefore, in double-stranded DNA the number of A molecules is equal to the number of T molecules and similarly G equals C. The complementary bases are bonded together by weak chemical bonds known as hydrogen bonds. These bonds keep the two polynucleotide chains together running in opposite directions and impart stability to the DNA molecule. The sequence of four kinds of bases on the long sugar-phosphate chains determines the biological properties of the molecule.

DNA of different species is distinguished by the relative number of AT and GC pairs and by their specific sequence. In fact each species of the living world is distinctive just by such qualitative and quantitative differences. A particular nucleotide sequence or a segment of DNA responsible for synthesis of a particular protein is known as gene.

Gene

Genes are the particulate determiners of a heredity trait. Genes of all organisms are made solely of DNA (with the exception of a few organisms in which they are of RNA). DNA, therefore, is rightly regarded as the primary "store house" of genetic information. The discrete segments of DNA which contain genetic information for the structure and production of proteins are known as genes. The specific proteins require specific lengths of the nucleotides and hence different genes. Different genes determine the structure of different RNA molecules, which in turn, produce different proteins. In living cells, only one strand ("sense strand") of DNA serves as a template along which the nucleotides of RNA are lined up according to the complementary rules to form RNAs (Fig. 3).

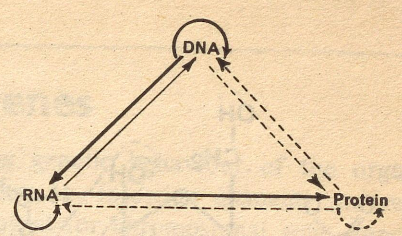

Fig. 1. Diagram of relationship between DNA, RNA and protein. The heavy lines indicate the known directions of transfer of information in cells. The thin lines indicate special information transfer machanisms. The dashed lines indicate directions of information transfer not yet denonstrated. (After Crick, 1970, *Nature*, 227, 561-563)

"The intelligence genes they have developed can only stimulate natural but dormant intelligence genes. So it cannot be of much help to you."

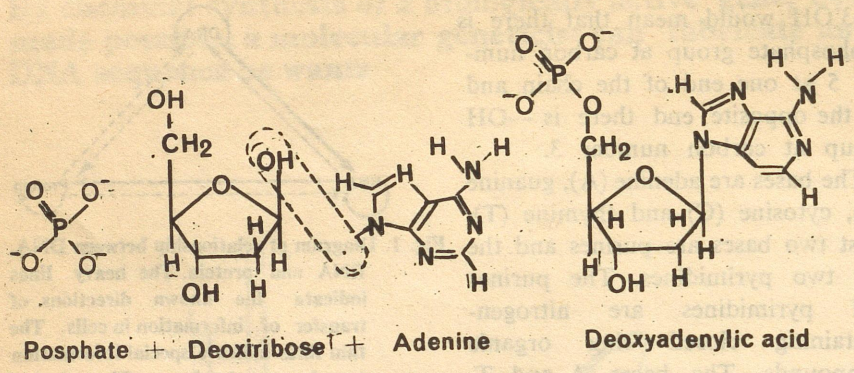

Fig. 2. Formation of the (deoxyribo) nucleotide

RNA structure

The second nucleic acid, RNA, occurs in multiple forms in the cells, each having an extremely important role. There are three kinds of RNAs which are classified according to their metabolic roles. The three classes are; messenger RNA (*m*RNA), ribosomal RNA (*r*RNA) and transfer RNA (*t*RNA). Each of these serves as an informational link between DNA and proteins. Specifically, the synthesis of *m*RNA on DNA template is called

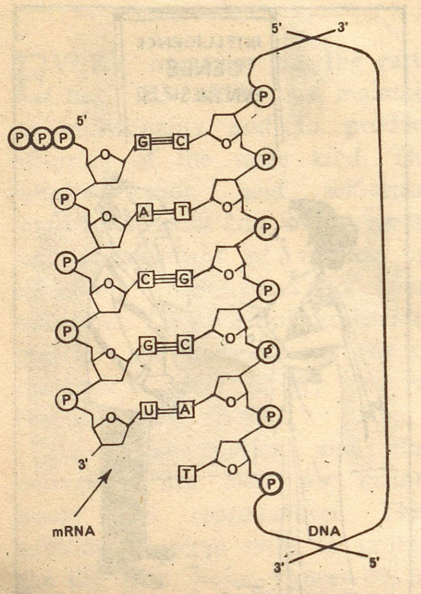

Fig. 3. Transcription of *m*RNA from the template strand of DNA showing that *m*RNA is complementary to the template DNA strand. Note that in *m*RNA there is U instead of T

"transcription" and the synthesis of proteins from messenger RNA is called "translation". The sequence of nucleotides in *m*RNA determines the sequence of amino acids to be incorporated in the protein molecule (translation). RNAs have base composition very closely related to DNA. However, they differ from DNA in the following important ways: (1) Molecules of RNA are single-stranded, linear polymers of mononucleotides. Although certain types partially assume a secondary double-helix configuration through complementary base pairing; (2) The sugar of the sugar-phosphate strand is ribose; (3) Nucleotide bases are the purine—adenine (A) and guanine (G);and the pyrimidines—cytosine (C) and uracil (U). The last replacing the thymine (T) of DNA; and (4) *t*RNA has "unusual" bases which are the known enzymatic modifications of A, G, U and C (Fig. 4).

The role of *m*RNA is to act as template upon which amino acids are lined up for the formation of protein. *m*RNA comprises about 5–10% of the total RNA of a cell. The role of *r*RNA is probably structural. It forms a skeleton for the assembly of ribosomes during the protein synthesis. It make up about 75–80% of the total RNA of a cell. *t*RNA consists of different species. They are a group of smallest RNAs that in some way act as interpreters of genetic information. In fact, *t*RNAs are the specific carriers of activated amino acids to specific sites on the protein synthesizing templates (*m*RNA). All these types of RNAs are produced on different DNA sequences. In other words, each kind of RNA has its specific gene. It was the gene coding for a specific *t*RNA which was first artificially synthesized by H.G. Khorana and his colleagues at the University of Wisconsin in Madison, USA.

Gene synthesis

For the artificial synthesis of a gene it is very important that it should be small and its base sequence should be known. It is difficult to synthesize an average gene as it is too long (about 1500–2000 or more nucleotide pairs) and its nucleotide sequence is too difficult to be known. However, the genes coding for *t*RNAs are reasonably small and the base sequences of about 60 *t*RNA species are known. Once the structure of *t*RNA mo-

Applications

THE applications of recent developments in genetic engineering are many. The most powerful use would, however, be fabrication of control sequences to find out how they work. By chemical synthesis of a biologically active gene now made possible, a molecular geneticist can fabricate any DNA sequence he wants. And recombinant DNA technology allows cloning of the synthesized DNA to make unlimited amounts. Insertion to any piece of DNA then follows. There are important applications in studying the structure and function of genes. But it may, however, also lead to real application in the production of insulin by *Escherichia coli*, for example.

Z. I.

lecule is known, it is easy to decipher the structure of its gene. Since *t*RNA molecule has been transcribed directly from the "sense" strand of DNA, it must be complementary to it (DNA). Then the other DNA strand would have the same sequence as *t*RNA but having T instead of U (Fig. 3). So the base sequence of the two DNA strands or a gene coding for *t*RNA is known by knowing the base sequence of *t*RNA itself. Therefore, for the synthesis of gene only known bases are to be stacked together as inferred from its product.

H.G. Khorana and his colleagues, while at Wisconsin, succeeded in synthesizing the gene for yeast alanine-*t*RNA which needed only 77 base pairs. At that time (1965), this gene was the only possible choice as it was the gene whose base sequence was known. Khorana's group exploited the inherent ability of polynucleotide chains to form double-helical complexes by complementary base pairing. It was hoped that the short, single-stranded chemically synthesized segments of DNA, which are complementary to each other, would be enzymatically joined together to form long double-stranded DNA specifying yeast alanine *t*RNA gene.

The chemical synthesis of the segments for alanine-*t*RNA gene was done by stepwise condensation between the hydroxyl group at the 3′ position of the first or receiving nucleotide and phosphate group at the 5′ position of the second or incoming nucleotide. All other functional groups of the nucleotides which were not taking part in the condensation were protected. This way di-, tri- and higher polynucleotides of specified nucleotides were synthesized to give rise to small deoxyribonucleotide chains ranging from 5-20 nucleotides (Fig. 5).

The general plan of procedure comprised the following three crucial operations:

1. *Chemical synthesis* of overlapping deoxyribonucleotide segments representing the entire two strands of DNA chain;

2. *Phosphorylation* of the 5′-OH group of each segment with γ-(^{32}P)-ATP and with an enzyme, polynucleotide kinase. It made the

Motile genes

GENES were so far known to be non-motile structures with fixed and specific positions on chromosomes. They drift from their specific sites at the time of mutation or recombinations. The view that genes are stable is changing rapidly, for in recent years it has been established that genes also move with frequencies as great as 10^{-2}. This was particularly noticed in bacteria, though there are evidences of this character of genes in higher organisms also.

The genes and segments of DNA change their positions on the same chromosome, and also move from one chromosome to another, or from chromosome to viruses and plasmids. These moving genes are categorised into two groups: the insertion elements and antibiotic resistance elements. Under the first group, short DNA segments, nearly the size of the genes, move and change off the expression of that block of genes to which they are transferred. The antibiotic resistance element or the larger segments of DNA of the genes which resist antibiotics also change their position. They are transferred from one plasmid to another and from plasmid to virus, to bacterial DNA also. They also turn off the gene expression.

The two types are quite similar in characters as both are specific in nature and both turn off the gene expression. In some cases they are also structurally related.

It is believed that these moving genes or "jumping genes" also play some important role in shaping genetic behaviour of the organism, i.e., insertion elements are required for chromosomal gene transfer during bacterial reproduction.

Bacterial pathogeneticity is increased due to presence of antibiotic resistance element. Plasmids and viruses are modes of transfer of these elements among the bacteria. F. Hefron and S. Fallow of Washington University (*Science*, 193: 4251, 1976) have observed that these elements move from benign plasmid to plasmids having toxin-containing genes. When bacteria pick up such genes, antibiotic resistance genes are also transferred alongwith. Meningitis bacterium, *Haemophilus influenzae*, has developed resistance to ampicillin and tetracycline.

Both elements function as "regular switches" also, as they turn off and turn on the gene expressions. They are believed to have some role in bacterial metabolism.

Presence of this phenomenon in higher organism is supported by both structural and genetic evidences. In *Drosophila* it was observed that there were sudden deletions and rearrangements of chromosomal segments, turning off and on the gene expression. Barbara Maclintock of Cold Spring Harbour, New York, who studied movement of DNA segments in corn, observed that movement is sporadic and may be identified by the change in gene expression.

These moving DNA segments may have a role in development of cells and their transformation to viruses.

N.B.

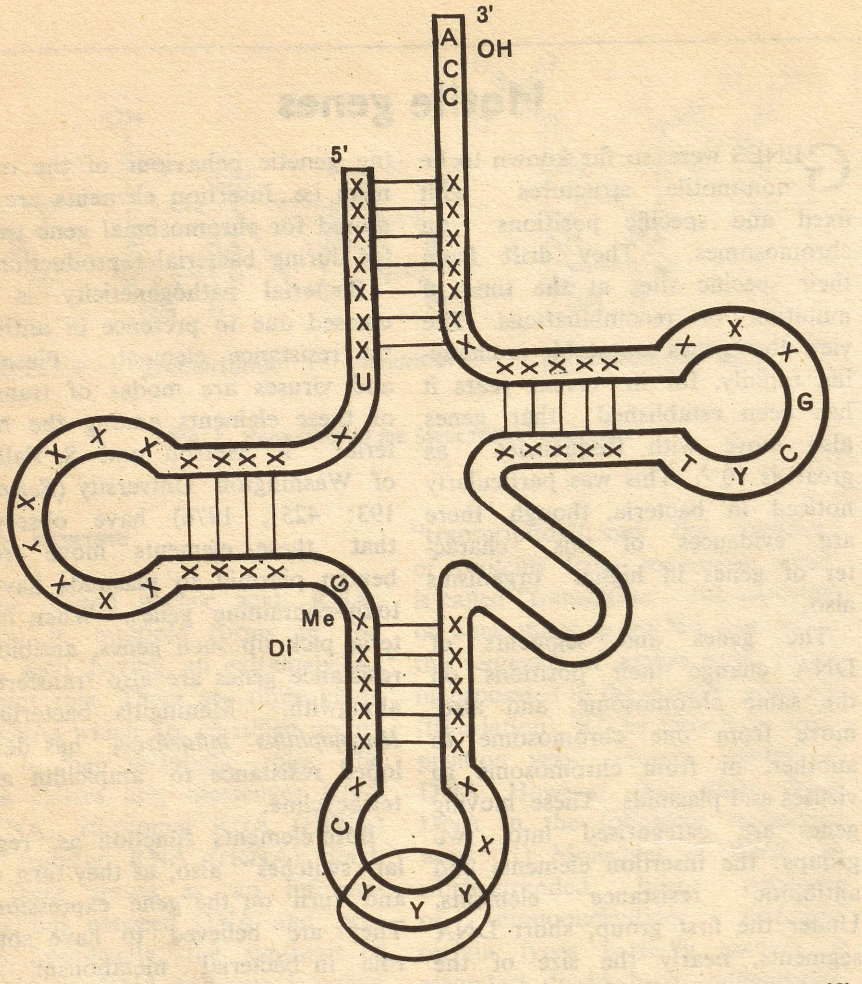

Fig. 4. Generalized two-dimensional cloverleaf model of tRNA, A = adenosine, C = cytidine, G = guanosine, T = ribothymidine, U = uridine, U = pseudouridine, DiMeG = dimethylguanosine, Y = any base of the anticodon, X = any other base

5'-OH group radioactive and therefore enabled the joining of the segments to be checked., and

3. *Ligase joining* of the aligned segments. The head-to-tail joining of the appropriate segments when they are aligned to form bihelical complexes is accomplished by using the enzyme polynucleotide ligase.

It was first decided to synthesize deoxypolynucleotide segments of unequal lengths of the range of 8 to 12 units only. The segments would represent the entire two strands of the specified DNA. When the complementary segments of unequal lengths were placed in solution they formed a two-stranded complex with the larger strand extending out. The extended segment or single-stranded DNA then helped bind the newly added adjacent segment of the complementary strand. Part of the newly added segment then as a single strand helped binding of another segment, and so on.

The detailed procedure for the chemical synthesis or operation 1 depended on the following steps: (a) chemical synthesis of small, single-stranded DNA segments, (b) synthesis of three, double-stranded DNA segments, and (c) synthesis of gene from double stranded DNA segments.

(a) It required the solution of two problems; the first was to develop a suitable protecting group each for 3'-OH, 5'-OH, the amino group of bases, and for the phosphate group itself. A protecting group was looked for with the capability for easy addition and removal under mild conditions.

(i) It was found that the amino groups of different bases required different protective groups (Fig. 5). The amino group of adenine was protected by Benzoyl (Bz) group, the amino group of cytosine was protected by Anisoyl (An) group and the amino group of guanine was protected by Isobutyryl (iB) group. All these different protective groups could be removed easily at the end of synthesis by treatment with ammonia.

(ii) The 5'-OH group of the first or receiving nucleotide was protected by monomethoxytrityl (MMTr) group. It could be removed easily by the action of mild acid.

(iii) The 3'-OH group of the next or incoming nucleotide was protected by acetyl (Ac) group. This group could be easily removed by treatment with alkali.

The second problem was to find an agent for chemical activation of the phosphate group of the mononucleotides. It was to make a phosphodiester or internucleotide bond in between receiving or first nucleotide and incoming or second nucleotide (condensation). Different condensing agents which could be used were mesitylene sulphonyl chloride (MS), dicyclohexyl carbodiimide (DCC), etc.

The two protected nucleotides were then allowed to get condensed under the influence of condensing agent. After each condensation protected 3'-end of the receiving group was made free so that, in turn, it could receive another incoming nucleotide. This way 15 small-single stranded segments of deoxyribonucleotide chains of the size of 5 to 20 nucleotides were synthesized.

The chemically synthesized segments were then labelled or phosphorylated at the 5'-termini using γ-(^{32}p)- ATP (operation 2). This enabled the joining of the segments to be monitored.

(b) These 15 single-stranded oligonucleotides were allowed to form three large DNA duplexes by the complementary base pairing. Thus the gene was divided into three parts A, B and C and each part consisted of several single-stranded segments. Each DNA duplex had at least one unpaired end (or the overlapping end). The overlapping ends help them pair up with each other. These three parts had their individual characteristics as given below:

Part A. This DNA duplex contained first 20 nucleotides with the nucleotides 17 to 20 as single-stranded. It was made with the help of ligase by joining (operation 3) 4 single-stranded DNA fragments.

Part B. This DNA duplex contained nucleotide residues 17 to 50 with two single stranded regions, i.e., 17 to 20 and 46 to 50. It was made with the help of ligase by joining 5 single-stranded DNA fragments.

Part C. It is composed of the rest of the 46 to 77 nucleotides with only one single-stranded region of 46 to 50. It was made with the help of ligase by joining (operation 3) 6 single-stranded DNA fragments.

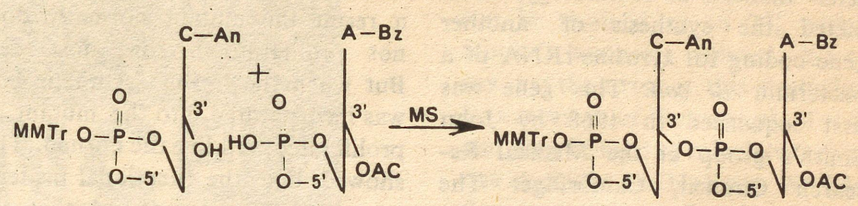

Fig. 5. The chemical synthesis of the di, tri and higher specified polynucleotides. Note that all functional groups not taking part are protected and condensation is brought about by a condensing agent

Ligase joining in each case was checked by esterification of the 5′-(^{32}P) termini in internucleotides linkage. Joining renders the ^{32}P insusceptible to the action of enzyme phosphomonoesterase and phosphatase.

(c) Because of certain reasons, it was decided that part B should be added to part C. After giving them enough time to pair up, ligase enzyme was added and the joining was carried out. Then the preformed B+C was brought into action with A. Ligase was again added and joining allowed to proceed. The correct head-to-tail joining was checked. This resulted in the synthesis of alanine-*t*RNA gene (Fig. 6).

The choice of the synthesis of alanine-*t*RNA gene proved unfruitful as it was nonfunctional both in cells as well as in test tube experiments. It was because of the fact that it did not contain the initiator andterminator signals that are necessary for its functioning. These signals are attached to both ends of the gene.

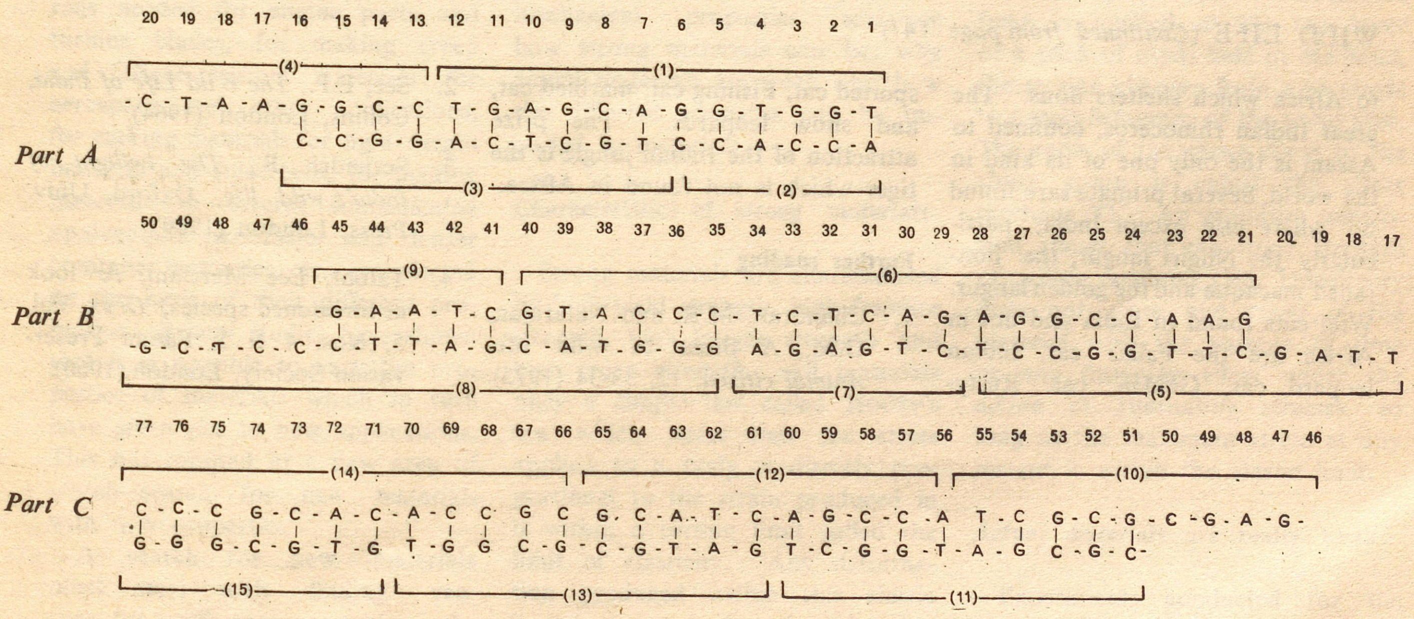

Fig. 6. A plan for the total synthesis of the DNA duplex corresponding to the yeast alanine *t*RNA gene

After this Khorana and his associates in 1973, now at Massachusetts Institute of Technology, completed the synthesis of another gene coding for tyrosine-*t*RNA of a bacterium *E. coli.* This gene was first sequenced in 1968 by John Smith's group at the Medical Research Council, Cambridge. The gene was synthesized in the form of four major sub-units. These 4 subunits were then combined to produce the gene. This was essentially the same procedure that was earlier used to synthesize the yeast alanine-*t*RNA gene. However, at this stage this gene also could not be shown working as it lacked the initiator and terminator segments.

Very recently, the Khorana's group has announced at the Centennial Meeting of the Americal Chemical Society that they have synthesized a complete gene. It codes for tyrosine-*t*RNA that functions in a living cell. This synthetic gene, when inserted into the bacteriophage lambda, has been shown to correct its mutational defects. A mutant strain of bacteriophage lambda when allowed to infect the bacterium *E. coli* produces short, nonfunctional proteins. As a result the mutant normally does not proliferate in the host cell. But when the normal synthetic gene was incorporated into the mutant, it proliferated well like the normal. This showed that the functional proteins were being produced and that the gene was completely normal and functioning.

According to Khorana, the chemical synthesis of a gene is a versatile technique. It enables the study of the effect of mutations and tells about the mechanism of gene control. It is expected that in near future the technique will help us to study why genes in cancer cells appear to be out of control. Other suggestion is, by incorporating a synthetic gene for insulin in a bacterium, it would be easy to produce this protein in large quantities from bacterium instead of from animals. Even the genetic diseases could also be treated by substituting healthy man-made genes for the "sick" ones. This assembly of the artificially synthesized or isolated genes into the chromosomes and the application of this to human problems have been known as "genetic engineering" (*S.R.*, June 1976).

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WILD LIFE (*Continued from page* 147)

to Africa which shelters lions. The great Indian rhinoceros, confined to Assam is the only one of its kind in the world. Several primate sare found no where else except India, particularly the Nilgiri langur, the lion-tailed macaque and the golden langur. Wild cats found in India and not in Africa are the Pallas cat, Indian leopard cat, Golden cat, Rusty-spotted cat, Fishing cat, marbled cat, and snow leopards. The prize attraction of the Indian jungle is the tiger which is not found in Africa.

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SCIENCE SPECTRUM

How strong materials can be

MATERIALS for different engineering applications, say, for building strong and low-cost houses, for making non-corrosive household utensils, for making bio-materials for heart transplant, for making good, semi-permeable membranes for use in desalination of sea water by reverse osmosis, for making temperature-resistant materials needed for engine parts and turbine blades, for making creep and fatigue-resistant materials for aerospace and other applications, for making materials for light-weight batteries and solar cells, for making materials in several sophisticated applications like faster and denser computer memories, etc., are selected on the basis of their different properties. Recent studies have shown that it is possible to vary the properties of materials which in turn have given rise to new applications. This has resulted in a new area of search—search for new materials with new properties.

A search for new materials must start with finding reasons for different properties; the theoretical limit to the values of properties that the materials can have, why the actual materials do not exhibit the different properties up to the theoretical limit and what can be done to improve the material properties to reach the theoretical limit. The material properties of interest can be broadly classified as mechanical, thermal, magnetic, electrical, electronic and optical. In this article, we will deal with the mechanical properties and see how strong materials can be, why actual materials are weak, and how the different strengths can be imparted to materials.

Characteristics of strong materials

Strong materials are characterised by high yield strength, high fracture strength, high fatigue strength and high creep strength. All materials obey a simple law called Hooke's law which states that the stress applied to a body is directly proportional to the strain produced in it within a certain limit called the limit of elasticity. Any deformation produced within this elastic limit is removed when the deforming force is removed. If the stress exceeds the elastic limit, the material does not completely recover its original shape and it is said to become plastic. Normal materials can be strained up to 2% without Hooke's law being violated. We can say that the stress at this elastic limit is a measure of the strength of solids and may be used to calculate the various strengths on this basis. We know that matter is made of atoms and in the solid state these atoms are bound together by some sort of bonding forces. Elastic forces have their origin in these inter-atomic forces due to the different bondings. Knowing the bond strength, it is possible to calculate the stress at the elastic limit. In the case of a body subjected to a longitudinal stress or a tensile stress, an atomistic calculation shows that the yield strength of a solid is about $E/10$ where 'E' is called the Young's modulus of the solid. Young's modulus is the constant ratio formed by the linear stress to the linear strain produced in the solid. When the deforming force is such as to change the shape of a body without changing the size, the body is said to be subjected to a shear stress. For example, when a tangential force is applied at the top layer of a pack of cards held in the hand, the section changes from a rectangle to a parallelogram of the same area. The ratio of the shear stress to the shear strain is called the shear modulus 'G'. An atomistic calculation shows that the shear strength of solids is about G/6. This theory does not allow any creep, of the material with the passage of time or any fatiguing effect under the action of alternating stresses, so long as the maximum stress at any instant is within the elastic limit.

Actual materials are really weak!

Experiments conducted for the determination of the various strengths of actual materials tell a different story. It is found that crystals yield or plastically get deformed at stresses 1/1000 of the theoretical value. The same is the story with shear strength. Apart from this, materials which are subjected to cyclic or alternating stresses yield suddenly even when the maximum stress is well within the elastic limit. That is, we say, materials get fatigued and fail because of ageing. Again, materials show viscous behaviour even within the elastic limit especially at high temperatures and give rise to a time-dependent deformation called creep, ultimately leading to catastrophic failures. Sometimes fractures occur suddenly without any prior indication. A fracture is the separation of a solid into two or more parts. There are two important types of fractures, namely, ductile fracture and brittle fracture. Such fractures occur even when the material is worked well within the elastic limit. When the fracture occurs within the elastic limit, it is called brittle fracture. Glass is highly susceptible to brittle fracture. When fracture occurs in the plastic flow region, it is called ductile fracture. In all cases fracture occurs rather suddenly.

Scientists studying the problem of weakness in materials were really puzzled to find such a wide discrepancy between the theoretical and the practical values. All the macroscopic approach they made by extending the theory of strains to large values could not offer any satisfactory explanation. It was soon realised that only a microscopic approach can give a clue to this problem and hence people turned their attention to the atomistic picture of materials.

Microscopic picture of an yielding crystal. The Fig. 1a represents two layers of atoms in a crystalline array under equilibrium conditions. Let the two layers be subjected to a shear stress. Any shear stress which displaces one row of atoms to less than half the inter-atomic distance will produce only an elastic deformation. That is, when the shear stress is removed the atoms will fall back to their original positions as shown in Fig. 1a. But if the shear stress is large, one layer of atoms may be displaced from the other by one lattice distance and fall into the equilibrium position as shown in the Fig. 1b. When the shear stress is removed, the atoms do not come back to the position shown in the figure (1a), but remain in their newly displaced positions as shown in the figure (1b). Obviously, the shear stress has exceeded the shear strength. It is on this picture that we calculated the shear strength of crystals as G/6. Let us consider another picture of the atomic array as shown in the figure (1c), as proposed by Frenkel and others. In this picture we see that there is a vacancy in the second row and we call this a crystal defect. If in such a crystal we apply a shear, we find that the crystal suffers a plastic deformation for a much smaller stress and the atoms take up the new positions as shown in the figure (1d). So we find that the defective crystals yield at much lower stresses than perfect crystals. In the case of perfect crystals the deformation takes place by the simultaneous slipping of all atoms in the row which slips. But in the case of defect crystals, deformation occurs by the simultaneous slipping of fewer atoms. In fact, the deformation of the defect crystal can be pictured as if it is caused by the movement of the defect rather than by the movement of the atoms. By working out the dynamics of dislocation motion or the defect motion it has been theoretically proved that a smaller stress is required to move the dislocation through a layer of atoms than to move the atoms along a perfect array. Let us illustrate this point by a homely analogy. When a big

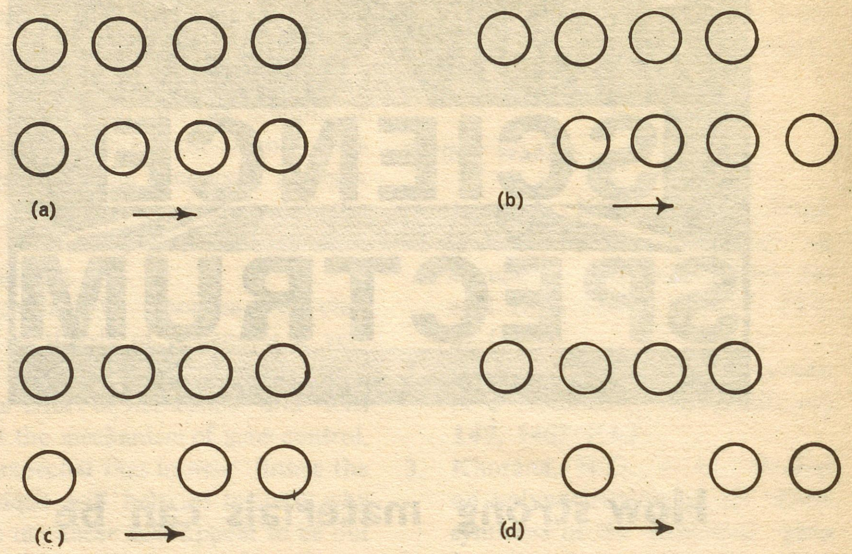

Fig. 1

blanket is spread on the floor we find invariably some wrinkles in the blanket. The wrinkles can be easily moved by hand from one end to the other and in this process the blanket suffers a small displacement relative to the floor. If there are no wrinkles in the blanket it requires a very large force to displace the blanket relative to the floor. A similar situation can be thought of as existing in crystals. The wrinkles in the blanket correspond to defects or dislocations in crystals. Just as the wrinkles move easily through the blanket, so also the dislocations move more easily through the crystal. Though the crystals may not initially contain enough dislocations to permit the large plastic strains observed, Frank and Read have given a mechanism of dislocation multiplication which is found satisfactory. The crucial factor in the role played by dislocations in plastic deformation is the relatively small stress needed to cause dislocation motion and dislocation multiplication.

The fracture phenomenon also has been explained on the basis of propagation of what are called microscopic cracks. There are many reasons for crack formation in crystals such as surface roughness, surface scratches, etc. These cracks are regions of high stress concentration in a surface. If the stress exceeds the bonding stress, the crack can spread very fast leading to unexpected failures. Fatigue and creep failures also get a satisfactory explanation on the basis of defect structure of crystals. An important point we notice at this stage is, that properties like yield strength, shear strength are highly structure sensitive and this may give scope for the molecular architect to vary the properties by varying the structures.

Why should crystals have defects?

Having established that defect structure is the cause of crystal weakness, we are inclined to ask why crystals should have defects. Again, it is the law of nature that makes it difficult for us to have perfect crystals. Thermodynamics tells us that any system takes up that configuration for which the free energy given by the expression $F=E-TS$ is a minimum. E is the internal energy, T is the temperature and S is the entropy. Creation of defects or dislocations increases the internal energy of the system. But at the same time it also increases the disorder or the entropy of the system. Since the entropy increases faster than the increase of internal energy, a system of minimum free energy necessarily has to be a defective system. In fact, it can be shown that the number of defects per unit volume at any temperature T is given by the expression $n=n_o\exp(E_g/kT)$, where E_g is the energy required to create one defect. On this basis it is calculated that there must be about 10^5 defects per unit volume at room temperature in a metal and this defect density increases enormously with rise of temperature. That is also the reason why the materials yield at much smaller stresses at higher temperatures.

Strengthening mechanisms

The ultimate aim of the microscopic analysis of the mechanical properties of solids is to understand the mechanism of hardening and strengthening the solids which are sick with the inevitable dislocations. The following are some of the methods adopted for strengthening solids: (1) Preparing defect-free materials, (2) Decreasing the grain size, (3) Increasing the dislocations by strain hardening, (4) Pinning the dislocation motion by adding solute atoms (5), Precipitation hardening, (6) Dispersion hardening, and (7) Making composites.

Defect-free materials. Since most of the engineering materials we use are polycrystalline, it is very difficult to prepare defect-free bulk materials. Besides they will be highly unstable thermodynamically. Materials in the form of thin fibers or whiskers, devoid of defects and having very high tensile strengths, can be prepared but they are not quite suitable because they are very brittle. But these fibers have been found to be very good in making composites as we will see later.

Decreasing grain size. Grain size has a marked influence on yield stress, fracture stress and ductility. In a fine-grained material there are more boundaries and its strain-hardening rate is also higher. The boundaries and the dislocations produced by strain-hardening act as barriers for further dislocation motion, thereby making the material stronger. With respect to fracture the grain size diameter can be taken as the initial crack length, and according to Griffith's theory, the fracture stress could be expected to depend on the inverse square root of the grain size. The difficulty in preparing grain sizes less than 10 microns sets a limit for indefinite strengthening by this process.

Work hardening: When you take a fresh copper sheet and bend it, you find it easy in the first instance. When you try to unbend it, you find it has become stiffer. When the process is repeated, the material becomes stiffer and stiffer. When you bend the material or deform the material, you are introducing dislocations. The dislocation density increases greatly during the process of deformation. Later, the dislocation become tangled together in such a disordered fashion that further dislocation motion becomes difficult. This phenomenon is called work-hardening or strain-hardening and is one of the methods used for hardening a material. This process however has the disadvantage of making the material susceptible to cracking or tearing. By special heat treatment like annealing and recrystallisation the material can be strengthened to some extent.

Pinning of dislocations by solute atoms. Another way of increasing the hardness and yield strength of a metal is by dissolving a second metal in it to form a solid solution. If the atoms of the solute metal are bigger or smaller than those of the original material, they will set up local strains around them. These strain fields act as obstacles to dislocation motion and hence raise the strength of the material. The most important example of a solute-hardened material is martensite, the hard constituent of quench-hardened carbon steel. The carbon is first taken into solid solution, upto four per cent in a typical steel, by heating to around 900°C where it is austentitic. It is then held in solution by quenching to room temperature. The steel transforms to the bcc structure under this treatment, but due to the rapidity of the quenching, the carbon is forced to remain in supersaturated interstitial solution and distorts the bcc structure to a body centered tetragonal which is a martensite. The stress field produced by the oversized carbon atom is so intense that the dislocation motion is very effectively hindered.

Precipitation hardening. If resistance to dislocation motion were all that was required of a strong material, we could use intrinsically hard solids like silicon carbide for engineering applications. Such materials are, however, brittle, and it is more often a combination of ductility and strength that is required. The ductility not only makes it possible to work the material to a required shape but also gives a much greater fracture strength (as opposed to yield strength) than does a brittle material. The best combination can be obtained from an intrinsically soft metal that is strengthened by finely dispersed particles of hard substances. Since these particles are usually produced by precipitation, such materials are said to be precipitation hardened. This is the process followed in hardening steel, where particles of iron carbide are precipitated into iron. Aluminium is strengthened by precipitating copper in it.

Each of the above mechanisms we have described can raise the yield strength to the order of G/100 to G/50. Unfortunately, all the mechanisms begin to break down at temperatures where diffusion can occur at an appreciable rate. Precipitated particles begin to dissolve and solute clouds begin, by diffusion, to drift along with dislocations which can climb over the barriers and glide along. The search for alloys with reduced diffusion rates at high temperatures resulted in the development of dispersion hardened materials.

Dispersion hardening. The principle of hardening by creating a closely spaced dispersion of a second phase is of great technological importance. These materials are composed of a metal matrix in which are embedded fine particles of oxides, nitrides, or carbides which are insoluble and incoherent with the matrix. The spacing and particle size are very critical. Since the particles are insoluble in the matrix, transport by diffusion through the matrix is negligible and so they will not agglomerate on heating. This means that unlike precipitation hardened alloys, such materials will retain the strength at elevated temperatures and so may be useful as creep-resistant materials. A typical material is TD nickel where nickel is hardened by a dispersion of thorium oxide. Another material is SAP, an aluminium-aluminium oxide composite.

Fiber composites. This is the latest concept in material strengthening. The basic idea is to achieve the extraordinary strength of thin fibers or whiskers in bulk materials by reinforcing a ductile matrix with the fibers. Glass reinforced plastics is a typical composite. Glass fibers have very high tensile strength but low shear strength. Plastics have high shear strength but low tensile strength. The purpose of the plastic matrix is two fold. It separates the individual fibers so that cracks cannot easily run from one fiber to another. Again, it binds the fiber surfaces so that the stress applied to the composite is mostly transferred to the fibers. For a given load, the strain in the matrix as well as the fiber is the same. This means that the major stress is carried by the fibers. The strength of the composite, σc, in terms of the strengths of the individual components is given by:

$$\sigma c = \sigma_f V_f + \sigma_m (1 - V_f)$$

where σ_f and σ_m are the strengths of the filament and the matrix and V_f is the volume fraction of the filament. If σ_m is sufficiently small and V_f very nearly unity,

$$\sigma c \approx \sigma_f$$

That is, the strength of the composite approaches the strength of the fiber itself. The practical realisation of the strength given by the above equation depends on the availability of the proper matrix and the fibers. The length and the volume fraction of the fibers are critical. If the matrix does not fail before the fiber strength is reached, it is practically possible to fabricate a composite nearing the ideal strength. A composite consisting of silicon carbide fibers embedded in a suitable epoxy resin gives a strength of 10^5 kg/cm^2 and this compares very favourably with the strength of the strongest available steel whose strength is $.42 \times 10^5$ kg/cm^2. Fiber composites seem to be the materials for the morrow and much work is being done at present to use this new philosophy to obtain strong materials.

Work done in India

The idea of fiber composites was first introduced in 1940. Since then the progress has been very rapid and tremendous. The fabrication of defect-free fibers requires some sophisticated technology which was not available in India till 1965. Till then glass fibers and resins were imported in our country. In 1965, a Bombay firm started producing glass fibers in India. Today almost all the essential raw materials for this fiber composite industry are indigeneously available. Research work on fiber composites is extensively being done at the National Aeronautical Laboratory, Bangalore and the Indian Institute of Technology, Madras. The results are quite encouraging and the technologists of tomorrow can hope to get materials with any required properties ranging from soft rubber-like materials right up to materials stiffer than steel, with ability to withstand very low temperatures to very high temperatures and survive very many mechanical abuses. Development of strong materials will make our nation definitely strong in all respects.

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Cities under the sea

POPULATION explosion forces us to view the earth's land masses in a new light. Experts say that the world's population will double by the year 2000. If this is true we should start exploiting the resources of the sea immediately. Population explosion has created two incompatible requirements. The first for more room to live in and the second for more food to eat. If the amount of arable land is reduced to provide living room, where will we find the land to grow the food for the larger population? We would not find the answer to these questions in outer space, because it is doubtful how many people will be living out there by 2000 A.D. The oceans can provide these answers if we exploit their potential intelligently and systematically.

Until recently this fascinating world of 'inner space' had been all but forgotten by human beings who inhabit only 28% of our planet located above the ocean's surface. There is no doubt that this barrier, the ocean's surface, has been one of the most formidable obstacles that man has known. Oceanography, the science of the oceans, is less than 100 years old though we have used these waters for commerce and limited food production for many hundreds of years. It is just in the last few years that we have moved into this area with an increasing sense of urgency, both from military and economic points of view.

There are dramatic legends about Alexander the Great's underwater observations from a glass barrel some 2300 years ago. Herodotus and Pliny spoke about marine science a century earlier. Leonardo da Vinci, the multi-faceted renaissance genius, designed an underwater apparatus. In 1609, Buonaiuto Lorini, a Venitian, also designed a diving apparatus. In the develop-

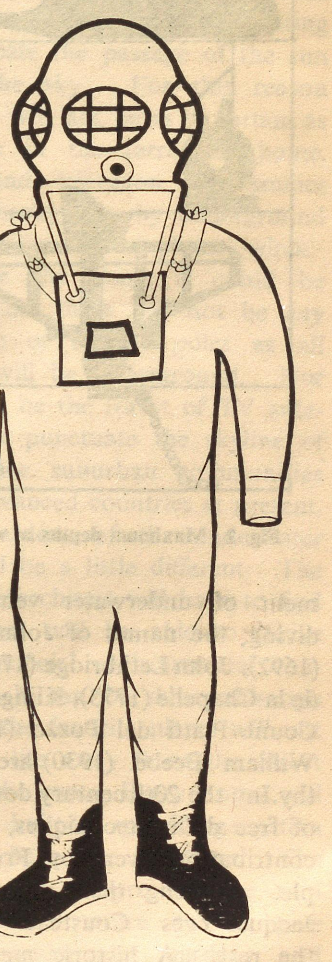

Fig. 1. August Siebe's first 'closed' diving suit of 1837

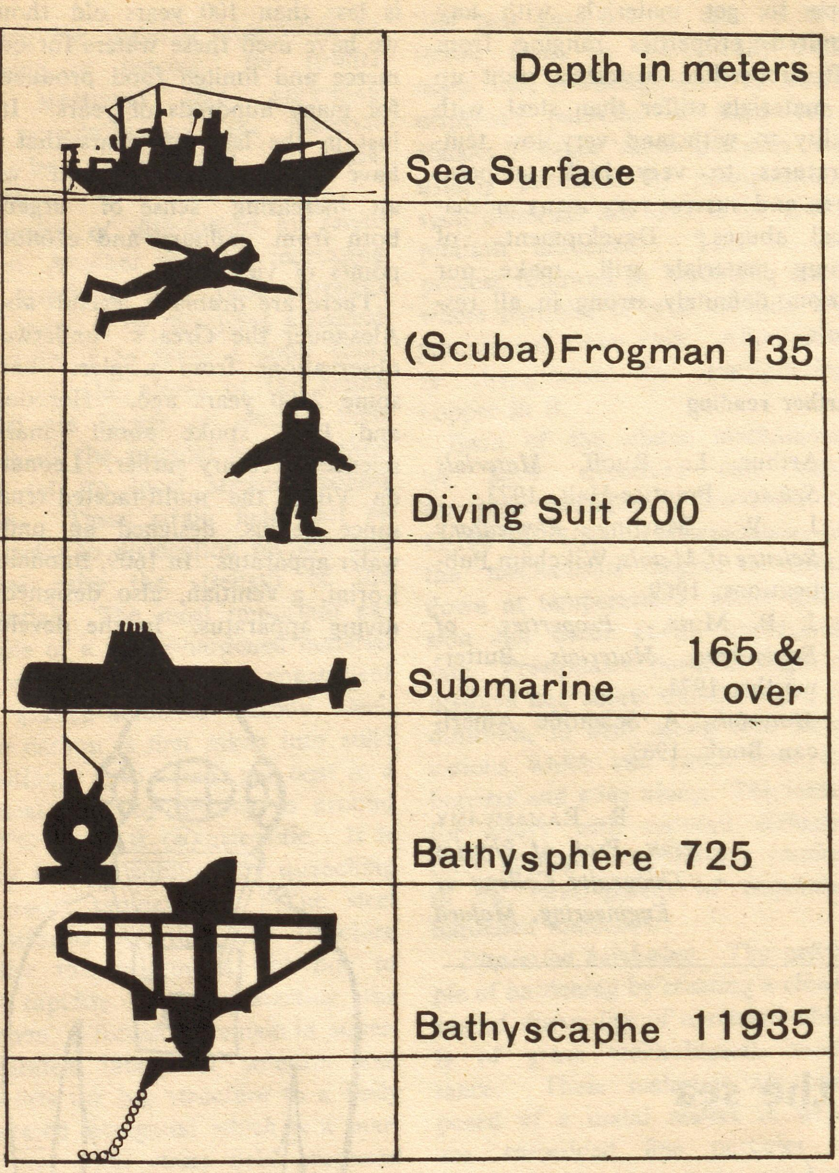

Fig. 2. Maximum depths at which various kinds of diving apparatus have been used

ment of underwater vehicles and diving, the names of John Williams (1692), John Lethbridge (1715), Abbe de la Chapelle (1775), Klingert (1797), Count Piatti del Pozzo (1898) and William Beebe (1930) are noteworthy. In the 20th century development of free diving techniques, the major contributions were by French people. Among them Commander Jacques-Yves Cousteau outshines the rest. A historic meeting between Cousteau and engineer Emile Gagnan in Paris in 1942 led to the most spectacular invention for opening up the oceans for free-swimming people—the aqualung. Since then there were two recent historic occasions which marked the birth of modern oceanology. One was the submerged crossing of the North Pole by the U.S. nuclear submarine *Nautilus* on 3rd August 1958 and the second was the descent to the bottom of Challenger Deep in the Marianas trench by Jacques Piccard and Don Walsh in the bathyscaph *Trieste* on 23rd January 1960. In 1965, Jacques Coustaeu again made history by his first *Conshelf* experiment. His team of divers lived underwater for one week at a depth of 30 feet, working from a cylindrical habitat moored on the sea floor and supplied with compressed air from the surface. This was followed by another more ambitious experiment. Many other experiments have since been carried out on the possibilities of living and working under the sea. Among them perhaps the best known are the American *Tektite* and *Sealab* programmes.

Many scientists are investigating the physiological problems concerned with submarine operations to assess human ability for enduring the long hours away from normal daylight and in close confinement. So far, the results have been very encouraging, but it must be remembered that the men they are working with are specially selected and tested for the rigours of submarine duty. In other words, they have been found to have the best adjusted personalities for adapting themselves to the job. The question then is not with a special selected group but with the average family and how they will be able to live away from the normal stimuli that make up a large part of our everyday life. "Stimuli" means the daily cycle of the sun passing across the sky, the stars, the moon, the smells, the noises, the rain, and the wind. It is very difficult to think about life without these things. So it is certain that there would be an artificial environment in the underwater city of the future but it would take some time to get used to it before it could become second nature to the inhabitants.

Man's first line of exploitation of the sea will be in harvesting its animals, mineral and vegetable resources on an efficient large scale basis. People will be ready for life in underwater cities when our coastal metropolitan centres become so overcrowded and people begin to strangle due to population congestion. At first these underwater cities will be in the form of residential areas near to the coastal cities. They would be located in fairly shallow water, not more than about 140 metres deep, on a flat or gently sloping bottom. At this depth there would still be quite a bit of sunlight though it would be blue tinted due to water. These underwater communities would be under a series of plastic domes connected by communication tubes for roads, walkways, and utilities. The gentle blue light would give the plastic 'sky' a late afternoon glow during the daylight hours on the surface. During dives with the *Trieste* there was daylight down to about 260 metres and twilight down to about 460 metres even though the weather on the surface was cloudy.

The artificial atmosphere would be created and controlled by a nuclear power source. The purity, humidity and the temperature of the air would be closely controlled to provide the most healthy environment for the residents. There would be no more smog, hayfever and the uncontrolled atmosphere of the surface. Heating of the air would be unnecessary due to moderate temperature of the surrounding sea water; however, this would depend somewhat on the location of the community.

Transportation to and from the sea floor would be via a rapid transit system that would either terminate at the city end of the entrance tube or connect directly into the city's rapid transit system. An electric monorail system would be ideal for this application. Any sort of internal combustion engine vehicles would not be allowed in the underwater community, as their products of combustion would create an overwhelming burden on the atmospheric conditioning system. The rapid

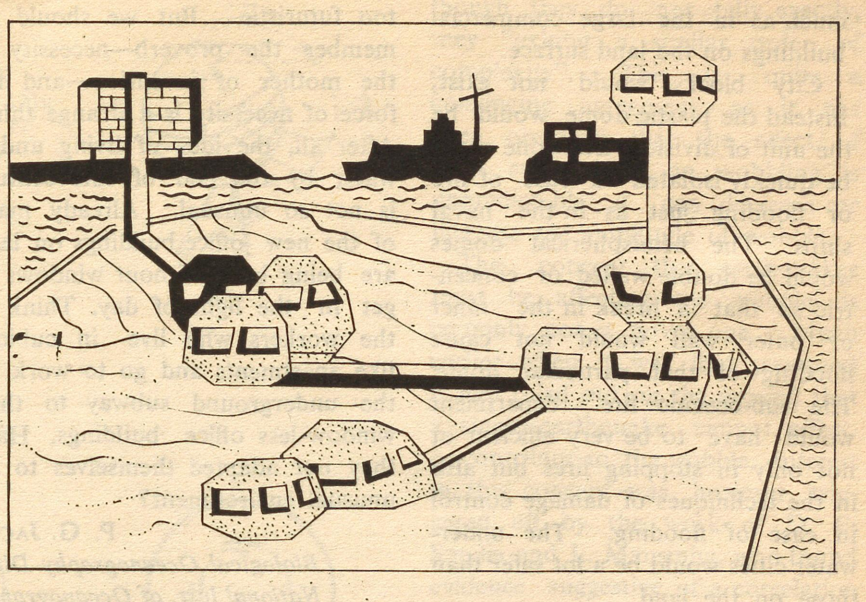

Fig. 3. Artist's concept of a future city under the sea

monorail system would carry people to within a short walking distance from their homes. Many people would have little electric carts for running local errands as would the service people such as the milkman and the grocery boy.

The home itself would be quite conventional-looking with a few exceptions. It would be connected to a central ventilating system much as the homes are now connected to sewers and water mains on land. This system would provide a constant ventilation of the home and would also be connected to the stove, water heater and fireplace to exhaust the fumes from these devices. These fumes and gases would be carried off through underground exhaust mains to the exhaust tunnel where they would be sent up to the surface of the ocean. Of course, the extensive use of electrical power for all uses would be encouraged to avoid any possible contamination of the underwater community's atmosphere. It would probably be cheaper too as the nuclear power plant would be capable of making electricity cheaper than any other devices. Lighting in the home would be more important than it is now. With proper design one would be able to regulate the daily lighting to duplicate the passage of the sun across the sky. For this reason windows will not be as important as they are in the terrestrial home. Radio and television programmes will be brought in by underground wires similar to telephone wires.

Outside the home it could be noticed that there will not be any telephone or electric poles as all utilities will be underground. Nor will there be the forest of TV antennas that punctuate the skyline of the surface suburban communities of the advanced countries at present.

The gardens of the underwater cities will be a little different. The landscape architect will have to find plants that will be able to thrive in the artificial environmental conditions. It can be done although some of the favorite plants will not adapt to life away from the direct rays of the sun. Every home will have a built-in sprinkling system that will have two functions. The first will be to provide the rain that mother nature cannot give to the underwater gardens and the second will be to give every home a built-in fire fighting system much as in the large commercial buildings on the land surface.

City blocks would not exist, instead the plastic dome would be the unit of division. Each one could be quickly isolated in case of fire or flooding just as in the naval ships. The hemispherical domes would be double walled or concentric so that a break in the inner or outer wall would not cause flooding of that particular dome. The sub-oceanic fire department would have to be very efficient at not only in stopping fires but also in the techniques of damage control in case of flooding. The underwater cities would be a lot safer than those on the land.

Perhaps all these may be a little too futuristic. But we should remember the proverb—necessity is the mother of invention—and the force of necessity is a strange thing. After all, the idea of living underwater by the end of this century is not so unusual. Already many of the new office buildings on land are being built without windows to get in the light of day. Think of the workers who live in cubicle-like apartments and go to work on the underground subway to their window-less office buildings. Have they not adapted themselves to an unusual environment?

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Large earthquakes wobble the earth

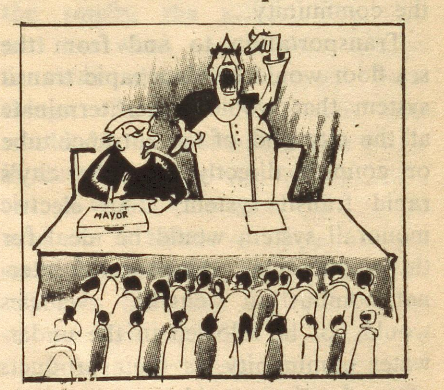
THE dictionary meaning of the word 'wobble' is 'to move unsteadily from side to side'. This word is often used in expressing the gait of a heavily drunk or ill person. Our mother earth, it would be a surprise for many to learn, also, 'walks' in this manner in her long repetitive journey round the sun! What causes her to act so is still a debatable issue. This is partly due to the fact that the 'wobbling' of earth is a complex phenomenon and partly because scant observations of it are available in the records of the past centuries.

Called specifically as Chandler Wobble, in honour of its discoverer, its origin is attributed to varied phenomena happening on and inside the earth; for instance, due to atmosphere, oceans, earthquakes, internal core-mantle interactions. Neither any of them is considered as the principal contributor to the wobbling, nor ruled out as a partial one. In short, the Chandler Wobble is today one of the unsolved problems in geophysics and the present researches are trying to solve it.

A recent effort in this direction was made by Richard J. O'Connell, of Harvard University, Massachusetts, and Adam M. Dziewonski, M.I.T., Massachusetts (*Nature*, **262**, 22 July 76). According to them, the large earthquakes have almost a fifty per cent contribution to the present wobbling of the earth. What makes their evidence convincing, its pros and cons, and how it tries to solve the problem would be better understood if the wobbling of the earth is discussed.

It is a well-known fact that the earth is spinning about its axis once every day. Consider that it has a 'leg' on which it can stand, just as a top does. Assuming the earth to be a perfect sphere with mass equally distributed, it would spin in a'stable' manner as shown in Fig. 1(a). But this is an ideal case. The earth, apart from being oblate, has discontinuities present on its surface such as mountains, shelfs, plains and internal irregular mass distribution. It being unsymmetrical, its axis of spinning changes and so it not only spins but also revolves; the process is called precession. It behaves just as a spinning top having one side of it more heavy (Fig. 1b).

Such a precession of the earth's axis, on the surface of the earth called the wandering of poles (as the poles of spinning axis rotate about the geographical poles of the earth) [Fig. 1.(e)], was calculated in 1765 by Eular, the great mathematician. Called as Eular's nutation, he calculated the period of polar motion of the earth as about ten months. However in 1859 Chandler in actuality observed it using the 'variation of earth's latitude' technique; its period was found to be much more, about 14 months. Morever the fluctuations in the period are of the order of four per cent, which could not be attributed to some natural cycle occurring in and about the earth. Also, as could be imagined, the motion traced out by pole, say, north, about the north geographical pole has to be a circle (Fig. 1 e), which, observationally, it is not. The trace of the polar motion



"Our town falls on seismographic line. Please, Sir, don't make an earth-shaking speech."

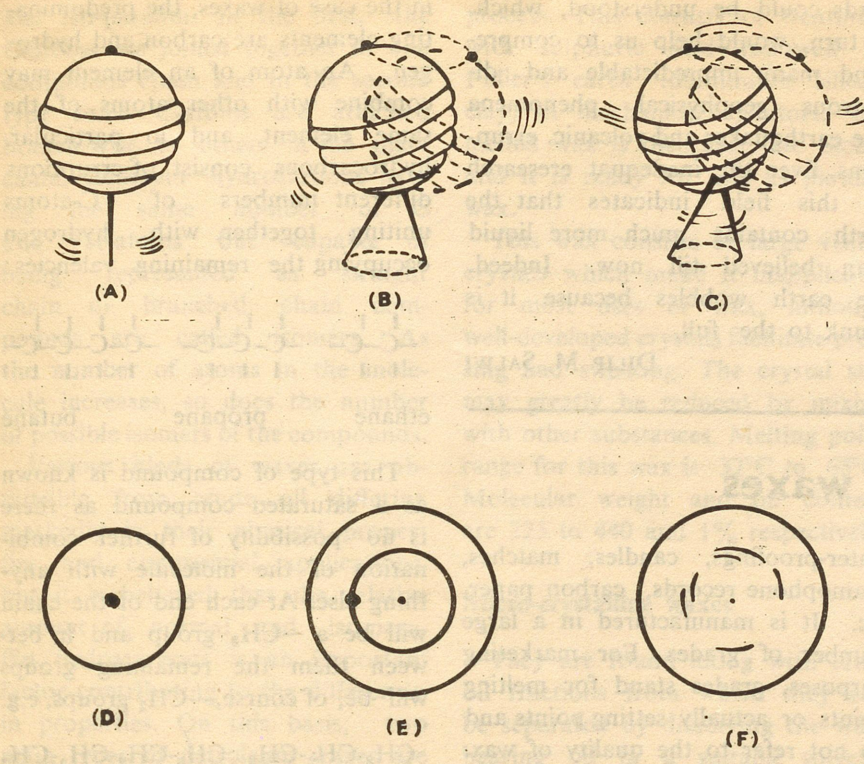


Fig. 1

is as shown in Fig. 1(f), comprising of many arcs with different centres. Apparently, the poles are being randomly jerked –literally. This is a clear indication of the fact that many other irregular or may be regularly irregular forces also influence the wobble and so it is not as simple as it was first imagined.

The causes for the jerks, now detected, are both inside and outside the earth. The earth, it is now firmly believed, contains lot of liquid and is enveloped in atmosphere, both acting as viscous fluids. When any phenomenon excites the spinning earth, it, having got excited (to say simply, disturbed), changes the period of wobble; but what results due to its liquid inside and air outside, is of more complex nature. Like the pendulum, which when once excited to oscillate gradually slows down due to the viscous damping of the air around, the earth too, after excitation, is damped—and that makes its wobbling more complicated and puzzling.

The recent study on the cause of wobbling by Richard J. O'Connell and Adam M. Dziewonski was based on 234 large earthquakes that occurred in the period 1901 to 1970. The amplitude of the earth's wobble changed in this period was very large in 1910; fairly uniformly decreased from 1910 to 1920; then till 1940 remained small but nearly constant; increased thereafter to reach a maximum in 1954; and since then is declining irregularly. What O'Connell and Dziewonski did was to calculate the synthetic Chandler wobble over the 70 year period based on the current earth models and data of the timings, location and strengths of large earthquakes which occurred during the period. A comparison between this synthetic wobble and the actual wobble observed in the period indicated that though they do not tally exactly, they "exhibit a similar order of complexity". This is quite a convincing agreement, as it has been observed that the effect of large earthquakes on wobbling is unpredictable; it can decrease or increase the amplitude of wobble.

The concept that earthquakes must be affecting the wobble is certainly not a novel one. Much earlier when it was first proposed it was ruled out on the ground that a single earthquake cannot affect, or contribute to, the wobble. Interest in this concept was, however, triggered off by the work of D. E. Smylia and L. Mansinha, who found evidence suggestive of a correlation between the earthquakes and the wobble period. The strongest objection to this concept was the observation that on occasions it was observed that the wobble-amplitude of the earth changed before an earthquake took place. An example of this is the earthquake at Chile in 1960, in which a few minutes before its occurrence the wobble amplitude changed. O'Connell and Dziewonski have found a solution to this puzzle.

'Silent earthquakes', also called aseismic events, they claim, are happening inside the earth, of which only recently geophysicists are becoming aware. These aseismic events, it is claimed, are more frequent than previously believed. They, however, bring about similar effects —all internally, what an otherwise normal earthquake produces externally as well. Substantial evidence of such silent earthquakes has not appeared in the literature but two researchers, J. N. Brune and G. F. Davies, have on their basis calculated accurate plate tectonic displacement rates which arise at converging boundary plates.

To conclude, O'Connell and Dziewonski claim that the Chandler wobble is caused partly by the cumulative effect of large earthquakes and partly by the earth's atmosphere; other minor variations may arise from oceans, moon's destabilising gravity torque, core-mantle interactions, etc.

Why one needs to know about the Chandler wobble? As mentioned above, that once the wobble is excited by a disturbance on or inside the earth, the earth is damped internally. So by studying the wobble, much about the earth's innards could be understood, which, in turn, would help us to comprehend many unpredictable and disastrous geophysical phenomena like earthquakes and volcanic. erruptions. Even the inadequat eresearch in this field indicates that the earth contains much more liquid than believed till now. Indeed, the earth wobbles because it is drunk to the full.

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Petroleum waxes

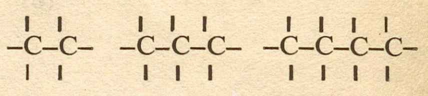
THE great industrial development of the present day depends on the ever-increasing extent of the application of scientific knowledge and the scientific methods of control over the operations of manufacturing processes. New industries often owe their existence entirely to the result of scientific researches which, in many cases, at the time they were carried out, gave no indication of their future great commercial value. The researches which are of great scientific importance and interest may not have any obvious bearing on the problems of manufacture and applications.

Wax is an important petroleum product manufactured in the country and marketed both at home and abroad. It occurs in most crude oils in dissolved state and hence its presence is not obvious at ordinary temperatures, but as the temperature falls during refining of oil, the wax begins to separate out. This temperature is largely governed by wax contents in crude oil; the greater the amount of wax, the higher is this temperature. After separation from oil, wax constitutes a valuable and interesting product in its own right, with special qualifications for a number of important uses, e.g., boot polishes, cosmetics, electrical insulators, water-proofings, candles, matches, gramophone records, carbon paper, etc. It is manufactured in a large number of grades. For marketing purposes, grades stand for melting points or actually setting points and do not refer to the quality of wax. Waxes having melting points ranging from 37°C to 93°C are commercially available.

Waxes melting above 49°C may be made practically free from oil and are semi-transparent, colourless and odourless. At ordinary temperature waxes of these grades are hard and frequently brittle, but on warming they become progressively softer and more plastic, finally melting into a thin clear liquid. The presence of small quantity of oil, due to insufficient refining, greatly affects certain properties. Such wax easily discolours when exposed to light and, with as little as 5% oil, is much reduced in mechanical strength, becoming easily crushable to a fine powder. The lower melting grades, 37°C to 49°C, usually contain oil and are more or less yellow. Wax of this kind is soft and plastic at ordinary temperatures.

Chemistry of petroleum waxes

All materials found in nature are formed due to combination of atoms of various chemical elements and, in the case of waxes, the predominating elements are carbon and hydrogen. An atom of an element may combine with other atoms of the same element, and in particular, hydrocarbons consist of crruptions different numbers of C-atoms uniting together, with hydrogen occupying the remaining valencies:



ethane propane butane

This type of compound is known as a saturated compound as there is no possibility of further combination of the molecule with anything else. At each end of the chain will be a —CH_3 group and in between them the remaining groups will be, of course,—CH_2 groups, e.g.

CH_3-CH_2-CH_3 — propane

CH_3-CH_2-CH_2-CH_3 — butane

The whole series of such hydrocarbons is known as the paraffin series or alkane series having the general formula, C_nH_{2n+2}, where n=1, 2,... etc.

Waxes are essentially mixtures of hydrocarbons which are all members of only one family—the paraffin series. The simplest member of this series is a gas, methane (CH_4), but the more complicated ones are successively liquids and then solids as the number of carbon and hydrogen atoms per molecule increases progressively. Paraffin waxes are high molecular weight members of this series.

Petroleum wax is principally a mixture of solid paraffins, the number and nature of which have a considerable effect on the properties of the mixture. For a given composition, a number of different paraffin hydrocarbons exist, dependting on the manner in which the component atoms of carbon and hydrogen are linked together. These fall into two broad classes—normal, and iso-paraffin. In the first, the C-atoms are joined together in one continuous chain and in the second type some C-atoms are attached branch-wise to others in the main chain. Different hydrocarbons having the same number of C and H-atoms but capable of being represented as straight chain or branched chain compounds are called isomers. As the number of atoms in the molecule increases, so does the number of possible isomers of the compounds.

Various kinds of waxes are obtainable from crude oil differing markedly in their physical properties and commercial applications, but it is believed that the relative amount of normal and iso-paraffin hydrocarbons is an important factor contributing to the differences in properties. On this basis, two main types of petroleum waxes are commonly recognized.

Paraffin waxes

When crude oil containing wax is distilled, a good deal of wax distills over. The lube-oil fractions and the wax distillate so obtained is chilled to a lower temperature, viz., 30°C. It is then allowed to filter through a large filter press. Filter cakes so obtained constitute crude waxes but they still contain 10%-40% oil which has to be removed. The crude wax is melted and allowed to settle by floating on the surface of hot water. The rate at which the wax cools is of importance, as the slower the cooling, the better the development of crystalline structure and the more easily can the oil flow away from interstices between the crystals in the sweating process. Thereafter, the slack wax is stored in the form of slabs in a room, the temperature of which can be slowly raised, at the rate of 1° C per hour. The sweated wax is still not quite colourless and is therefore subjected to refining process. This consists of treatment with sulphuric acid followed by Fuller's earth (aluminium silicate clay) in mechanical agitators. The melted wax is then cast into blocks and it is ready for sale as paraffin wax.

This wax consists of large visible crystals which make it inapplicable for most uses of wax, although well-developed crystals facilitate pressing and sweating. The crystal size may greatly be reduced by mixing with other substances. Melting point range for this wax is 32°C to 65°C. Molecular weight and oil content are 225 to 440 and 1% respectively.

Micro-crystalline waxes

They are found along with lube-oil fractions from which they can be separated by dissolving the wax-bearing oil in a suitable solvent, e.g., dichloroethylene, propane, etc., and refrigerating the mixture to a lower temperature at which the solvent power of oil which is itself an excellent solvent for wax falls off quickly and wax separates out as clouds of small crystals. Now, separation is done either by filtration or centrifuge in an instrument just like the cream separator in which oil solution behaves as milk and wax as a cream. After separation the solvent has to be removed by distillation. Micro-crystalline waxes may contain additives such as polybutenes which partly inhibit crystalline growth and tend to increase plasticity.

They are less volatile, usually made up of much smaller crystals and are considered to contain a large number of iso rather than n-paraffins. They are generally more opaque than paraffin and may vary from soft and plastic to hard and brittle and from white to dark brown in colour. They have m.p. range and molecular weight 65°C to 98°C and 450 gm to 1000 gm respectively. They usually have appreciable quantity of oil, sometimes upto 15%. It should be noted here that the highest m.p. waxes of this class could be made only from tank bottom.

Finally all types of waxes are melted and then cast into blocks when they are cold, and when completely solidified they are packed for transport.

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Cyclic adenosine 3′:5′ monophosphate and brain function

THE discovery of cyclic adenosine 3′ : 5′ monophosphate widely known as cyclic AMP (c-AMP) and an appreciation of its biological significance grew out of the classical work of E. W. Sutherland and his collaborators (1951-1957) on the hormonal stimulation of glycogenolysis. Soon after this discovery, neuroscientists, in the last few years, have turned their serious attention to this elusive molecule which may provide an important key for explaining many of the unsolved phenomena in brain regulation. A. L. Goldberg and co-workers (1959) investigated the possibility that c-AMP is involved in the release of neurotransmitters, because of the fact that : (i) the enzyme adenylcyclase (catalyses the formation of c-AMP from ATP) and phosphodiesterase (catalyses the hydrolysis of c-AMP to 5′-AMP) are found in high concentration in brain and on differential centrifugation they are primarily present in that fraction containing synaptic membrane; (ii) evidences suggest that the release of neurotransmitters and the release of intracellular packets from exocrine and endocrine tissue may occur through similar mechanism; (iii) much of our knowledge of synaptic mechanism has been obtained through studies of transmission at the neuromuscular function. It is well established that catecholamines facilitate neuromuscular transmission by promoting the release of acetylcholine from motor neuron.

Role of c-AMP in metabolism

Of recent interest the following metabolic roles of c-AMP are fairly known.

(i) Histone phosphorylation and neuronal function,(ii) Glycogen metabolism, and (iii) Pineal gland function. Much evidence has accumulated to support the idea that the formation of long-term memory requires the synthesis of RNA and protein (E. Glassman, 1969). The general scheme for regulation of RNA and protein synthesis may operate in brain also, with the hormone replaced by a neurotransmitter. In neurons, c-AMP generated by neurotransmitters might induce specific synthesis of proteins needed to form more efficient synaptic connection. According to this view, some of c-AMP generated by the neurotransmitter

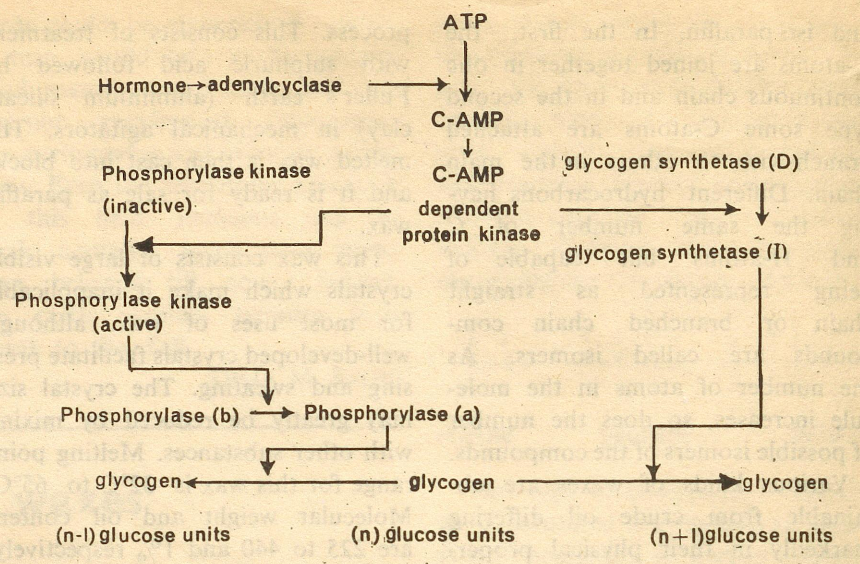

Fig. 1

would find its way to the nucleus, resulting in the phosphorylation of histone and the synthesis of specific RNA and protein, while the more immediate effects of the transmitter, such as impulse generation and the changes upon which short-term memory depends would be mediated by interactions of c-AMP or neurotransmitter with some pre-existing component of the synaptic structure. In this way, the use of a synapse would result in the synthesis of proteins required for permanent facilitation of transmission across that synapse. c-AMP plays a dual role in glycogen metabolism and possibilly all biochemical effects of c-AMP are mediated via protein kinase activity (Fig .1)

Glycogen is hydrolysed to G-I-P by the enzyme phosphorylase, which exists in two forms b and a. Phosphorylase b is converted into phosphorylase a by an enzyme phosphorylase kinase, which exists in two forms, active and inactive. A c-AMP dependent protein kinase has been shown to activate phosphorylase kinase. In contrast to glycogen breakdown, glycogen synthesis is dependent on an enzyme glycogen synthetase, which also exists in two forms inactive (D) and active (I). The same c-AMP dependent protein kinase catalyses phosphorylation of glycogen synthetase to an inactive form. Glycogen synthesis is shut off as soon as glycogen breakdown is commenced. On the other hand glycogen breakdown ceases when c-AMP concentration decreases with an accompanying dephosphorylation of phosphorylase and synthetase I by an enzyme phosphatase, which also requires c-AMP for its activity.

Recent studies of potential role of c-AMP in pineal function have been well described. The addition of Norepinephrine (NE) to rat pineal organs cultured with C^{14}-tryptophan resulted in increased levels of C^{14}-tryptophan, and C^{14}-protein within the gland as well as increased secretion of C^{14}-hydroxy tryptamine, C^{14}-melatonin, and C^{14}-hydroxy indole acetic acid (HIAA) into the medium. Dibutyrl c-AMP (DBC) enhanced the effects of NE on the release of radioactive indoles into the medium, but it did not enhance the uptake or incorporation of C^{14}-tryptophan into protein. Alpha-adrenergic blocking agents, such as dibenzylene, had no effect on either action of NE. However, the effects of NE, but not the DBC on pineal indole synthesis is blocked by beta-adrenergic blocking agents, such as propanolol NE apparently acts on two receptors in the plasma membrane of the pineal parenchymal cell; (i) it stimulates tryptophan transport into the cell, (ii) it enhances the activity of adenylcylase and thereby stimulates the synthesis of c-AMP. This c-AMP acts at one or more undefined intracellular loci to acclerate the formation of serotonin and melatonin. Thus the factors which control melatonin synthesis are important for the pigmentation of skin, pituitary gonadal function, sexualy maturation, ovarian growth and cyclicity.

c-AMP and current developments

Of current interest in the c-AMP research in brain regulation, mention may be made of two important developments, viz., (i) whether specific hormone receptors and the enzyme adenylcylase are components of a single molecule as suggested in an earlier hypothesis by G.A Robison (1967, 1969) that hormone receptors are part of a "regulatory sub-unit" of adenylcylase; and (ii) involvement of c-AMP with behavioral disorders related to manic and affective illnesses.

Outstanding work of different group of investigators [G.A. Robison, E.W. Sutherland and other, (1970); O.M. Rosen and S.M. Rosen (1970); B. Weiss and co-workers (1970)] gives a suggestive evidence that receptors and adenylcylase are not necessarily a part of the same molecule.

c-AMP has been implicated as a possible mediator of behavioral changes. Semi-micro injection of dibutyryl c-AMP (DBC) into various areas of brain produce different behavioral changes. Thus injection of DBC into lateral ventricles of cat brain produces a syndrome of agitation and hyper-excitability. When injected into mesencephalic reticular formation it produces catatonic-like state. Unlike c-AMP, DBC when injected is not destroyed by phosphodiesterase which is abundant in all regions of the brain except cerebellum, where c-AMP produces some effect as DBC. The effect of DBC cannot be blocked by pre-injecting animals with reserpine (which blocks NE stores in nerve cells) or chlorpromazine (which blocks adrenergic receptor sites) indicating that the effects are not adrenergically mediated. Measurements of endogenous level of tissue c-AMP showed interesting results. Abdulla and Hamada (1970) confirmed the finding that urinary excretion of c-AMP in mania is elevated while in depression the level is markedly diminished. Patients treated with L-dopa showed dose-related increase in c-AMP excretion in association with clinical change. It has been claimed that imipramine, amitryptyline, and nortryptyline might improve the level of c-AMP by inhibiting brain phosphodiesterase activity. It has been pointed out that changes in urinary c-AMP are associated with the 'Switch process' from depression to an agitated manic state. This specific psychobiological process in accompanied by a rapid and profound change in mood, behaviour, thought content which probably reflects sudden marked alterations in brain metabolism.

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Food cooking by microwaves

We are constantly exposed to the electromagnetic radiation coming from various sources like broadcasting and radar. Since World War II, researchers have been attempting to find out the ill-effects of electromagnetic radiation on human health.

Since 1946 the microwave heating is being successfully used in diathermy, a technique used for providing therapeutic heating to tissues by the conversion of physical forms of energy like ultrasound, electromagnetic shortwaves, or microwaves into heat after being transmitted to deep tissues and fatty layers beneath the skin. The technique has been used in physical medicine from the time physical energy sources have been available to man. Meanwhile, this process of microwave heating appeared in the form of a spohisticated new kitchen appliance, the microwave oven. Now, housewives can utilize this microwave appliance in kitchens. Today, Japan is producing more than 800,000 microwave ovens in a year.

In conventional heating the material to be cooked is kept in a metallic pot and the pot is heated. Heat is transferred to the surface of the material by conduction, convection and/or radiation, and into the interior by thermal conduction. In this process a large amount of heat is wasted in heating the pot.

Moreover it takes long time to cook. On the other hand, in the microwave heating the heat is generated directly inside the material. Therefore, the temperature rises fast to cook the food.

The application of microwave energy for diathermy and cooking is dependent on three variables; radiation intensity, frequency, and the molecular characteristics of the irradiated material. For example, water absorbs incident microwave energy readily converting it into heat.

On an atomic scale, water molecules are actually tiny electric dipoles (an electric dipole is a combination of two equal point charges of opposite signs separated by a small distance) that attempt to align themselves with the rapidly oscillating microwave field. This continuous molecular movement (kinetic energy) produces extensive, increased collisions (friction) between adjacent water molecules and thus heating the entire medium.

Other common substances such as glass, ceramics, chinaware, plastics and paper are transparent to microwave as their molecules are electrically neutral at all points. Microwave ovens are much more efficient than standard ranges because of the "molecular discrimination". Energy is spent only in heating the food which typically has a high water content, while containers, cookware and even the oven's reflective metal walls remain cool.

Microwave oven

The microwave oven is simply a chamber connected through a waveguide to a high power microwave generator, the magnetron. A glass plate is fixed on which the food to be cooked is kept. The microwaves generated by the magnetron at a frequency of 2450 MHz enter the chamber via waveguide system. At the entrance of the chamber the mode stirrer breaks up microwave radiation in such, a way that all parts of the oven cavity, and therefore the food, are evenly irradiated. The internal surfaces of the chamber walls also reflect the microwave energy incident on them, and hence all the microwave energy is absorbed by the food. The magnetron is either 'on' delivering full rated output to the oven cavity or it is 'off'. Essentially all the available microwave energy is absorbed by the food regardless of size. For example, two potatoes will take about twice as long to cook as one potato.

The operating frequency affects the depths of tissue or food penetration at which microwave energy can produce heating. The majority of microwave ovens now being manufactured and used operate at 2450 MHz. Originally this frequency was assigned to diathermy equipment in 1946 due to its claimed superior therapeutic value.

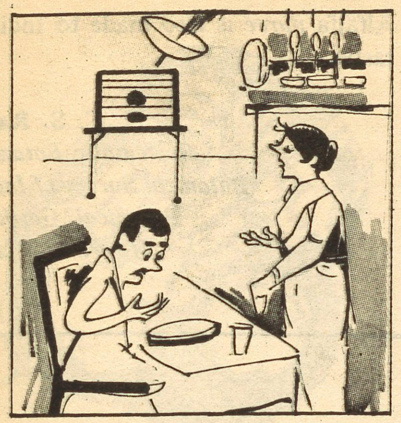
Recently, Dr. A.W. Guy and his colleagues of the University of Washington School of Medicine, USA, criticised the use of microwave fequency of 2450 MHz while discussing the Therapeutic Applications of Electromagnetic Power as "....a classic example of how the historic lack of engineering in medicine has prolongated ill conceived practices, not only in medicine, but also in non-related industrial applications....the frequency be changed to 900 MHz or less" (*Proceedings of IEEE*, Vol. 62, No. 1, pp. 55-75, January 1974). Unfortunately, the lower frequency equipment with sufficient power is not commercially available at present.

Processing requirements

Before selecting the food to be cooked by microwave heating a lot of information about it is needed. All food materials are dielectric (insulator) in nature. A dielectric is a non-conductor of electricity and is a substance in which an electric field gives rise to no net flow of electric charges but only to a displacement of charges. Therefore a parameter known as dielectric constant, which is a measure of insulation, is an important quantity. The dielectric heating, a form of heating in which electrically insulating material, which may be food, is heated by being subjected to an alternating electric field (which may arise from microwaves), which results from energy being lost by the field to electrons within the atoms and molecules of the material. A higher loss of electromagnetic energy within the dielectric material produces higher rise in temperature. If the dielectric constant of the food material is high, it will absorb more incident power and better results will be obtained. But dielectric constant is not the only decisive factor as the dielectric properties of food material are greatly affected by frequency, temperature, composition, and to some extent, by orientation in the field. The electromagnetic waves incident on the surface of the food material are attenuated exponentially. The penetration depth, the distance from the surface where the power of the wave has decreased to 0.37 of the surface value, is an important quantity. The greater the penetration depth the higher will be the energy produced. At a low temperature the penetration depth is high. At higher frequencies the dielectric loss is low but the low electric field results in a high rise of temperature. Hence, the proper compromise of frequency, temperature, design of the oven and the field strengths is needed beforehand. Also, it is necessary to know the dielectric properties of food materials if it is desired to heat mixtures of food materials.

Food processing results

Many promising results of food processing by microwave heating are



"Take it easy, Dear. The food is not fully cooked today because the microwaves were interrupted by clouds while I was cooking"

available. In many cases the technique has been industrialised. It often takes several days to thaw frozen foods in bulk at cold stoiage temperatures. The usual heating techniques pose dangers of contamination. To solve this problem microwave dielecric heating has some value. For thawing fish, meat, etc., treatment times of less than one minute have been reported at capacities of 1/2 ton/hour with the processing cost below one paisa per kilogram for a 10 kilowatt plant. With such a plant the reduction in processing time by 75% and reduction in weight loss by 5%-10% has been achieved corresponding to a cost saving of about 35 paisa per kilogram. Now microwave heating is used in preparing meat patties and instant rice. This technique is economically advantageous, for it gives fat of better quality than is possible by conventional heating.

Pasteurisation destroys vegetative microorganisms and heat labile-spores. Pasteurisation by microwave heating for 2-3 min. after packaging of sliced bread and cakes to a final temperature of around 65°C -70°C reduces mold infection and increases shelf life. One such industrial plant for microwave bread pasteurisation has been installed in a Swedish bakery. Good experimental results are available for microwave pasteurisation of ham. In laboratories, pasteurisation of milk, beer, and other nonviscous beverages is common. Laboratory scale experiments to kill all pathogenic bacterial spores in food packed in plastic pouches using microwave heating improved the flavour qualtity of foods. The microwave blanching of potatoes and a range of vegetables also improves their flavour. However, the microwave heating for this purpose cannot compete economically with the very efficient conventional heating methods.

The best known and largest commercial application of microwaves is the frying of potato chips. There are more than 20 industries for it in the United States. The reason for its success is that lower quality potatoes can be used which, otherwise, show brown discoloration. The process has improved the storage life of potatoes also. Another development is the microwave dehydration of fruit juices and fats. With microwave heating the moisture level can be reduced to 3% in 25 min. It is interesting that the quality of the fruit juices is markedly improved.

Through microwave dielectric heating baking time for bread has been reduced to minutes. However, for baking, microwave heating is more expensive than conventional baking. But this should be weighed against the reductions of baking time and saving of floor space together with a slightly larger bread volume. Microwave heating has considerable potential for high temperature, short time sterilisation of foods. It provides biological stability with improved quality compared to presently available sterilization methods for solid piece food materials.

As heat is generated directly inside the food material itself, the advantages with dielectric heating alone or in combination with other heating methods are that very fast heating in depth is possible. Microwave heating leads to improved yield and quality. In addition, the process is compact, flexible and well suited for continuous and automated heating lines. Rapid heating through insulating packaging is possible and sometimes advantageous.

Indian perspective

Food cooking by microwave heating in Indian conditions is very uneconomical, for it reduces drastically the manpower needed. The initial installation cost is also very high. Microwave ovens are very costly. The most important factor which keeps the microwave oven away from Indian kitchens is that a lot of data are needed for cooking the mixture of vegetables with salt and 'masalas' in a wide range of combinations.

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All about alfalfa

ALFALFA the world's foremost forage crop is also a homoeopathic tonic. Popularly known as 'Lucerne' the plant was called Haliss by the ancient Greeks. Fifty million acres are under alfalfa all over the world, but in India it is confined to military farms only.

Botanically alfalfa is *Medicago sativa* Linn. It belongs to family *Leguminosae* of pulses like clover, berseem and indigo plants. The shoots are erect and have foliage resembling *methi* and purple flowered racemes. The pods are spirally coiled up bearing kidney-shaped seeds. There are many varieties and taxonomi cally recognisable entities which go under the name of alfalfa.

Alfalfa plant prefers neutral or slightly alkaline soil. It requires more moisture than barley and wheat. In cultivation, the lucerne fields are flooded once a month and tops harvested once in 30-40 days. The seeds of lucerne are hard and should be scarified or kept in dry heat of 35° C for one hour before sowing at a rate of 5 kg/acre. When grown for the first time they should be inoculated with rhizobium.

Chemical constituents of alfalfa give us an idea of its nutritional value as feed. Lucerne contains crude protein 19.3%, calcium 1.6%, phosphorus 0.26%, copper 6.2, magnesium 0.06, iron upto 0.16, cobalt 0.14, zinc and selenium 8 ppm on dry weight basis per pound.

Alfalfa also contains vitamins B_1 B_2 niacin, choline, folic acid, tocopherol and estrogens in sufficient quantities to meet the needs of cattle and men.

Alfalfa hay proteins are comparable to whole egg proteins with amino acids essential for human health. Arginine, histidine, isolucine, lysine, phenylalanine, threonine, tryptophan, valine and cystine found in alfalfa make it a natural tonic. As it is protein rich cattle should be fed only prescribed quantities. Green shoots are fed to dairy cattle, horses and sheep. It is given in pellet form to swine and poultry. One interesting use of alfalfa is to prevent scale formation in metallic containers employed in industry.

Lucerne can also be cooked as a vegetable and is relishable like *methi.* About 50 gm of cooked alfalfa can be taken in diet every day. The herb should be blanched in boiling water and chopped before serving. In Argentina, the Institute of Nutrition developed 'alfalfa tortilla', fruit saute, croquets and souffu. Alfalfa *puree* is also made to Indian tastes.

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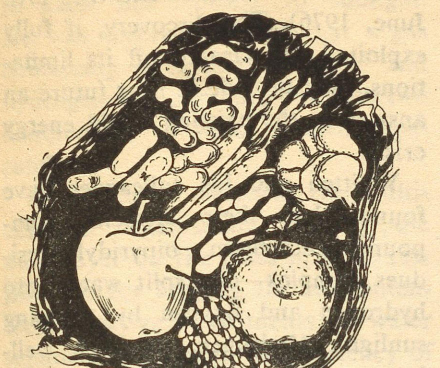
The hazards of natural foods

THE plants are endowed with the genetically determined capacity to synthesize a wide variety of chemical substances which are distributed in the various parts of the plant, i.e., root, stem, leaves, flowers, fruits, and seeds as their natural constituents. The dietary value of a plant depends upon its chemical constituents. The plants which have naturally occurring toxic substance are of little value as food and, therefore, are avoided by man and animals. Plants rich in useful ingredients have come into use as foodstuff as a result of human experience since antiquity. The primitive man learnt to avoid the use of plants which produced immediate and unpleasant reactions. Animals also learnt to avoid such plants as a result of experience and instinctive behaviour. The plant foodstuff which however proved harmless came into use by the human beings for several hundred years to evolve into the present day foodstuff combinations.

Here we may think that whatever we eat is safe for us. But researches have proved that even the plant foods which are among the most commonly used may have toxic ingredients in them. However, most toxic ingredients may not produce an immediate violent reaction but may act like a slow, cumulative poison resulting in a disease or affecting normal health. Although the problem of toxicity to man by such constituents is not at times fully appreciated, it has been found that extracts of such plant foodstuff produce harmful effects in laboratory animals. These harmful chemical substances have been extracted from our favourite and delicious vegetables, fruits and cereals, and have been put into various groups on the basis of their physiological properties. These groups are protease inhibitors, hemmagglutinins, goitrogens, cyanogens, cycads, saponins, gossypols, lathyrogens, and allergens. The protease inhibitors are found in seeds of various leguminous plants such as soyabeans and also in other seeds like groundnut, *mung*, rice and wheat. The soyabean protease inhibitors are known to inhibit trypsin enzyme found in the stomach. On experimental animals this has an effect of retarding growth rate and body weight. However, most of the protease inhibitor of soyabean is destroyed by heating or cooking. Hemmaglutinins found in castor seeds have been used as a purgative for long. The castor seed or its oil has the property to agglutinate or clump the blood cells. The cyanogens are glycosides which on hydrolysis yield toxic hydrocyanic acid. The most common glycoside is amygdalin found in almonds; the



bitter almonds are its richest source and hence may prove fatal if consumed in a large enough quantity. A number of deaths in children due to eating bitter almonds have been reported from many countries. The Kola bear found on the tip of eucalyptus trees in Austrialia avoids the use of those leaves which are rich in hydrocyanic acid. And it eats selectively fresh and young leaves which have little or no cyanogen. Cyanogens are also found in other common foodstuffs such as sweet-potato, maize, beans, apples, sugarcane and oranges. Cycads, saponins and gossypols are, however, among the less important toxic ingredients.

The most important toxic ingredients are lathyrogens because several outbreaks of lathyrism in India have been reported from Madhya Pradesh, specially during famine due to abnormal consumption of the lathyrus (commonly known as *khesari dal*). The substance responsible for lathyrism has been identified as an amino acid. The goitrogens are found in the members of the genus Brassica; for example, radish, cabbage, and mustard are among the chief sources of goitrogens. Animals fed on mustard seeds have been found to develop goitre. In Tasmania people who drank unboiled milk from the cows fed on Brassica plants have developed goitre. The goitrogens are known to reduce the iodine absorption capacity of the thyroids.

Several other examples of toxic substances occur naturally in plant foodstuff. Among them, the solanine alkaloids found in potatoes have caused many cases of human poisoning specially under circumstances of unusual consumption involving the potato eyes and skin. Solanine of potato is known to increase if freshly harvested potatoes are kept in open sunlight. Potatoes with solanine concentration above 0.1% are unfit for human consumption. In unripe grapes a glycoside naringen is found which is irritating to gastrointestinal tract. Tomatoes contain a hydrocarbon lycopene related to carotene. Long term consumption of large quantities of tomato juice is known to result in lycopene accumulation in the liver and cause illness in man. The presence of a toxic ingredient in onions has also been reported. It has been observed that raw or cooked onions fed to dogs lead to severe anaemia. It is very likely that people would develop anaemia if they consume 350 gm of onions a day.

In certain circumstances accidental feeding by cattle on certain harmful plants may make their milk fatally injurious. It is reported that Abraham Lincoln's mother died due to consumption of milk from a cow that had eaten white snakeroot (*Apolopapus heterophyllus*). It contains the poisonous unsaturated alcohol, tremetol.

It is clear that we are surrounded by poisons which may be in our foods and in our environment. It must be borne in mind that a biologically important substance is useful to only certain limits of consumption and becomes toxic or harmful when it crosses the threshold limit. So, one should not be ordinarily worried about his food. One should, however, avoid taking too much of any particular article in the food. Today, scientists have started thinking that a good many human problems related to old age and health can possibly be correlated to one's dietary habits. Scientists believe that the same attention should be given to harmful chemical substances that occur naturally in plant food as is given to the additives and pesticidal residues in food.

ZAKA IMAM

Case of male pregnancy

THE burden of bearing and rearing the offspring rests with the female of the species, especially in the advanced groups of the animal kingdom like the mammals. In lower orders the responsibility of females is just that of laying eggs in suitable environment. The eggs and young ones are left to the care of nature thereafter. Instances are however known where the parents exhibit remarkable parental care. The most interesting case in fishes is that of "Sea horse" (*Hippocampus*). Here the females are the liberated ones, the males are burdened with the load of pregnancy.

In sea horse, females lay eggs, but the rearing responsibility entirely rests with the males. The male receive the eggs from the female in brood pouches. They, with the enlarged brood pouches, present a picture of being pregnant. The walls of the brood pouch is supplied with blood vessels. The young, when fully developed comes out of the brood pouch by the rupture of its

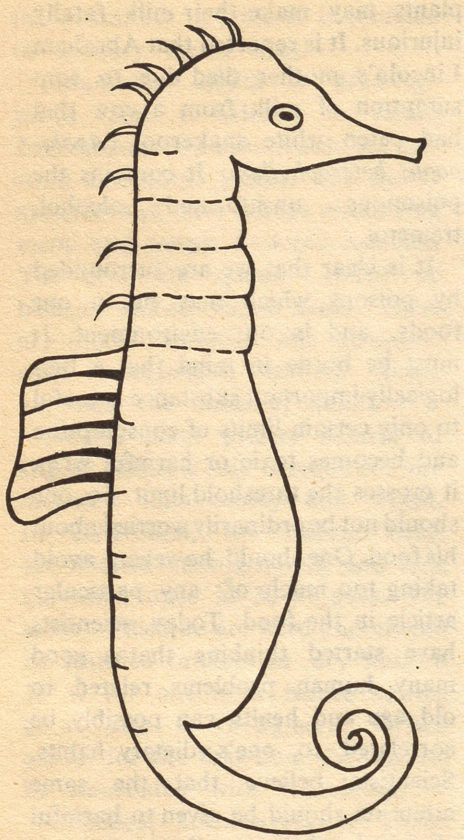


Fig. 1

walls giving a sort of labour pain to their father. No further interest is

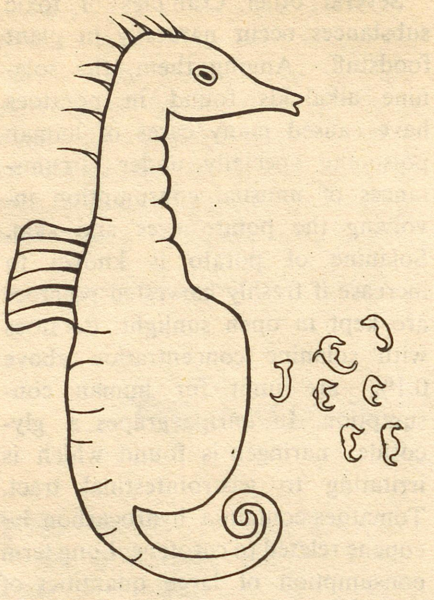


Fig. 2

evinced by the male in the welfare of its young ones A similar phenomenon is also exhibited by Pipe fishes (*Syngnanthus*).

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The rewarding ruthenium

A member of the transition elements, ruthenium has been in news for sometime past. Its complexes have the peculiar characteristic of mimicking natural catalytic systems ; for example, the active centre of chlorophyll molecule which absorbs sunlight and transforms it into energy, and the plant enzyme, nitrogenase, which converts atmospheric nitrogen into ammonia. Recently, a new use of a ruthenium complex has by chance been discovered by David Whitten, Professor of Chemistry at the University of North Carolina, USA (*New Scientist*, 17th June, 1976). The discovery, if fully exploited and cleared off its limitations, may provide in near future an answer to the existing world energy crisis.

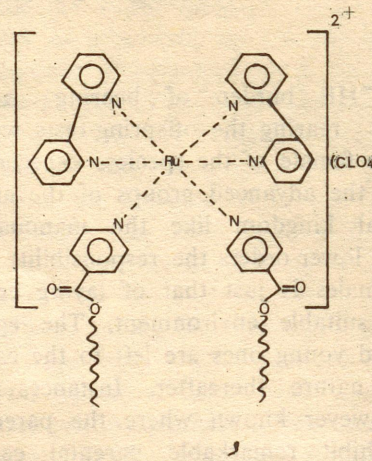

Fig. 1. Ru at centre of complex of bipyridyl residues. The long tails (octadecyl residues) help split water

Whitten and his colleagues have found that their artificial compound—ruthenuim bipyridyl residues complex—can split water into hydrogen and oxygen by trapping sunlight. Hydrogen, as it is well-known, is a promising fuel of the future which on use does not add to the pollution. No economically viable technique is available today for generating hydrogen for fuel purposes.

The ruthenium complex (Fig. 1) has two parts; a bipyridyl residues ring structure with ruthenuim in the centre, and long tails of octadecyl residues or dihydrocholesterol attached to the former. The complex, without long tails attached to it, is an orange/red colour . substance which can absorb visible light at 377 nm and 430 nm wavelengths. When illuminated it fluoresces with a deep red colour. It is because an electron in the ruthenium becomes 'excited' on absorption of light and rises to a higher energy level. When the electron returns back to its original position, it emits light of deep red colour. Since this complex (without long tails) is soluble, it fluoresces continuously when dissolved in water. It means that the light energy which is being absorbed by the complex is also simultaneously being released.

It was here that the element of chance stepped in. Whitten observed that if long tails are tagged onto the ring, the complex becomes insoluble in water and stops fluorescence. However, it develops a new property; the energy which it absorbs from light is no more released but is rather trapped in some way and can split water into its constituents—hydrogen and oxygen. Actually, Whitten had coated the tailed complex on to a glass sheet, placed it in water and exposed to sunlight. He was surprised to see that a gas containing molecular oxygen and hydrogen was bubbling out. The two components of water existed separately.

According to Whitten, the multicomplex organisation forming the monolayer on the glass may be responsible for keeping the two potentially reactive constituents of water separate. Although the efficiency of this system is remarkably high (quantum yield being 10%) which can further be raised by stacking more monolayers one above the other, Whitten clearly confesses, "We do not know how the monolayer will stand up as a practical system; this is a major problem". Then, economic aspect of the system cannot be lost sight of as ruthenium is an expensive metal.

C. B. SHARMA

The "bright spot" in oil exploration

TODAY oil and gas are world's leading sources of energy. But they have first to be found and brought out of the earth to be of use to us. Finding oil and gas has always been a gamble. The geophysicists and geologists play the odds the same way that an insurance company or a gambler does. For some years now oil and gas prospectors have known that about 7 to 8 of the exploratory wells would produce nothing of value and 1 in 25 will produce enough oil to pay for all costs involved. With the passage of time these odds have turned more against oil prospectors, as the easily found oil deposits have all been discovered.

Now a new method is being used to improve oil prospecting. The new technique is called "Bright Spot" technique. It is a direct means of finding oil and gas without drilling a hole. The technique does not take away all the risks of oil prospecting but it does improve the odds considerably.

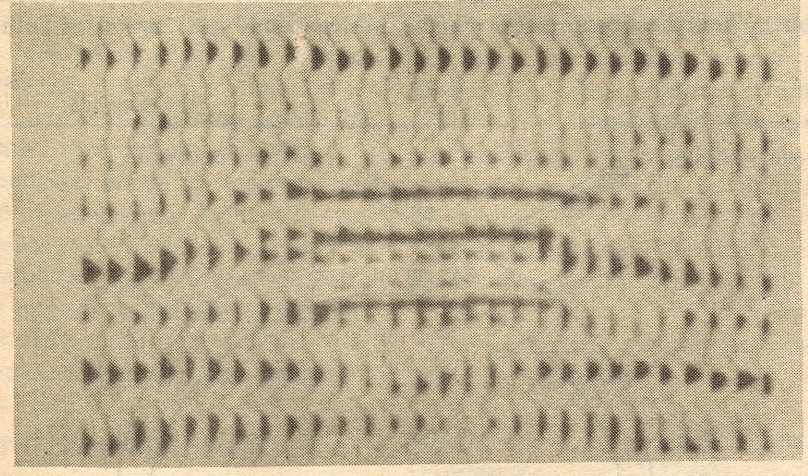

Fig. 1

For nearly 50 years, the standard method of oil prospecting has been based on the seismic reflection. In this method the geophysicist creates a loud sound just below the earth's surface by setting off an explosive charge in a hole or in a body of water. Echoes of this sound return to the surface from various underground rock layers and are picked up by sensitive electronic instruments at the surface.

Complex electronic receivers have been designed to enable geophysicists to detect these echoes and to measure the time taken by them to arrive at the surface. Computers instructed by sophisticated programs translate the reflected signals into pictures of how the earth's rocks would look like if we cut the earth's crust like a layered cake. Such pictures, giving the cross-section of the earth's crust show only the sequence and the shape of the layers. They do not tell us what the layers are made of or what kinds of liquids might be permeating the pores and cracks in the rocks. It is as if we had a line drawing of a layered cake but could not tell which of the layer is chocolate, cake, cream or jam.

From these structural pictures of the layers, geophysicists can make shrewd guesses as to where oil and gas might have accumulated. The maps made by geophysicists from such seismic surveys have over the years improved the driller's odds by a factor of at least 10. With the development of space age electronics in the '60s, it became possible to extract some additional information from the seismic echoes. The new equipment could record the strength as well as the arrival times of the echoes accurately for better interpretation.

Geophysicists have long known or at least strongly suspected that

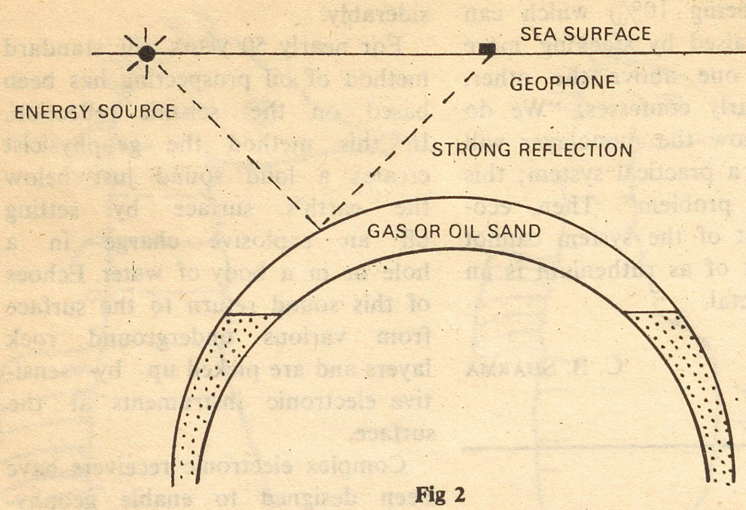

Fig 2

porous rocks, filled with oil or gas, are better reflectors of sound than are the same rocks filled with water.

A sound wave travelling through any medium such as water, air, wood, rocks, etc., continues undisturbed until it reaches some sort of change in the material. When a change of material is reached, a part of sound enters the other material and a part is reflected back. The proportion that enters the second material is the greatest when the two materials are nearly alike. So, in such a case, very little is reflected back. If the two materials are quite different, most of the sound is reflected and very little enters the second material. Sounds in air are strongly reflected by hard walls, cliffs, etc., because they are different from air. Submarine detection by using sound techniques and echosounder works well, because a submarine or the ocean bottom is distinctly different from water and so reflects back most of the sound energy. Sound techniques are also used by submarines to measure the distance from the submarine to the water surface. Because air is different from water, more than 90 per cent of the sound going upward in water is reflected down again. It is this kind of phenomenon which lets geophysicists find oil or gas directly in the earth.

When a geophysicist creates a loud sound pulse in the ground by explosion or some other means, the sound waves travel through many kinds of rocks. But to a sound wave one kind of rock is just like another, so that the geophysicist has to depend on only 1 to 2 per cent of the energy reflected back from a typical change in the type of rock.

Most rocks beneath us are full of empty spaces, e.g., pores between grains in sandstones, cracks and shattered places in limestones. Such pores are invariably filled with some fluid, typically salt water. When the openings are filled with oil or gas, the rocks become a valuable object for our oil technologists. The new technique of bright spot has been able to find these oil or gas-filled rocks and can be relied on.

Some gas-filled porous sandstones are, however, more like gas rather than rock ; they send back very strong echoes. They reflect nearly 50 per cent of the sound energy directed towards them.

While the unusual strength of the reflected signal is a sure sign of gas or even oil, there are other confirming indicators. One is a change in the polarity of reflected waves.

To understand polarity we should examine the nature of sound. A sound in air or rock is a series of compressions and rarefactions of the material in which it travels. The material is alternately squeezed or compressed or stretched or rarefied. When the sound in one medium meets another hard medium, a compression is reflected as compression. On the other hand, when it passes through a softer medium, a compression is reflected back as a rarefaction. This is what we understand by change in polarity. If the geophysicist notes an unusually strong reflection and the reflection is opposite in polarity from those he sees from the nearby rocks, he can be reasonably confident to claim that he has found gas or oil or both.

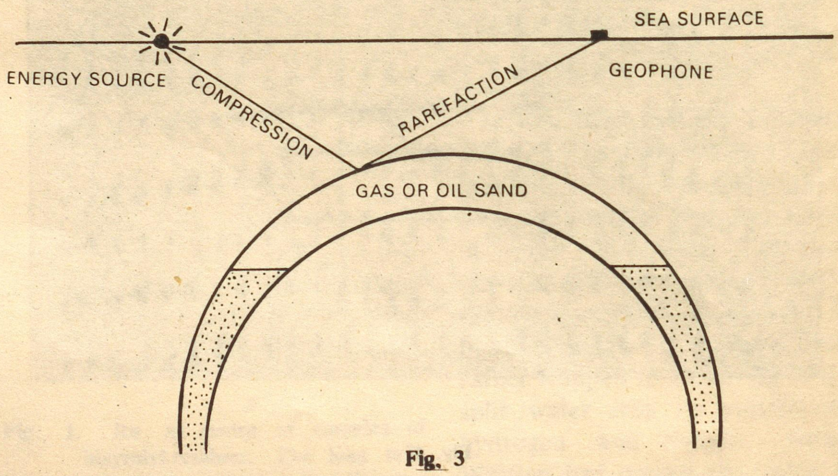

Fig. 3

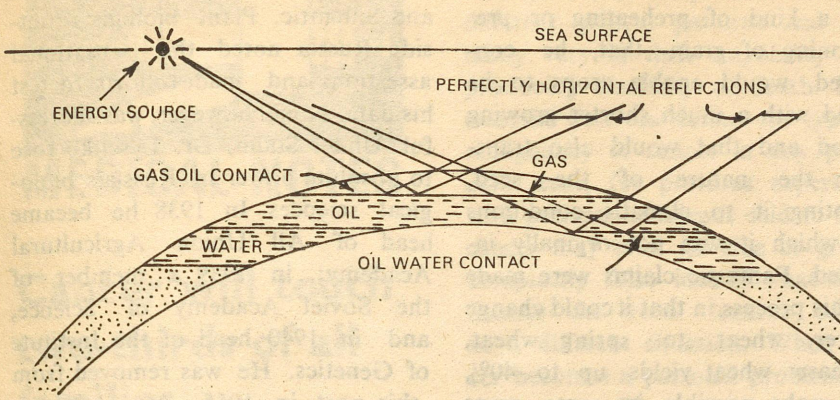

Fig. 4

There is one more characteristic which gives him further confidence. With new instruments and the latest computer programs, he can distinguish between very fine details of reflections. At times he finds a set of reflections which come from a perfectly horizontal surface associated with strong reflections of opposite polarity. Now, in practice, very few geological structures are horizontal, so these horizontal reflections are coming from an interface between two fluids—gas over oil, or gas over water or oil over water. There is no other possibility and the geophysicist is nearly sure of finding oil or gas or both.

The combination of all these three features—a strong reflection, a change in polarity and horizontal reflectors —is a guarantee for the presence of gas or oil. In Fig. 1 all three features are seen in the bright spot in an actual seismic record. In the central portion, which appears more prominent than the rest, we can see that the reflected signal is stronger than nearby reflections. Moreover, the polarity has reversed and the three reflections are nearly horizontal indicating gas-oil and oil-water contacts. The same three factors are explained in Figs. 2, 3 and 4.

Scientists first became interested in the bright spot technique in 1960. They concluded that in the process of removing noise from the reflected signals they were destroying the quality of reflections, specially the amplitudes. In 1966, they introduced recording systems that would preserve the information about the amplitude of the received signals. They developed special computer programs needed for this purpose. The investment and the labour paid off in the development of this reliable method of finding hydrocarbons.

The method is being used in India, too. Geophysicists working in Oil and Natural Gas Commission on land and in offshore areas of India, on the seismic ship *Anveshak*, are now increasingly using this method.

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FOR HER (*Continued from page 193*)

from the surface of the skin, emollients are often added to creams. Spermeceti, cetyl alcohol, vegetable oils and lanolin serve this purpose. Spermeceti, in addition to its emollient effect, makes the cream more opaque and lighter in appearance. 1% cetyl alcohol acts as an emollient and emulsion stabilizer. Care must be taken not to use too much of it, for the cream may soften and become less opaque.

Liquefying cleansing creams

Liquefying anhydrous type of cleansing creams consists of a mixture of oils and waxes designed to liquefy when gently massaged and to cleanse in the same manner as the bees-wax-borax emulsion creams.

The normal creams of this type are translucent in appearance. A more opaque cream can be obtained by adding approximately 2% of zinc oxide, titanium dioxide, magnesium stearate or zinc stearate.

The percentage composition of the cream is as follows :

Mineral oil	65.00	per cent
Petrolatum	12.00	,,
Paraffin	18.00	,,
Cetyl alcohol	1.00	,,
Spermeceti	4.00	,,

Procedure

Melt the waxes first. Add the petrolatum and finally liquid oil. Stir thoroughly, add the perfume at 45°C and pour into jars. The melted product should be strained to remove impurities.

The addition of antiseptics to cleansing creams supports their purpose. Some antiseptics used are 2.2′ dihydroxy, 5.5′ dichloro diphenyl methane and 2.2′ dihydroxy 3.5, 6, 3,′ 5,′ 6′ hexachlorodiphenyl methane.

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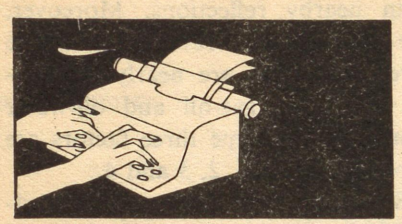

NEWS & NOTES

Agricultural biologist Dr. Lysenko passes away

DR. Trofim D. Lysenko, one of the century's most controversial scientists, whose theories dominated the Soviet natural sciences during the rule of Josef Stalin, died on November 20 at the age of 78. Dr. Lysenko contended that his view that environment could cause hereditary changes in plants was in line with Marxism. Under N.S. Kruschev's rule he was dismissed as President of the Academy of Agricultural Sciences, but made a partial comeback in the latter part of the Krushchev era. After Krushchev's own exit in 1964 Dr. Lysenko headed an experimental research station near Moscow. His argument that hereditary characteristics could be changed by the environment was in direct opposition to the classical view that hereditary characteristics were passed along through genes.

Born on September 29, 1898 at Karlovka in the Ukraine, the son of peasant farmers, young Lysenko studied at the Poltava High School and obtained a degree from Kiev Agricultural Institute in 1925. Since 1928 he was concerned with cultivation of new variety of plant forms at the Kirovbad Experimental Station. His first great scientific discovery was achieved on his father's farm near Poltava where he developed the process he called "yarovzation" or vernalization of grain. The essence of the process was a kind of preheating or preseasoning of grain that, he contended, would enable crops to be raised with a much shorter growing period and that would also transform the nature of the seed, adapting it to climatic conditions for which it was not orginally intended. Fantastic claims were made of this process in that it could change winter wheat to spring wheat, increase wheat yields up to 40% and make possible in some areas the raising of up to five crops of spring wheat a year. It was also claimed that by using Dr. Lysenko's method tropical plants could be made to flower in the Artic and Subantic. Plant biologists outside Russia noted the sensational assertions and made efforts to test his data. None, however, was successful. Under Stalin, Dr. Lysenko rose to absolute power in Russia's biological sciences. In 1938 he became head of All Union Agricultural Academy; in 1939 a member of the Soviet Academy of Science, and in 1940 head of the Institute of Genetics. He was removed from this post in 1965.

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IV International Heat and Mass Transfer conference

(10-12 Nov. 1977)

The Conference is being organised by the University of Roorkee under the auspices of Indian Society of Heat and Mass Transfer.

The Conference hopes to bring together persons working in the field of Heat and Mass Transfer in various industrial organisations, educational institutions and research establishments in the country and abroad to exchange ideas and information, to critically evaluate the present knowledge and to focus attention on new areas of basic and applied research.

Further information may be obtained from Dr. Rajendra Prakash, Professor, Department of Mechanical & Industrial Engineering, University of Roorkee, ROORKEE-247672.

Yant Award for Dr. Zaidi

DR. Sibte H. Zaidi who established the Industrial Toxicology Research Centre at Lucknow in 1965 under the aegis of the Council of Scientific & Industrial Research, New Delhi, is a distinguished toxicologist and a world authority on diseases related to industrial dusts.

1977 Yant Memorial Award—established in honour of William P. Yant, the first President of the American Industrial Hygiene Association, Ohio—would go to Dr. Zaidi. The Award is given to a person living outside U.S.A. who has made significant contributions in the field of industrial hygiene.

Dr. Zaidi has been invited by the Association to receive the Award at its annual conference scheduled to be held at New Orleans, Louisiana, in May 1977 and deliver a lecture on his contribution to the science of industrial hygiene.

ZAKA IMAM

MEDICAL NOTES

Cancer will touch two-thirds of all families

TWO of every three families in the United States and throughout the world will have some personal contact with the cancer problem. The magnitude of this problem is emphasized by looking at the long periods of time which are involved.

First, there is the period of growth of the cancer itself; secondly, the period over which treatment is administered; and finally, the long period of time during which watchful, expectant follow-up is essential. Such follow-up may well involve maintenance of the patient for whom cancer has progressed beyond the point of total eradication. This long period of awareness plus the type of the disea e which seems beyond human capability to prevent it produce complex circumstances. Due to this complexity, the diagnosis of "cancer" is one of the most dreaded pronouncements that can be made by a physician. To lessen the awesome impact of this diagnosis, it is necessary that both patient and family understand many of the truths which are not well publicized.

What is cancer? It is a variety of diseases about which we have much information, but we still know little concerning basic problems of its origin. One or another of the various forms of cancer may occur in any tissue of the body. These various forms may have entirely different growth patterns and certainly vary in their capability for producing disability or death. It is essential that one defines the type of malignancy of cancer in any particular case, for previous experience with patients or friends said to have cancer may offer no clue or give a completely false idea of what significance the word 'cancer' carries in a different situation. When cancer becomes a personal problem one deals not with statistics, but with individuals.

Many forms of cancer are curable. This is especially true of the most common form of cancer, carcinoma of the skin. Yet other forms of cancer arising in the same portion of the body may have different needs for treatment and an entirely different outlook for eventual cure. In many instances, concern may be relieved by adequate information. There are now more than 1,500,000 living Americans who have been cured of cancer. These have been cured by timely action.

If then action should be taken, where to begin? There are the seven danger signals which appear at the end of this article. These are signs which may suggest the presence of cancer and which are of reasonable concern on the part of any individual. We are today curing one out of every three patients who develop cancer. This could be improved to one out of every two by the application of modern techniques of early detection and adequate treatment. We would need no new information about cancer beyond what we already have. In many cases one can achieve a long period of survival, often with long freedom from symptoms, even though complete cure cannot be hoped for. This survival may well be a product of early diagnosis, for the maximum effect of some forms of treatment can be expected when the tumour is still small. The action begins with early suspicion and diagnosis

There are presently many ways of treating cancers and these vary with the type, location, and stage of spread of the cancer. The principal methods of treatment are aimed at destruction of the initial growth. These treatment programs are almost never undertaken without a proven diagnosis of cancer by examination of tissue or cells from the involved portion of the body. Most frequently, this destruction of the tumour is accomplished by surgery, but radiation may achieve the same effect. After selecting the appropriate form of treatment for the initial lesion, the physician may decide to use one of the many drugs or more recently developed methods of increasing the resistance of the patient to cancer. We are now able to employ in many cases combined therapy, which uses more than one of the basic techniques for treating cancer. The effective treatment of a given cancer thus depends on a knowledge of the various available techniques and the use of the appropriate method.

The treatment does not end with a direct attack on the disease itself. Instead, treatment involves a continuing concern for the return of the patient to a useful and effective life pattern. This might appropriately be called the 'quality of survival', and it is of natural concern for the family as well as the physician. Many special techniques of restoration of physical and social activity are available, but it must be remembered, for the patient with cancer the fear of being abandoned is even greater than the fear of death.

The more prevalent forms of cancer are those seen in the late decades of life. But cancer is not confined to older patients. There are types of cancer which occur predominantly in children, and other types which occur principally in young adults. The frequencies of types of cancers vary between man and women. If we are to achieve our goal of improving early diagnosis and cure, risk factors must be identified and made known to the public. The medical profession is actively concerned with public education, and it has made available through the medical society upto date information.

Much has been written about cancer and our environment. There are many new factors being introduced into our environment by modern technology and industry. There are reasonably effective methods for testing the capability of substances to produce cancer. These methods are in constant use by industry, government and various research institutions. The unfortunate thing is that even in the presence of strong cancer producing agents there is still a 15-20 year lapse before that exposure may produce a cancer. Not until ten years after the heavy smoker quits smoking can he or she expect to return to relatively the same risk of cancer as the non-smoker. This same delay is found in many other forms of environmental cancers, and the need for concern is great. Before any great advances in the control of environmental cancers can occur we must have more information about the basic facts of the origin and spread of cancer. Still, an educated public can avoid smoking, which is associated with 90 per cent of the known environmental cancers.

Then what may be said about the cancer problem in the light of our capabilities today? Cancer is curable in 50 per cent of the cases occurring today. There are four principal methods of treatment: (1) surgery, (2) radiation, (3) chemotherapy (drugs), and (4) immunotherapy (increasing body resistance). These may be used separately, at the same time or in sequence depending on the type and extent of the cancer.

The medical profession is actively involved in education programmes to bring the best and the latest information on diagnosis and treatment to its members; but at the same time, the greatest asset the profession can have is an educated and informed public. This area is one for continuing concern and effort. The future will certainly show great gains in the diagnosis and even prevention of cancer. But the knowledge of the future hopes does not justify neglect or undue fear in light of todays' solutions to many of the problems related to cancer.

Cancer's seven warning signals

1. Change in bowel or bladder habbits.
2. A sore that does not heal.
3. Unusual bleeding or discharge.
4. Thickening or lump in breast or elsewhere.
5. Indigestion or difficulty in swallowing.
6. Obvious change in a wart or mole.
7. Nagging cough or hoarseness.

Dr. Raghunathan
Nashville, Tennessee, U.S.A.

Suppression of ethanol withdrawal syndrome

AMONG many neuromuscular withdrawal effects of ethanol are general agitation, tremors, convulsions, hallucinations and delirium tremens. Ethanol withdrawal syndrome is a serious medical problem requiring proper management. Treatment of ethanol withdrawal syndrome focuses primarily on reducing neuromuscular and autonomic hyperactivity. In an attempt to attain this objective in an animal model, Dr. E. Majchrowicz and his associates at the St. Elizabeths Hospital, Washington, D. C. tested 1, 3-butanediol for its ability to suppress an ethanol withdrawal syndrome (*Science*, **194**, 1181, 1976). They rendered male Sprague-Dawley rats physically dependent on ethanol by intragastric administration of ethanol at a dose of 9 to 15 grams per kilogram per day over a 4-day period. They administered a non-intoxicating oral dose of butanediol at 4 grams per kilogram after elimination of ethanol from the blood and found that it was effective against the tremulous and convulsive components of the ethanol withdrawal syndrome in all animals for 1 to 5 hours. Further, this period coincided with the time of maximum severity of the withdrawal syndrome, as seen in the control animals. Whether butanediol can be used in a clinical setting remains to be determined.

Bhakti Datta
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For Her

Cleansing creams

THE purpose of a cleansing cream or lotion is to remove facial make-up, surface grime or pigments and oil from the face and throat. Although the use of soap for adequate washing will perform the same function, a cleansing cream has certain advantages. The chemical nature of facial make up is such as to allow quick removal by a cleansing cream. The latter is specifically formulated to dissolve or remove the greasy material holding pigments on the skin.

In addition to the primary function of cleansing, a multipurpose character can be assigned to a cleansing cream by appropriate formulation. The properties required of a good cleansing cream are :

(1) It should be stable and have a good appearance; (2) Should melt or soften on application to the skin; (3) Should spread easily without much drag. During application, it should not make skin greasy or oily. After evaporation of water the cream residue should not become viscous; (4) Its physical action on the skin should be that of flushing rather than absorption; and (5) A light emollient film should remain on the skin after use of cream.

Types of cleansing creams

Traditionally, cleansing creams are classified into two categories.

One is usually white or cold-cream type, often referred to as the bees-wax-borax type cream. The other is translucent, liquifying type usually anhydrous in character and consisting of a mixture of hydrocarbon oils and waxes. As a result of the development of the newer emulsifying agents many cleansing creams of the emulsion type are made without using either bees-wax or borax.

Bees-wax-borax emulsion type The bees-wax-borax emulsion represents an important formulation among cleansing creams. The typical creams are usually white, of high luster and free from graininess. The creams have a firm consistency. On application to the skin, they liquefy and spread with ease. These creams contain a high percentage of mineral oil and many of them belong to the oil-in-water type of emulsions. When the creams have been rubbed on the skin sufficient water evaporates to permit phase inversion to the water-in-oil type. With oil, as the external phase, the solvent action of the oil for cleansing purpose is facilitated.

The basic ingredients required for this type of creams are bees-wax, mineral oil, borax and water. Other ingredients are normally added to modify or improve the properties of basic formulation. A generally accepted basic preparation is as follows:

Bees-wax	16.67	per cent
Mineral oil 65/75	50.00	,,
Borax	0.83	,,
Water	32.50	,,

Procedure

Melt the bees-wax and mineral oil together and bring the mixture to a temperature of 70°C. Dissolve borax in water and heat the solution to 70°C. Add the water phase to the oil phase with rapid stirring. After the addition of water, agitate the mixture slowly while cooling. Add the perfume at 50°C. When the cream has cooled down to 42°C fill it into jars. This procedure can be followed for more complicated bees-wax-borax formulations.

Basic materials

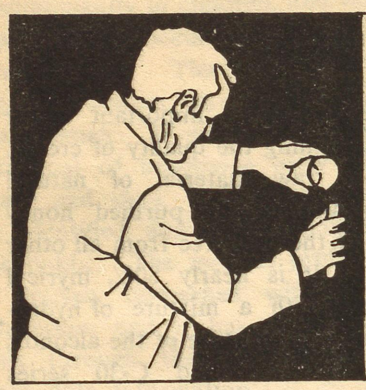
Bees-wax is an important factor in determining the quality of cream. It is a raw material of natural origin and is the purified honey comb of the bee, free from all other waxes. It is nearly 80% myricyl palmitate with a mixture of hydrocarbons, 5% of some of the alcohols of C-26, C-28 and C-30 series occurring as esters, and about 10% of higher fatty acids referred to as cerotic and melissic acids. Its colour varies from light-yellow to dark-brown. It is easily bleached either by sunlight or by chemical agents. The melting range of this material is 62°C–65°C with acid number ranging from 17 to 24. Bees-wax does not develop rancidity. It is neither an irritant nor a sensitizing agent. The commercial bees-wax normally used for cleansing creams is of bleached white grade.

Mineral oil is a hydrocarbon that is stable, inexpensive, and not subject to rancidity and odourless. It is a good solvent of oils and greases. The cleansing power of a cream is related to its mineral oil content. Mineral oil has the advantage in that it can be absorbed by the tissues of the skin when retained on the skin for long. Mineral oils suitable for cleansing creams are of light and medium viscosity grades.

The amount of borax used is an important factor in preparing a satisfactory cream. The calculated quantity of borax is necessary to neutralise the free acid present in the bees-wax. Insufficient quantity of borax will result in a dull, grainy cream. Excess of borax can cause the formation of hard, sharp crystals of boric acid resulting from limited solubility of boric acid in the waterphase.

Since mineral oil removes an appreciable quantity of natural oil

(*Continued on page* 189)



SCIENCE FOR THE YOUNG

Wolves of the insect world

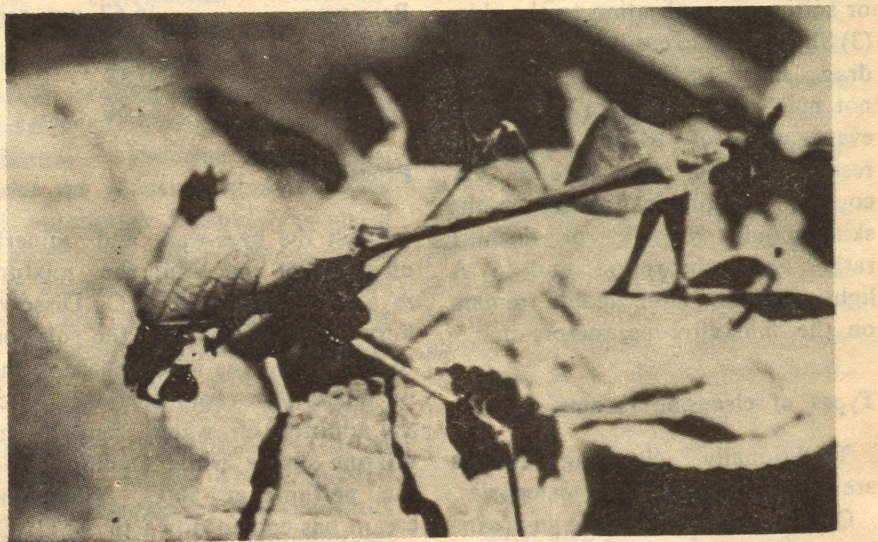
WHEN we talk of wolves, the picture of a ferrocious, carnivorous animal immediately comes to our mind. But there are "wolves" in the insect world too, and some species of insects behave like wolves, for example, the mantis.

There are a thousand different types of mantis and they are found in almost every part of the world. They are also known as 'devil's horses' or soothsayers. Literally, the word mantis means diviner. The ancient Greeks believed that the insect was able to see into the future. In some Muslim countries, it is believed that the mantis always prays with its face towards Mecca, thereby implying that it is a pious animal.

The body of a mantis is slender. Usually it stands on its four hind-legs with the frontal pair of legs held together as if in prayer. The frontal legs are actually the grasping organs, adapted for seizing and holding preys. The mantis is probably the greediest of all insects and is always in quest of living preys.

The best way to learn the habits of mantis is to watch one. The insect has well developed wings but it seldom uses them. Normally it sits on twigs of plants, alertly waiting for a prey. When awaiting motionless, the insect appears to be a part of the plant it is sitting on, owing to its green or brown coloration. When the prey comes within striking distance, the mantis starts slowly and imperceptibly moving towards the prey. Reaching it close enough in a twinkling of an eye, the grasping forelegs are shot out, and the next moment the prey is tightly grasped The insect then starts drawing the victim closer to its mouth, and in no time the whole prey is devoured. With the victim thus disposed of, the forelegs are cleansed; the mantis peers this and that way for a while and starts moving further afield in search of fresh preys.

The love life of the mantis is short and snappy. After a brief honeymoon, the insatiable female kills and devours her mate, who is smaller than herself in size. This fact was noted in 1886 by Riley who wrote: 'It is a well-known fact that the male insects of the family *Mantidac* approach the female at the risk of life". The male of an American species, *Stagmomantis carotina*, was seen by Dr Coleman, an Entomologist, with its head, forelegs and a good portion of the thorax devoured by the female. The male which seemed in no way inconvenienced while being preyed upon by the female, remained quietly engaged in the copulatory act while the female continued her meal. Coleman interrupted the copulation by pulling aside the abdomen of the male; but no sooner the abdomen was released than the male came to his original position and proceeded with covering the female as it did before disturbance.



Mantis can eat a tremendous amount of food. Normally it feeds on grasshoppers, other insects as well as spiders. But it can also kill animals bigger than itself. The ferrocity of the mantis is proved by the note of Maj. Browne published in the Society's Journal (*J B N H S*, Vol. 12: 579; 1899): A small sunbird (*Nectarinia minima*) happened to come hovering about a branch on which a mantis (*Hierodula bipapilla*) was biding its time. The mantis struck out at the bird with its forelegs and scalped it, which made the bird drop dead. The incident was recorded from Dharwar (Karnataka).

There are some mantis who display a fantastic camouflage. An interesting example is offered by the roseleaf mantis of India which can verily be called a 'wolf in sheep's clothing'. This mantis has an expansion along its body sides and the legs resemble the shape of leaves. The insect is green in colour but the underside is tinted a beautiful pale lavender violet. The insect hangs with its head down wards among the green foliage and swings lightly in the air currents every now and then, like a leaf or a flower, to strike at an unwary victim.

Not much work has been done on feeding habits of Indian species of mantis, What is now required is careful observation of their food habits to establish their economic importance in biological control of agricultural pests.

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The inspector's trickery

LAST week, an inspector from Health Department came to me to collect records of my family members. He was, to my wonder, a funny mathematician too. When I was about to tell the number of my sons and daughters, he stopped me and asked,

"Write down the number of letters in the word 'DAUGHTER' times the number of sons that you have.

(1) Add to it the number of letters in 'SON' times the number of our daughters;

(2) Multiply the result by the maximum number of children that a married couple may have under the new family planning instructions (i.e.; 3)

What was the trick ?

(3) Subtract the number of letters in 'SON' plus 1 times the number of your sons; and

(4) Subtract the number of letters in 'DAUGHTER' minus 1 times the number of my daughters."

The trick

We know that the number of letters in 'SON' is 3, and that in 'DAUGHTER' is 8. Let s be the number of sons, and d the number of daughters.

We make an algebriac expression following the statements of the trick, and find that

$$3(8s+3d)=4s-7d$$
$$=20s+2d$$

$(20s+2d)$ was the answer I gave to the inspector.

Dividing this answer by 2, we will get $10s+d$, which is equivalent to a number having s in the tens place, and d in the units place. So we have reached our goal (the numbers s and d).

For example, if I had 4 sons and 5 daughters, I would give him the figure 90. He, then, simply has to divide my answer by 2, which yields 45, and get the solution FOUR FIVE, that is, 4 sons and 5 daughters.

The trick will always be true, of course, for s and d less than 9.

UMA KANT SHARMA
District Jail, Lucknow U.P.

Series of 'Ologies

AGROLOGY : Science that deals with the soils especially in relation to crops.

Agrostology: Scientific study of grasses.

Algology: Science that deals with algae.

Anthropology: Science that deals with the man in relation to distribution, origin, classification and relationship to races.

Archaeology: Scientific study of material remains of past human life and activities.

Archology: Science that deals with government.

Astrology: Science of the influence of stars on human and terrestrial affairs.

Bacteriology: Science that deals with bacteria.

Biology; Science that deals with living organisms.

Cardiology: Scientific study of heart and its action.

Cartology: Science that deals with maps and charts.

Chronology: Science of computing time.

Climatology: Science that deals with the climate.

Cosmology: A treatise on the structure and parts of the systems of creation.

Criminology: Science that deals with crimes and criminals.

Cryptology: Science of secret language.

Cytology: Part of biology that deals with cells.

Dermatology: Science that deals with skin.

Ecology: Science that deals with the living organisms in relation to environment.

Embryology: Science that deals the embryo.

Endocrinology: Science of ductless glands.

Enology: Science that deals with wine and wine making.

Entomology: Science that deals with insects.

Etiology: Branch of science that deals with the causes.

Ethiology: Science of character of bionomics.

Ethnology: Science that deals with varieties of human race or cultural anthropology.

Etymology: Science of linguistics that deals with the deviation and original significance of words.

Genealogy: Science of history of descent of families or pedigree of a particular person.

Geology: Science relating to the history and development of earth crust with its successive flora and fauna.

Gynaecology: Branch of medicine that deals with women.

Histology: Science that deals with minute structures of tissues.

Hydrology: Science dealing with the properties, distribution and circulation of water on the surface of the land, in the soil and underlying rocks and in the atmosphere.

Ichthyology: Branch of natural history that deals with fishes.

Immunology: Science that deals with immunity (resistance).

Lichenology: Science of lichens (fungus-alga association).

Meteorology: Science that deals with weather and atmosphere especially with the weather.

Microbiology: Science that deals with microscopic living organisms.

Minerology: Science of minerals.

Musicology: Science of music.

Mycology: Science that deals with fungi.

Necrology: Obituary.

Nematology: Science that deals with nematodes.

Neurology; Science that deals with the nerves and their function.

Numerology: Science that deals with the numbers.

Ontology: Branch of metaphysics relating to the nature and relation of being.

Ophthalmology: Science that deals with eyes.

Palaeontology; Science of fossils.

Palynology: Science that deals with the spores and pollen grains.

Parasitology: Science that deals with parasites.

Pathology: Science that deals with diseases.

Pedology: Science that deals with the soils.

Philology: Science of language.

Phycology: Science of algae.

Physiology: Science that deals with the processes of life.

Phytology: Science of plants (Botany).

Pomology: Science of fruits.

Radiology: Science of radioactivity and radiation.

Serology: Science that deals with serums.

Technology: Science that deals with the techniques or methods in any branch of science.

Terminology: A set of terms used in any part of science.

Thanatology: Science that deals with earth.

Toxicology: Science that deals with toxins

Urology: Branch of medicine that deals with urogenital tract.

Virology: Science that deals with viruses.

Xylology: Study of structures of wood.

Zoology: Science that deals with animals.

Zymology: Science that deals with fermentation.

A. V. Rao
Asstt. Prof. of Microbiology
College of Agriculture
Solan (A.P.)

Do it at your home :

Battery eliminator

YOU must have seen battery eliminators displayed in shop windows. They range in price from Rs. 14 for a small one to Rs. 75 plus. But have you realised that you can make one at home at a fraction of the market price without any sacrifice in quality? In this issue we shall describe how to make a small 6V eliminator.

The circuit given in Fig. 1 represents the simplest eliminator that you can make. It consists of three portions: the transformer, the rectifier diode and the filter capacitor. What the transformer does is to convert 230 volts AC into 6volts AC. The diode now steps in. A diode is a device that allows current to flow only one way, i.e., it acts as a valve. So the AC which till now was sinosoidal as shown in Fig. 2, will now appear as shown in Fig. 3.

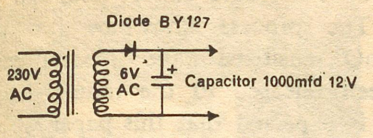


Fig. 1

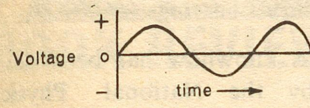


Fig. 2

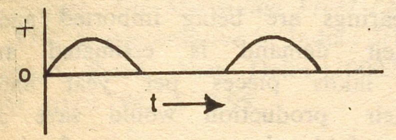


Fig. 3

This is unidirectional current. However, it is not DC. It can be thought of as the sum of a bit DC and a bit AC. If we take the circuit as that it becomes easier to understand the function of the capacitor. We have only to remember that a capacitor has low resistance to AC and infinite resistance to DC. As a result, the AC component is shot-back and the DC goes through. So we have thus an eliminator that can give 6 Volts DC. If we now modify this circuit, we can get still better DC. At the moment we are wasting the portion below the 0 volt line in the AC diagram (Fig. 2). By substituting a different rectifier circuit, that portion can be used. Any of the circuits shown in Fig. 4 can be used.

The circuit (i) (Fig. 4) is called a full-wave circuit. It, however, needs a special kind of transformer which has a tap on the secondary and is made such that the output voltage between the centre-tap and either end is 6 volts. The circuit (ii) is called a bridge circuit. It uses an ordinary transformer.

The second improvement that we can incorporate into our eliminator is in the filter circuit. If we add a choke (an inductance) to the output, the output is a far better DC than we otherwise get. It is because the inductance has higher resistance to AC than DC. As a results it lets the DC through but not the AC. This is known as an LC (L stands for inductance and C for capacitance) filter.

The circuit for making a simple battery eliminator is shown in Fig. 5.

where T: Transformer which converts 230V in to 6V. Current rating 200 milliamperes to 500 milliamperes depending upon the use intended.

R: Rectifier bridge stack. This has four pins and is built so that you don't have to worry about how to connect the diodes. Two of the pins will have yellow dots on them. Connect the wires from the transformer to them. Two of the other pins will be interconnected and will have a black dot. This is the negative output. The pin that is left will have a red dot on it. This is the positive output.

C: Electrolytic capacitor 1000 mfd 12V. Remember that the longer lead indicates the positive end indicated by + in the circuit diagram.

L: Inductance (It is better to say 'choke' to the shopkeeper) 100 milli Henries.

S: Toggle switch for on-off 230V 2Amp.

B: You can put in a bulb here. Use a 6.3V bulb.

You will also have to buy a mains lead wires for the output (red for positive and black for negative) and

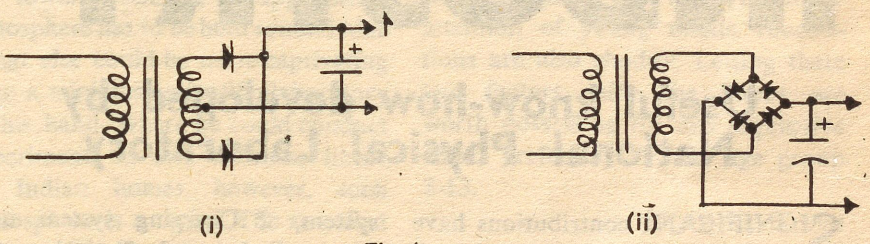


Fig. 4

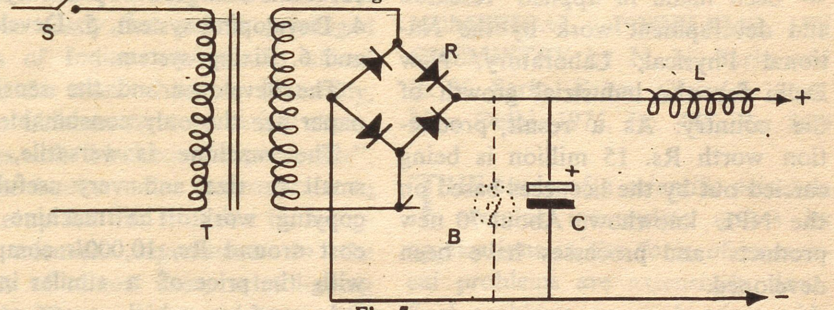


Fig. 5

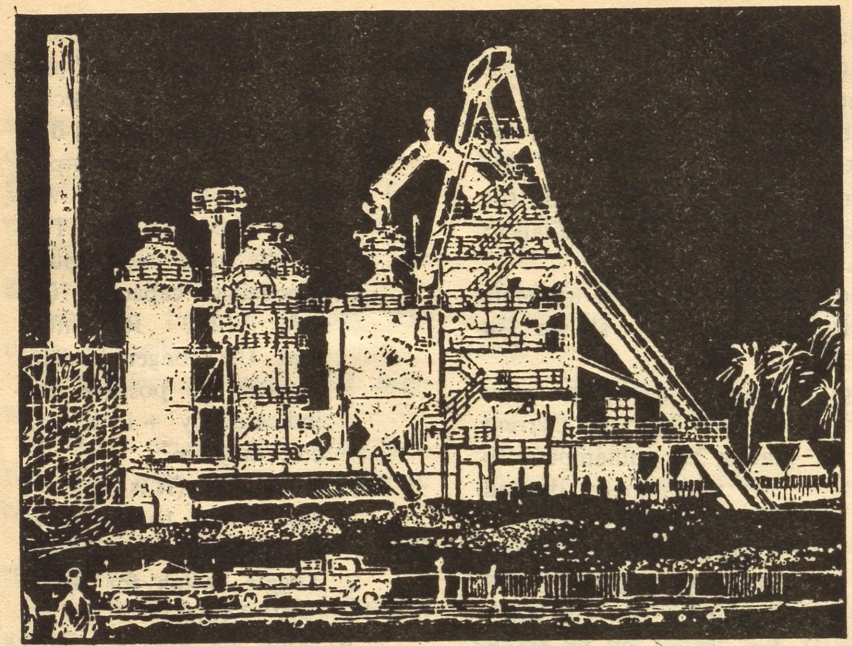
a box to house the whole thing.

Usual prices of the items are as follows:

Transformer	Rs. 3.00
Bridge	Rs. 2.50
Capacitor	Rs. 1.60
Inductance	Rs. 1.50
Toggle switch	Rs. 2.00
Mains lead	Rs. 1.50
Output wires	Rs. 0.60
Box	Rs. 3.00
	Rs.15.70

These are the maximum prices. Your expense will probably be

(*Continued on page* 161)



SCIENCE IN INDUSTRY

Useful know-how developed by National Physical Laboratory

SIGNIFICANT contributions have been made in applied research and development work by the National Physical, Laboratory, New Delhi for the industrial growth of the country. As a result, production worth Rs. 15 million is being carried out by the licencees based on the NPL knowhow. About 70 new products and processes have been developed.

Electrostatic photocopying machine of electrofax type

The machine is an automatic electrosatic photocopying machine using sensitized ZnO coated paper capable of copying documents in about ten seconds. It consists mainly of the following:

1. ZnO sensitized paper feeding system, 2. Charging system using corona discharge, 3. Optical system, 4. Developing system, 5. Developer, and 6. Fixing system.

The developer and the sensitized paper are the only consumables.

The machine is versatile, very small in size and very useful for copying work. The machine may cost around Rs. 10,000/- compared with the price of a similar imported machine which costs around Rs. 20,000/- or even more. A manufacturer can easily sell 200 machines per annum earning Rs. 20 lakhs.

The working of the machine has been demonstrated to visitors.

The interest shown by the people and seeing the facilities provided in the advanced countries, it is felt that thousands of machines would be needed in the country. The machine would also have export potential.

The process knowhow for the ZnO sensitized paper has already been released to the industry and it is expected that this paper would be available in the market soon.

Carbon thrust bearings

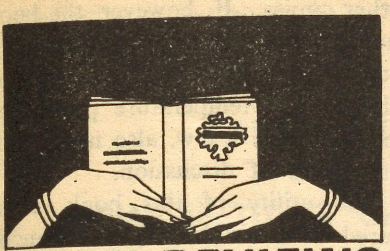
Process knowhow has been developed by the National Physical Laboratory, New Delhi for manufacture of carbon thrust bearings for automobiles. At present these bearings are being imported and their demand is estimated at 2 lakhs pieces per year and their production would save a few lakhs in rupees in foreign exchange. The samples made at NPL were tested in the NPL vehicles and their performance was found to be quite satisfactory and the product meets the specifications. All the raw materials like petroleum coke, coal tar pitch, carbon black, synthetic graphite, natural graphite, etc. are indigenously available.

Electrographite carbon block for automobile generator

A process for manufacture of electrographite carbon brushes for use on automobile generators has been developed. It is an import substitution based on raw materials indigenously available. The product has been tested and found satisfactory. It would save foreign exchange amounting to a few million rupees.

The process utilises mainly graphite and carbon block mixed together with coal tar pitch as a binder material. The mixed mass is moulded and given low and high heat treatments. The process has been worked out on laboratory scale and would be of interest to people desirous of setting up a small scale industry for carbon product production.

The annual requirement of such brushes is about 50 tonnes and their indigenous production would save a few million rupees.



BOOK REVIEWS

PRINCIPLES OF ENGINEERING THERMODYNAMICS by E.M. Goodger, *The Macmillan Press Ltd.* (1974); Representative in India: 2/10 Ansari Road, New Delhi-110002, Pp. xiv+194, £ 2.95.

THERMODYNAMICS deals with the study of heat and its relationship to the other forms of energy such as mechanical, electrical and chemical. This subject is of interest to students of physics and engineering. While physicists are interested mainly in the fundamental concepts, engineers are concerned with their applications. This book is of help to the latter.

The first half of the book has been devoted to the topics like thermodynamic considerations of energy forms, energy transfer and energy conservation. Thereafter physical properties of the fluids have been discussed. Finally different thermodynamical processes and cycles have been dealt with. The book also contains a small note on systems of units, conversion tables for units of different systems, glossary, bibliography, etc.

The text of the book has been well written and properly illustrated. Numerical examples have been discussed at various stages. Every chapter ends with a set of test questions and a number of good problems whose solutions have been given at the end. After each test question, reference of the relevent portion of text to which the reader should consult in case he is unable to answer has been made. Students will undoubtedly be benefited by such an arrangement.

The book is concise, and only the main principles of the subject have been identified and explained. However, essential details have not been missed as promised in the Preface. The book will definitely be useful to the undergraduate students of engineering for whom it has been written.

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SCIENCE IN ACTION (Parts I, II, III, IV) by Meera A. Parasnis, *The Macmillan Co. of India Ltd.*, 2/10, Ansari Road, Daryaganj, New Delhi-110002, Rs. 4.80 (I), Rs. 5.25 (II), Rs. 6.00 (III), Rs. 7.00 (IV).

TO draw a child's attention towards science, an appropriate atmosphere has to be built around him. What else could be more captivating than a miniature scientific laboratory at his hand, where he could conduct experiments as and when he likes? In Indian homes, however, such atmosphere is a rarity. The so-called "Science Kits" available in the market are so costly that only a privileged class of Indian society can afford them for their children. Naturally, other children have to satisfy themselves with "blackboard experiments".

The books under review serve to make up for this situation by bringing scientific experiments to the home of almost every school-going child. The authoress, who is the Principal Coordinator, School Science Materials Projects, Education Development Center, I.I.T., Kanpur, has done a good job by using her 10-year involvement with children to bring out this series of books. Every experiment, she claims, has been "tested in life".

The books, indeed, in the experiments, cover all the principles which are to be learnt in classes, so that while doing experiments the child learns as well. Firstly, every experiment has been given a catchy heading, and the procedure, as desirable to a child, has been laid down in a stepwise manner. To "stimulate thinking", a question about the "Why" of the experiment has been put in at the end of every experiment. Answers are given at the end of every book.

The significant feature of the books is that not only the material required in the experiment, as claimed, is "easily available and low cost", but also it could be made available at home; for example, materials like jam, milk bottles, coffee tins, paper cartons, drinking straws, etc. Wherever needed, makeshift material has been mentioned. For instance, it has been told that metal foils can be had from coffee or tea tins, box from a shoe container.

The covers of the books are, however, gaudy and won't catch the attention of young minds. Illustrations are also shoddy. Letting these two factors aside, the books are worth possessing for any inquisitive child, preferably in the age group 8-13.

DILIP M. SALWI

NUMERICAL PROBLEMS IN CHEMISTRY by N. N. Sarin and R. N. Sarin, *Sultan Chand & Sons*, New Delhi, 1976, Pp. 448, Rs. 7.00

THE study of a scientific principle remains incomplete unless its applications in the form of numerical problems are extensively done. Such problems, on one hand, provide a good drill to the students and, on the other hand, can be thought-provoking. The changing pattern of examinations, university as well as competitive, where more of short numerical problems are asked, is in keeping with the above view.

The book under review is intended to serve as a textbook on numerical problems in chemistry for Higher

Secondary, Intermediate and other equivalent examinations. Running in its twelfth edition, it deals with numerical problems and their principles related to physical, inorganic and organic chemistry. This small, comprehensive book is divided into twenty one chapters, which covers different topics on chemistry taught at pre-university level of mostly all Indian Universities. The principles underlying the problems have been explained at the start of every chapter, which helps the students to refresh their understanding of chemistry. In every chapter, a number of solved examples have been cited. Diverse types of unsolved problems have been added to make students understand the principles involved more thoroughly. Examples and exercises have been selected largely from latest examination papers of Universities, Boards and I.I.T., etc. The book can be recommended for both weak and average students who are appearing for competitive examinations as well as those who would like to use it for their regular studies.

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MODERN PHYSICS by N. K. Seghal, K. L. Chopra and D. L. Sehgal, *Sultan Chand & Sons*, Delhi, Second Ed., 1976, Pp. xi 472, Rs. 12.50.

THE book, though entitled "Modern Physics", is on atomic and nuclear physics. It is divided into three parts. The first part contains an introduction to the theory of relativity; the second part consists of eight chapters dealing with atomic physics; while the third part, again in eight chapters, is about the nucleus of an atom. At the end, there are seven appendices which deal with some portions of solid state physics, quantum mechanics, atomic and molecular spectroscopy, and contain some solved problems from latest university question papers.

The book is quite detailed and is well illustrated. Each topic has been built up from the beginning, giving a historical background, which is more than required. Many different methods are discussed for the measurement of each physical quantity. One usually does not find so many methods in a book of this type. Frequent use of S. I. units has been made. After each chapter, a large number of solved problems, questions, and a list of references for further reading are given. Questions are of three type: essay-type, objective-type and numerical problems. Objective-type questions are mainly of the fill-in-the-blanks type. Apart from self evaluation, these questions, coupled with their answers, would also help the students in taking a quick review of the material given in any particular chapter. The book also contains some very useful information on physical constants, nits, symbols and various conversion factors.

In some sections, there is a lack of proper emphasis on important points. This may create confusion in the mind of an average or below-average student. Moreover, the subject matter could have been written in a more comprehensive way; some portions need improvement to enhance the clarity of the subject.

The reviewer fails to understand the reason for making a separate part for the theory of relativity in a book dealing with atomic and nuclear physics. Introduction to relevant portions like the mass-energy relationship and the relativistic correction to mass could have been given wherever mentioned for the first time, or in an appendix alongwith the other copies. If, however, the book is truly on modern physics, then other fields like astrophysics, plasma physics, low-temperature physics, to mention only a few, also need, their due share of discussion.

The utility of this book, compared to other books, is enhanced as its text material is frequently borrowed from some standard western books on the subject. This, coupled with its price, is likely to make it popular with the Honours students. Further, it would be a valuable aid for candidates appearing in advanced professional and competitive examinations. The pass course students may, however, find the detailed treatment quite irritating. They have to be little smart in picking out the important points from the unimportant ones.

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BOOKS RECEIVED

THE PENGUIN DICTIONARY OF PHYSICS by Valerie H. Pitt, *Penguin Books*, Representatives in India: Penguin Overseas, 706, Eros Apartment, 56 Nehru Place, N. Delhi-110024, Ppl 428, £ 2.

AN INTRODUCTION TO FLUID DYNAMICS by R.K. Rathy, *Oxford & IBH Publishing Co.*, 66, Janpath, New Delhi-110001, Pp. 684, Rs. 24

SPICES AND CONDIMENTS by J.S. Pruthi, *National Book Trust*, A-5, Green Park, New Delhi-110016, Pp. 270, Rs. 14.50.

MEDICINAL PLANTS OF INDIA, Vol. 1, published by *Division of Publication and Information*, Indian Council of Medical Research, Ansari Nagar, P.B. 4508, New Delhi-110016, Pp. 487, Rs. 30.

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