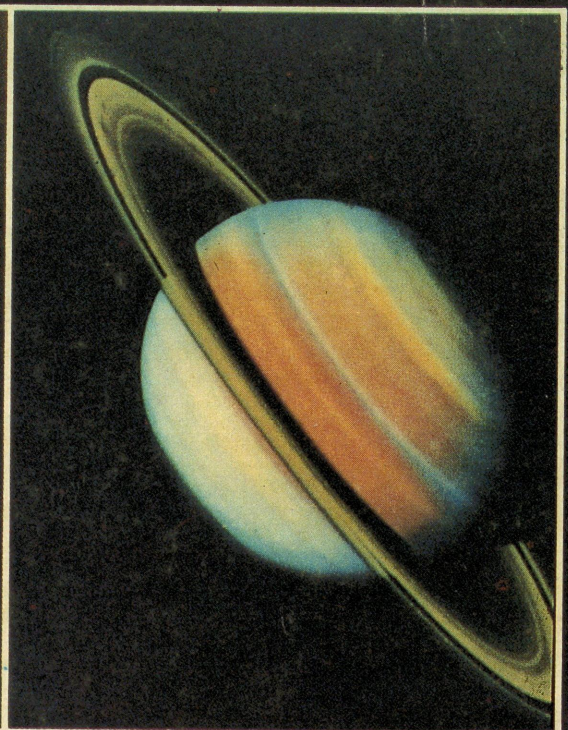


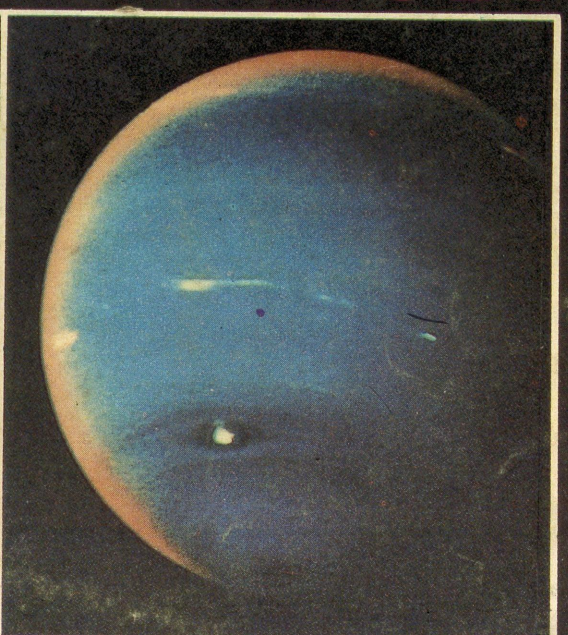
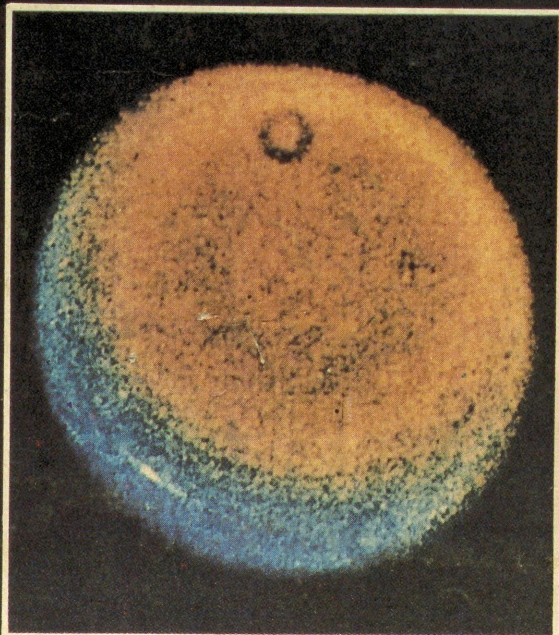
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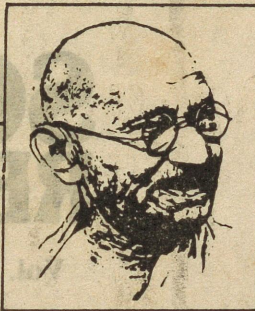
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*"True Democracy cannot be worked by twenty men sitting at the Centre. It has to be worked from below by the people of every village". — Gandhiji*

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## SALIENT FEATURES

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- \* Panchayats at village, block and district levels.
- \* All seats at all the three levels to be filled by direct election under supervision of Election Commission.
- \* Term of office - 5 years. If any Panchayat is dissolved sooner, election to be held within six months.
- \* Seat reservation for SC/ST in proportion to their population.
- \* 30 per cent reservation for women
- \* Panchayats to prepare and implement local plans for development with social justice.
- \* Provision of adequate funds to Panchayats to do their job.

### Nagarpalika Bill

- \* Provision for constitution of three types of Nagarpalikas - Nagar Panchayats, Municipal Councils and Municipal Corporations.
- \* Direct election under Election Commission's supervision - Term five years.
- \* If any Municipal body is dissolved before expiry of office, election to be held within six months.
- \* Provision for Wards Committees to afford an opportunity for public-spirited citizens to serve their locality.
- \* Effective devolution of powers to local bodies.
- \* Greater role for them in the planning process.
- \* Adequate finance to be ensured for municipal bodies.



davp 89/634

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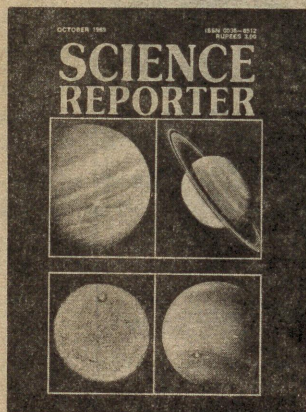
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Voyager 2 images of Jupiter (top left) July 1979, Saturn (top right) August 1981, Uranus (bottom left) January 1986, and Neptune (bottom right) late August 1989

IV Cover: The Great Spot, a violent Earth-size storm in Neptune's mid-section shows clearly in this false color view from Voyager 2

Transparencies Courtesy : U.S.I.S.

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# SCIENCE REPORTER

Vol. 26 No. 8, October 1989

Publications and Information Directorate (C.S.I.R.)

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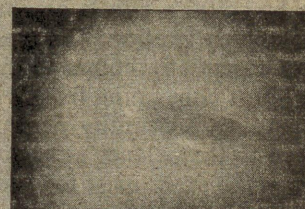
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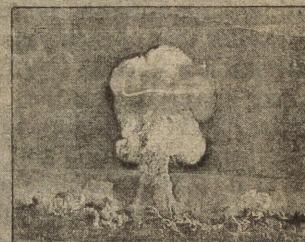
Genetics Today • Science Teasers & More Science Teasers • Surface Mounted Assemblies • Inherit the Stars • Elements of Electrical Science • Handbook of Elementary Physics • Proceedings of the Second National Symposium on Recent Trends in Aphidological Studies-1986



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## LETTERS

### Pleasant sequences

Sir, Seetha Rama Raju, writing under the above title (*S.R.*, April-May 1989), had given two problems. In the answer (also given by him) to the first problem, he cautions about the selection of a solution, illustrating with a mathematical solution devised by him which essentially states that  $n^{\text{th}}$  term = (zero times first term) + (zero times second term) + ... + (zero times  $(n-1)^{\text{th}}$  term) +  $(n^{\text{th}}$  term of the sequence, if  $n$  is not the number of the term for which answer is to be found out; otherwise any number chosen by you) !! This is obviously an unnecessary caution. The second problem essentially comes to this: 'If one keeps consuming from a fixed quantity, a quantity which is unrelated to the balance at each stage, can the stock exist for ever? The answer is immediate as would have been the case, for instance, if the author had started with one unit instead of ten units in his illustration. Supposing the same problem states that in each year consumption is a fraction (say  $f$ , which may be variable) of the balance (say  $B$ ) at the beginning of the year, then we may find a balance of  $B(1-f)$  at the close of the year. Since  $f$  is less than 1, this closing balance is never zero and its value depends mainly on the fraction  $f$  and one may find oneself in a pleasant (?) situation!

**V.R. Srinivasan**

*Scientist  
Indian Institute of Horticultural Research  
Bangalore-560089*

### The author replies:

The novelty and beauty of the problem can only be realised by finding out how many answer the 1st problem correctly. V.R. Srinivasan's solution follows from the given solution. The algebraic solution given in the article is obviously better than the solution suggested by him in words.

The aim of the article has been

hinted in the last para of the article. It is only to show the beauty of some problems and solutions from the area of sequences. The second problem formulation was prompted by my observation that many reasonably good mathematics students do not answer the following question correctly: Is the series  $1+1/2+1/3+1/4+...+1/n+...+...$  convergent? If one can live without petroleum, the situation will be more pleasant.

### B.O.D. and C.O.D. not mentioned

Sir, Thanks for publishing **Making best use of waste water** by Paritosh Tyagi and others (*S.R.*, April-May 1989). It is quite interesting and informative. The authors have described different methods of recycling reuse of waste water and recoverable matter from industrial waste waters. However, I would like to point out that they have not mentioned B.O.D. (Biological Oxygen Demand) and C.O.D. (Chemical Oxygen Demand) of different waste waters. High B.O.D. 35000 mg/l and C.O.D. 65000 mg/l of distillery effluent is one of the greatest environmental problems facing the country. Rivers are carrying their effluent and as a result their aquatic flora and fauna are fast disappearing.

If effluent is stored in kutch pits (lagoons) for anaerobic treatment and solar drying it not only produces poisonous gases (methane, hydrogen sulphide and carbon dioxide) but also percolates deep into the soil polluting ground water in the process thereby creating imbalance in atmosphere and hydrosphere respectively. Very few distilleries have set up effluent plants to generate biogas for their boilers which reduce B.O.D. and C.O.D of effluent to permissible limits (B.O.D. 500 mg/l and C.O.D. 250 mg/l) for crops.

**M.A. Ali**

*Environmental Science Lab  
Kisan P.G. College,  
Simbhaoli  
Distt. Ghaziabad, U.P.*

### Some suggestions

Sir, I am a regular reader of *Science Reporter* since 1972 when I was in class IX. The magazine is useful for science students of Intermediate/B.Sc/M.Sc standard. Will it not be possible for you to publish *SR* in different branches of science?

Please publish articles on the historical development of sciences because B.Sc/M.Sc students must know the development of mathematical/physical/chemical/biological sciences. Unfortunately, this aspect has been neglected in our universities. It would also be worthwhile if B.Sc/M.Sc students are acquainted with the scientific works of eminent personalities.

**Rahul**

*502 A, Bichhiya Rly Colony  
Gorakhpur (U.P.) 273012*

### Science in Nepal

Sir, Thanks for publishing the article **Cultivating science in Nepal** (*S.R.*, June 1989) which gives an idea of how the RONAST is developing science in Nepal.

I also thank you for publishing crossword puzzles and quizzes.

**Peter Mohammad**

*B.Sc (Ag) 3rd year  
IAAS  
Central Campus  
Rampur (Chitwan)  
Nepal*

### Indoor pollution

Sir, All appreciation and thanks for publishing "**Indoor air-pollution**" by Vikas Kumar (*S.R.*, June 1989). The article attracted the attention of all types of readers as it was full of facts, figures and remedial measures.

I request you to add a new section for the candidates taking JEES.

**Momina Hasin**

*Rampurhat  
Birbhum (W.B.)*

Can any element be stronger than steel yet softer than a flower? Yes, recently, scientists have discovered such an element. It is hydrogen. **BAL PHONDKE** throws light on the discovery

# HYDROGEN: THE CHAMELEON ELEMENT

**T**HE multifaceted personalities of saints have been described in Sanskrit as *Vajradapi Kathorani, Mruduni Kusumadapi*, stronger than steel yet softer than a flower. As a poetic flight of fancy, one can only appreciate such imaginative depiction. But scientists, thoroughly rational beings that they profess to be, are apt to ask if in reality this is ever possible. Can any element indeed possess such paradoxical properties? Can an element, one would want to know, display such chameleonlike characteristics and metamorphose at the dictates of circumstances?

The immediate answer to these questions would be a firm negative. But let us ponder for a while and look around us. Consider water, that ubiquitous substance which is the very essence of life on this earth. When a drop of it falls on us, its touch is soft as a petal. It caresses us

lovingly even if it has descended from a distance of a few kilometers.

But let that very drop turn into a hail and we cannot get away fast enough to avoid its beating a tattoo on our bodies. When it falls, even from a shorter distance, its lashes are harsher than those of a cat of nine tails. Can we not say then that water, like saints, is as hard as tempered steel while being softer than a rose petal?

This is so because every substance, every element in nature, exists in three different states, solid, liquid and gas. The form in which the substance is usually seen is merely the state that is in tune with the ambient surroundings.

That is why water is usually seen as a freely flowing fluid. However, if the ambient temperature starts dropping this state of water undergoes a change. At four degrees Celsius water displays an anomalous expansion (This is responsible for the split-

ting of water-carrying pipes in colder climates). At zero degree Celsius the freezing point of water is reached and instead of a free liquid it becomes a solid.

As one moves away from the equator, either southwards or northwards, the average temperature even at the sea level drops. In the Arctic or the Antarctic circles it reaches such a low value that water is mostly seen as a solid.

If, in contrast, the temperature is raised, again water starts changing its state. At 100 degrees Celsius, the boiling point of water is reached and it totally adopts the gaseous state.

Of course, the statement that water boils at 100 degrees Celsius is true only at the sea level. As one starts ascending to higher altitudes water boils at lower temperatures. This is because the boiling point is dependent on the atmospheric pressure. Whenever the pressure of the water vapour equals that of the atmos-

phere, water starts boiling. It is obvious that at higher altitudes where the atmospheric pressure is lower, water vapour has to attain a lower pressure for the water to commence boiling.

On the other hand, in a pressure cooker where the pressure is raised water can remain without boiling even at temperatures higher than 100 degrees Celsius. Consequently, it is capable of supplying food with greater heat energy helping its speedy and more efficient cooking.

It should be obvious then that any substance or element remains in a specific state only under the specific temperature and atmospheric pressure. Let either or both of these parameters change and the substance will respond by assuming a different state.

Whenever, such a change of state occurs it is not only the external vis-

ible form of the substance that undergoes a change but its internal structure too alters. The relationship and juxtaposition of its molecules with respect to each other may become different. At times the alteration may be more severe resulting in the internal structure of it registering distinct changes.

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### **For the last half a century an intense debate has been raging whether hydrogen can become a solid or not**

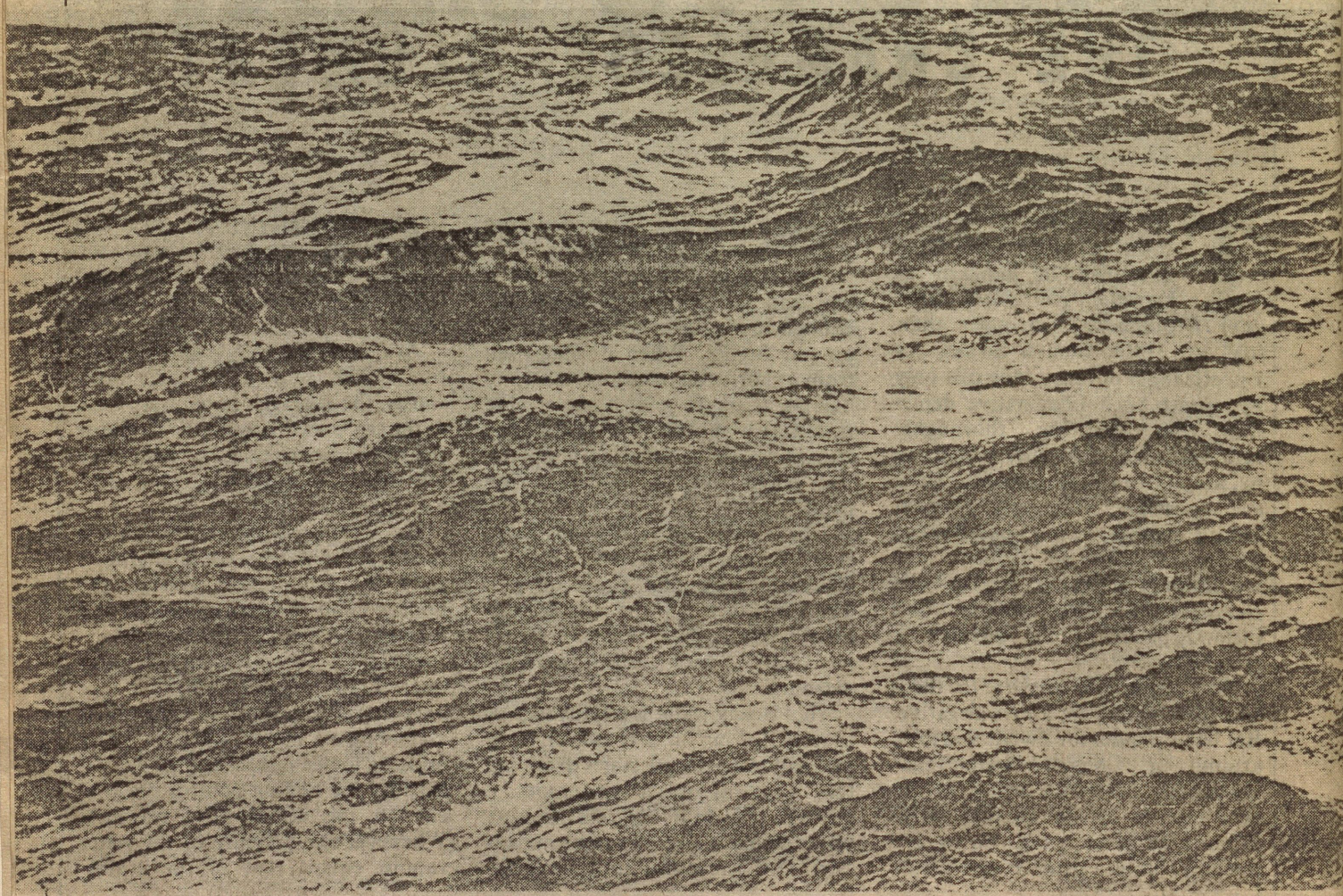
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A very familiar example of this is our sun or any similar star. The internal temperature of any reasonably bright star is so high and the gravitational pull so intense that the atoms of its core elements experience a severe

pressure. In the sun, for example, this results in the fusion of the atoms of such elements like hydrogen or helium. Consequently, a heavier element is formed, simultaneously releasing phenomenal amounts of energy.

Having known these facts scientists naturally thought that if the lightest of elements, hydrogen, is subjected to low temperatures or high pressures it could be induced to abandon the gaseous state in favour of the solid state. Nitrogen has already been made to adopt liquid state by lowering the temperature to 196 degrees below zero degree Celsius.

Liquid nitrogen is commercially available in our country today. Hydrogen too has been converted into a liquid by lowering the temperature. But to achieve that feat the temperature had to be lowered down almost to the lowest temperature that can be



reached which is — 273 degrees Celsius

Obviously then, hydrogen could not have been coerced to adopt a solid state by lowering the temperature alone. To force it into submission intense pressure had also to be brought to bear on it.

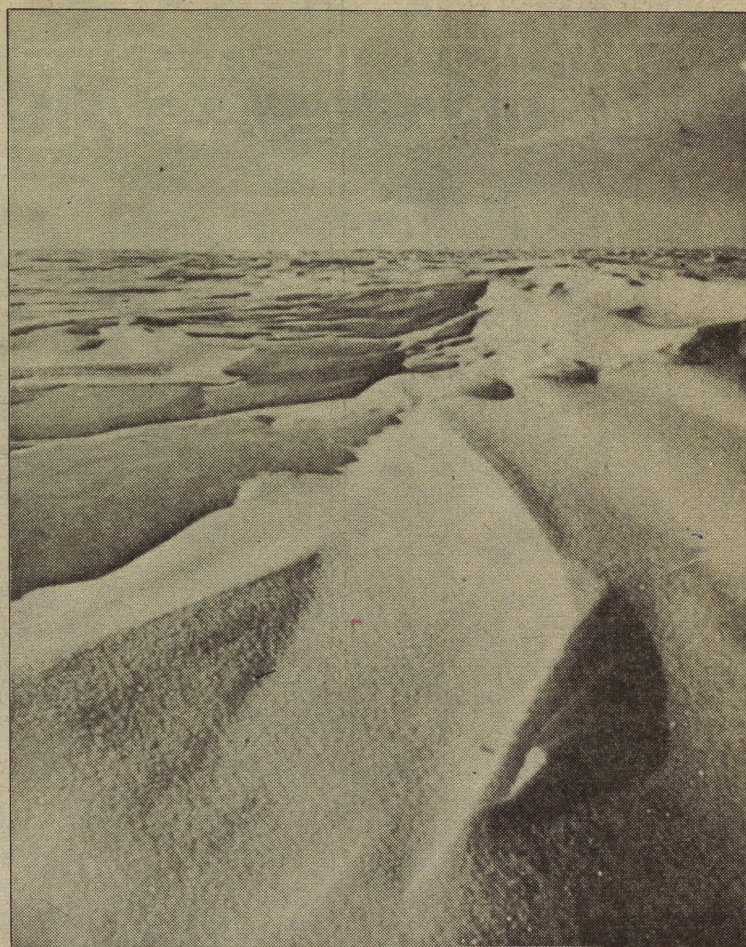
This is precisely what a duo of scientists from the Carnegie Institute in Washington, Ho-Quang Mao and Russel Helmely thought. They placed the hydrogen gas between two tiny anvils of transparent diamond—the hardest substance that could be found. The whole assembly was placed in liquid nitrogen meaning that the surrounding temperature was reduced to a low of -196 degrees Celsius. And then Mao and Helmely started turning on pressure till it reached a whopping 2.5 million times that of the atmosphere. At that stage they found that the all too familiar gas had turned into a black solid.

That, of course, was the change in its external appearance. Did the internal structure undergo any discernible alterations? Yes, say Mao and Helmely who think that under these forbidding conditions hydrogen behaves like a metal.

Not all solids are metals. For, one of the characteristic properties of metals is their electrical conductivity. Every solid is not necessarily a good conductor. Wood or porcelain are solids, but they act as insulators.

On the other hand, not all metals are solids. There is mercury, which is a good conductor. So it qualifies as a metal despite its normally assuming a liquid form. The reason Mao and Helmely feel that the solid hydrogen is a metal is that it acts as a good conductor. In fact, it goes one better by becoming a superconductor.

For the last half a century an intense debate has been raging among the scientists over the possibility of hydrogen ever becoming a solid. Some have argued that since the hydrogen nucleus is so light it can never assume the solid state no matter how much the temperature is reduced or the pressure raised. For any element to become a solid its atoms have to be arranged in a geometric pattern which becomes its characteristic crystal structure.



According to these scientists, the light-weight hydrogen atoms can never be tied down to a unique position however stifling the conditions. They would keep flitting around. So at best hydrogen can become a liquid.

The other school of thought does not accept this theory. They contend that if hydrogen is to become an electroconductor metal under any set of conditions, it would have to don the mantle of a solid. Mao and Helmely have now provided evidence which should settle this controversy once and for all.

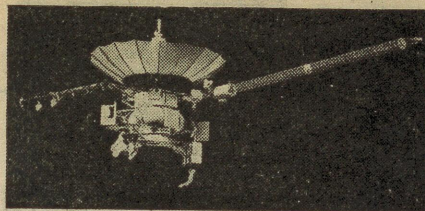
Astrophysicists too are interested in this curious experiment. Jupiter and Saturn harbour in their core phenomenal stores of hydrogen under equally mind boggling pressures. Since these planets are further away from the sun than the earth, they are also much cooler. The astronomers have, therefore, always believed that the hydrogen there must be in a solid state. Since the

present experiments lend credence to that conjecture, it would be possible to compute the electrical and magnetic properties of these planets with a greater degree of accuracy. In turn, it would be possible to predict how these electrical and magnetic fields affect our own planet.

But by far the most significant finding of Mao and Helmely is about the superconductivity that the metallic hydrogen exhibits. For they have found that this transition from a good insulator to a superconductor has come about gradually. They are hopeful, therefore, as are many others, that a detailed study of the transition would help them solve the riddle of the high-temperature superconductors that have been in the limelight since the last three years. If the solution is at hand, then everybody feels that to fabricate superconducting materials for day-to-day use would not remain a far cry.

□ □

# THE LAST PLANET



**N**EPTUNE, named after the Roman God of the sea, had remained an enigma for astronomers ever since it was discovered about a century and a half ago. Despite its large size (diam. 46,600 km) the planet held its secrets from earth-bound observers because of its extreme remoteness, till *Voyager-2* lifted the veil last August. In a spectacular feat, unparalleled in technological history, the

**On 25 August 1989, after a 7 billion kilometer voyage lasting 12 years, the frail-looking *Voyager 2* arrived at its last port of call, Neptune. BIMAN BASU narrates the exciting findings of the encounter**

12-year old aging craft sent back breathtaking close-ups of the blue-green planet—at present the solar system's most distant member. In just over 24 hours, as it swept past the planet and its large moon Triton, *Voyager* revealed more about Neptune than could be gleaned in almost 150 years of telescopic observation. For the first time, evidence has been found of violent storms in the planet's methane-rich atmosphere,

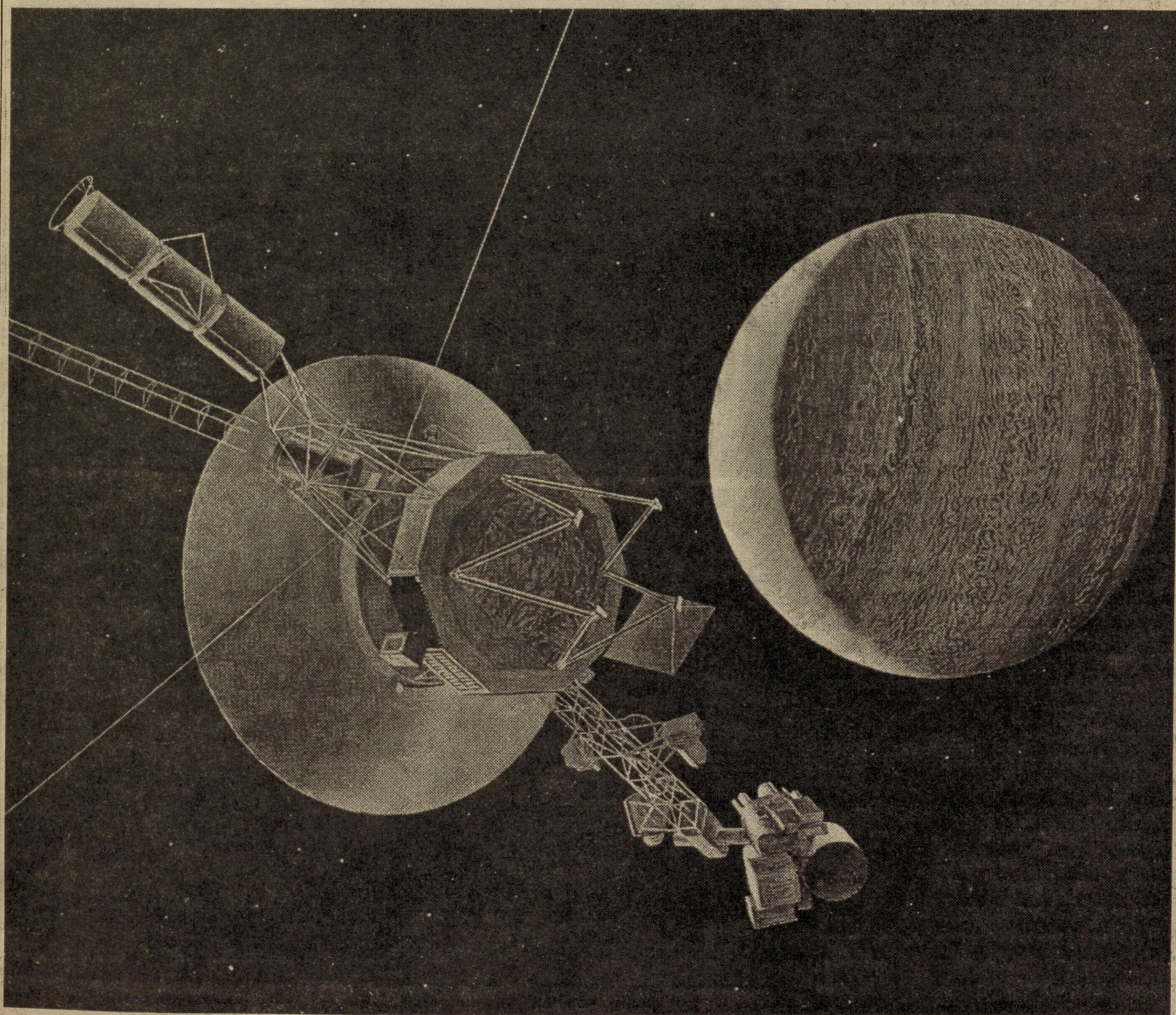


Fig. 1. Artist's impression of Voyager-2 near Neptune

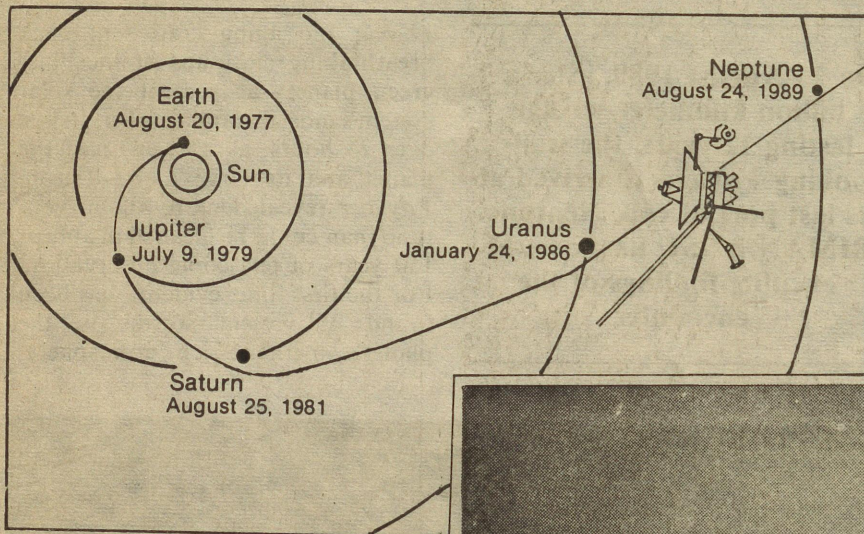
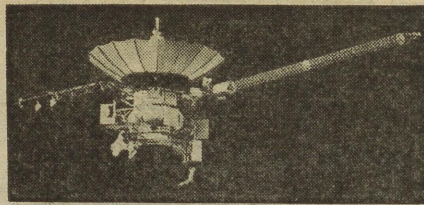


Fig. 2. Voyager-2's grand tour of four planets

rapidly moving white clouds, and intense radio emissions, confirming the existence of a magnetic field. From the period of rotation of the magnetic field as measured by *Voyager-2*'s instruments, it is now confirmed that the planet rotates once in 16 hours, and not in 17 or 18 hours as estimated earlier. The *Voyager* has also found six new moons and a most unusual ring system around the planet. In a span of a few hours, *Voyager* has transformed Neptune from a mere bluish-green dot in an earth-bound telescope to a "fascinating world in its own right". Yet more surprises may be in store, for the bulk of the data sent back during the flyby—in the form of some 500 kg of magnetic tape—is yet to be processed.

Some of the most startling data have come from Neptune's largest moon, Triton. The *Voyager* data showed that Triton was only 2784 km in diameter and not 4000 km as believed earlier. It was found to have a thin atmosphere made up of nitrogen with a little methane, with an atmospheric pressure a mere hundred-thousandth that on the earth. *Voyager* photographs showed

a prominent ice cap—believed to be mainly frozen nitrogen—at the south pole of Triton. The spacecraft also found evidence of largescale volcanism on Triton in the past. The photographs showed a smooth, roughly circular area several hundred kilometres across that could be a crater of an ancient 'ice volcano' that once spewed frozen gases. The surface of Triton was found to be covered with

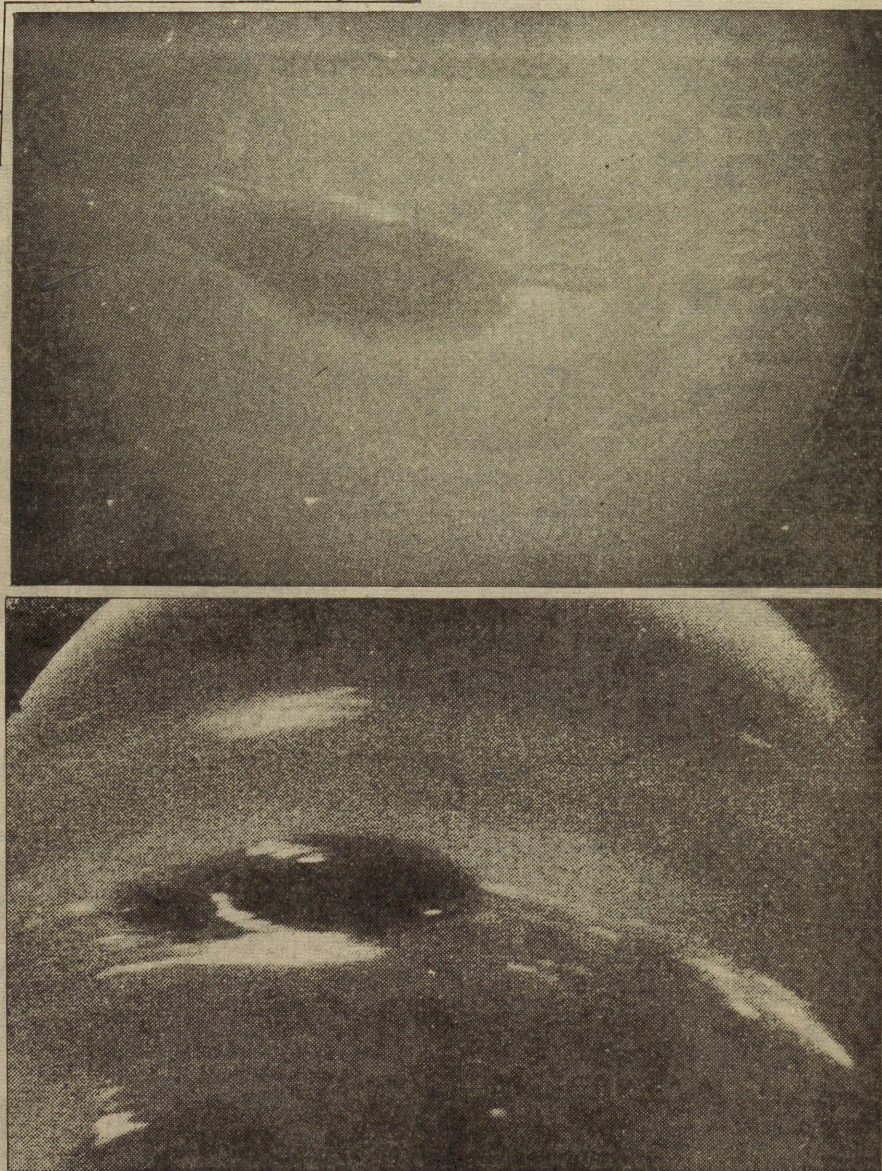


Fig. 3. Two views of the Dark Spot and white clouds in Neptune's atmosphere showing rapid movement

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cliffs, faults and glacier-like terrain 'with a sprinkling of craters'.

**N**EPTUNE is the fourth largest planet of the solar system, after Jupiter, Saturn and Uranus. It was discovered less than 150 years ago as a result of a well-planned careful search by the German astronomer Johann Gottfried Galle. The first hints that there could be a planet beyond Uranus came as astronomers tried to calculate the first trans-Saturnian planet's orbit. They found that Uranus was not following its calculated path, as if it was being pulled out of its orbit by some unknown body. Two astronomers—an Englishman, John Adams and a French, Urbain Leverrier—independently working on the problem came to the same conclusion: There must be a large planet beyond Uranus. They even predicted exactly where to look for it. But neither Adams nor Leverrier followed up their predictions with actual observation. The credit for that went to a young astronomer of Berlin Observatory named Johann Gottfried Galle. He spotted the new planet in the constellation of Aries in his first attempt on the night of 23 September 1846. Named after the Roman God of the sea, Neptune was the first planet to be discovered on the basis of mathematical prediction. Neptune's largest moon Triton was discovered in the same year by William Lassell. A second smaller moon Nereid was discovered by Gerald P. Kuiper in 1949.

Neptune is so far away—nearly 5 thousand million kilometers from the sun—that despite its being the fourth largest planet of the solar system it is invisible to the naked eye. Through even the largest telescopes it appears only as a small, mottled, bluish-green disc. Atmospheric methane, which absorbs red light, gives Neptune its greenish colour. From the study of the markings on its surface, known to be caused by cloud movements in Neptune's atmosphere, astronomers had predicted that the planet rotated once every 18 hours. It was also con-

jectured that the planet had an active weather system. But apart from these minor observations and conjectures, man's knowledge about Neptune had not improved substantially since its discovery, till *Voyager's* recent fly-by.

tened the whole mission. Eight months after launch the primary radio receiver of the craft shut down and a failed capacitor drastically curtailed the performance of the backup receiver. Yet the mission scientists were able to get over the problems

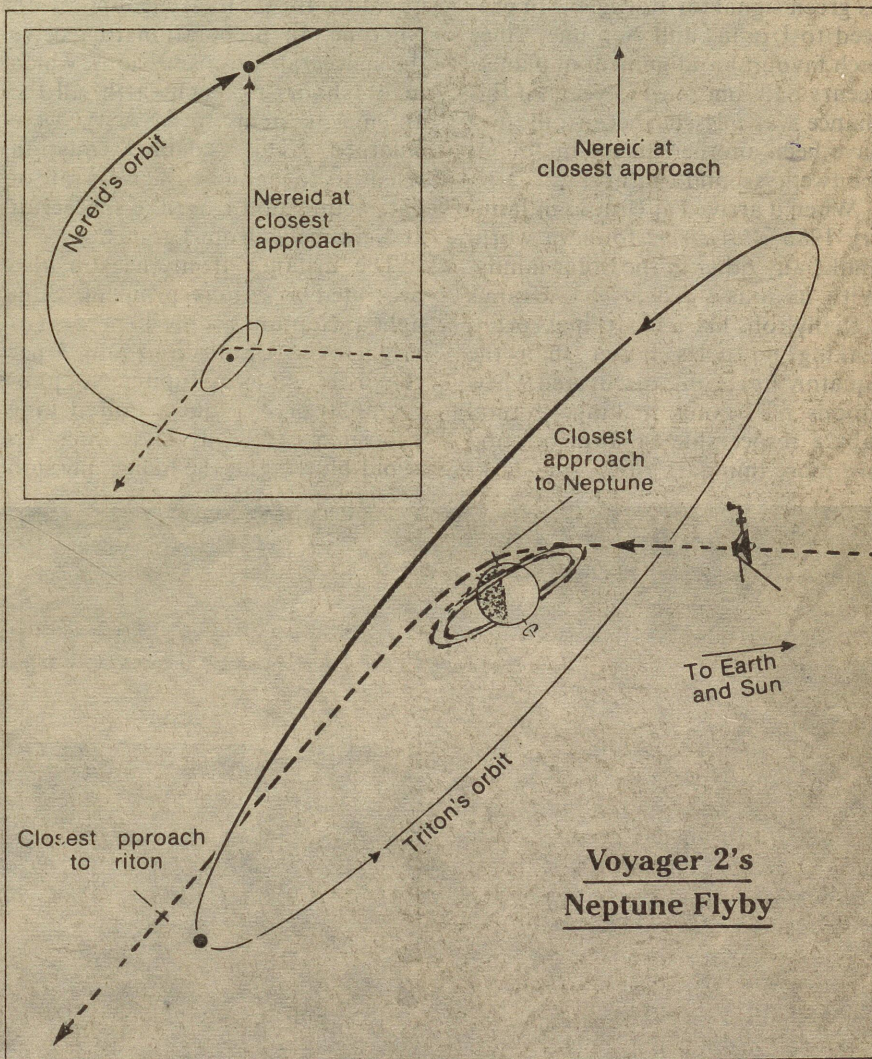
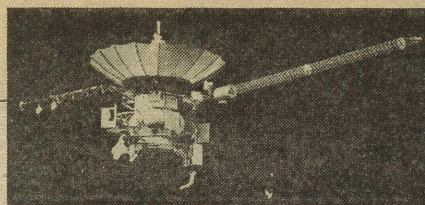


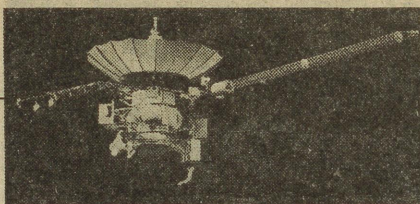
Fig. 4

*Voyager-2* was launched on 20 August 1977, with only two objectives—to explore Jupiter and Saturn from close range. Its expected lifespan was just over 5 years. But within weeks of its launch, the spacecraft suffered the first in a series of equipment breakdowns that threa-

and keep the mission going.

*Voyager-2* reached its first port of call, Jupiter, on 9 July 1979, sending back a wealth of pictures and scientific data on the giant planet and its moons. It complemented the data collected by its predecessor *Voyager-1* a few months before. Accelerated by

pid



Jupiter's gravity, *Voyager-2* then was set on course to Saturn, arriving there in August 1981. In the meanwhile *Voyager-1* had successfully completed its Saturn mission and was heading out of the solar system. It was at this stage that NASA gave its green signal for *Voyager-2* to proceed to Uranus and Neptune. Since such favourable alignment of planets occurs only once in 175 years, if this chance was missed, there would not have been another till the middle of the twentysecond century!

When it arrived at Uranus in January 1986, *Voyager-2* found a world unlike any other in the Solar family. With its axis tilted at 98°, Uranus actually rolls like a barrel in its orbit, making its poles hotter than the equator. *Voyager-2* discovered 9 new moons of Uranus making its total tally a respectable 14. It also found five more thin dark rings—the dark-

of rotation of the planet, although it may be tilted by a few degrees. But in case of Uranus, the magnetic axis was found to be tilted by a remarkable 59° from the planet's axis of rotation.

After the Uranus fly-by, the spacecraft and ground systems were upgraded for the final encounter with Neptune. In preparation to receive the spacecraft's transmissions, which take 4 hours to reach earth, all the antenna systems of NASA were enlarged. This enabled mission scientists to maintain the same rate of data acquisition from the spacecraft at Neptune as from Uranus.

The distance from the sun also presented a serious problem. Sunlight at Neptune is only 40 per cent as bright as at Uranus and only 3 per cent as bright as at Jupiter. So, photographs of Neptune required long exposures—typically 15 seconds. To avoid blurring of the image, mission

how effective these measures have been.

On 13 March 1987, about 15 months after its historic encounter with Uranus, *Voyager-2*'s small rocket engine fired for the 15th time setting it on course to Neptune. The Neptune encounter period actually began on 5 June this year when the spacecraft was 117 million kilometers away. The first details of the planet's cloud tops started coming in when the spacecraft was still 8 million kilometers from the planet. The very first pictures gave the scientists a glimpse of Neptune's surprisingly stormy atmosphere. They showed several huge hurricanelike storms and violent winds surging through the planet's atmosphere. The biggest storm appeared as a huge dark spot—roughly the size of the earth—in Neptune's southern hemisphere, similar to Jupiter's Great Red Spot.



**Fig. 5. The south polar region of Neptune's largest moon Triton showing a great variety of surface features. Scientists say Triton is the coldest place measured so far in the Solar System**

est in the solar system—around the planet. One of the most unusual phenomena observed on Uranus was its magnetic field. In most planets with magnetic fields, the magnetic axis generally coincides with the axis

technicians developed ingenious ways to steady the spacecraft and to compensate for its motion relative to a passing target. The sharp pictures sent by *Voyager* of Neptune's cloud systems and its moons demonstrate

Some of the pictures also showed cirrus-like clouds high above the dark spot, indicating the presence of unexplained energy.

The rapid cloud movements and turbulence of Neptune's atmosphere

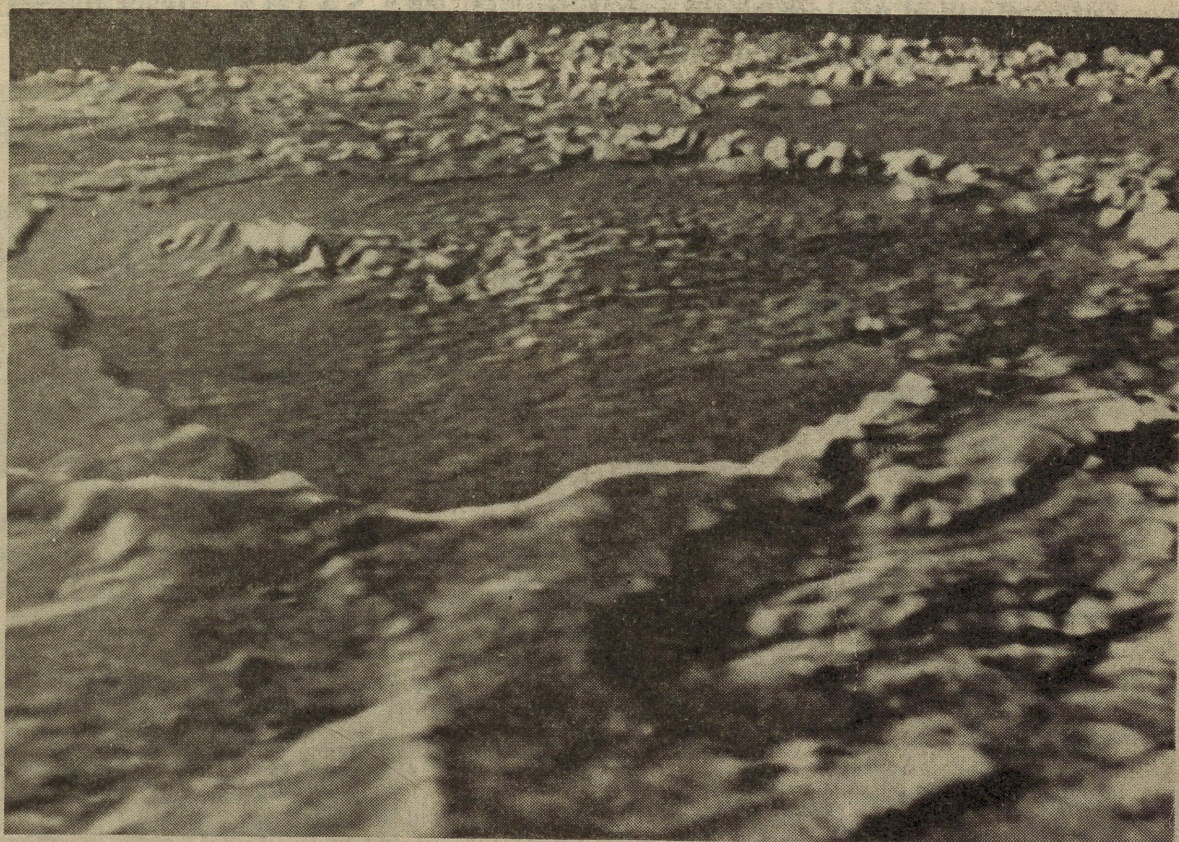
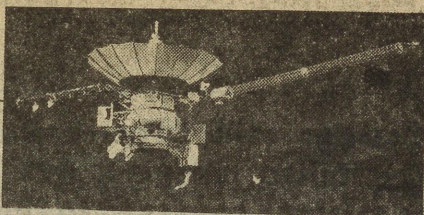


Fig. 6. A caldera-like depression on Triton photographed by Voyager-2

have come as a surprise for planetary scientists. Being far away from the sun, Neptune receives about a thousand times less sunlight than the earth. Since weather is generated by heat, scientists believe the planet must be generating internal heat of its own. But they don't have any idea about its origin. Maybe the *Voyager* data will provide some clue.

Another surprise find of *Voyager-2* was the tilt of Neptune's magnetic axis. It was found to be inclined at an angle of  $50^\circ$  to the axis of the planet's rotation. This makes Neptune almost a magnetic twin of Uranus, which has a magnetic axis tilt of  $60^\circ$ .

The *Voyager* photographs have confirmed the existence of one of the most bizarre ring systems in solar system around Neptune. While not as spectacular as the delicate threads around Uranus or the magnificent

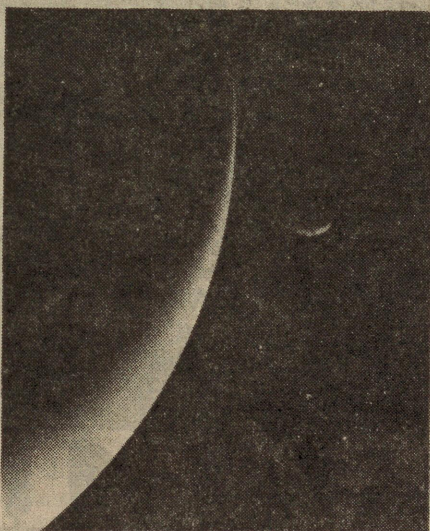


Fig. 7. A parting shot of Neptune and Triton sent back by Voyager

bands of Saturn, the broken 'ring-arcs' of Neptune are baffling. Of the three ring systems picked up by *Voyager*, one is the most uneven ring yet detected, with thicker arcs strung out along it at intervals, and clumps within the arcs. It is like a garland of elongated beads strung along a thin thread.

After its 12-year four-planet 'Grand Tour' *Voyager-2* is now heading for the stars. It is not yet dead, and is likely to continue sending back scientific data on interstellar space for at least 25 years. It carries on board a 12-inch copper disc carrying sounds of earth—whalesong, music and greetings in 60 languages for aliens in case they find it! Back home, planetary scientists have enough *Voyager* data to keep them busy for years.



The cryptic telephonic message said "The Italian navigator has arrived.... The natives are friendly". The Italian navigator was none other than the physicist Enrico Fermi and the message conveyed to the world the news of the first successful controlled nuclear chain reaction. R. M. SATHE describes the exciting developments that ultimately led to the epoch-making event



# BREAKING THE BARRIER

## The atomic age

**M**ANKIND witnessed the initial outburst of atomic energy—nuclear energy to be exact—in its most horrifying form during the bombing of Hiroshima and Nagasaki. Most of those engaged in the manufacture of the 'atom bomb' were flabbergasted and deeply dismayed at this devastating and destructive outcome of their 'scientific' endeavour. After a time however a silver lining appeared on the dark clouds of impending extermination during a 'nuclear war'. It was realised that nuclear energy could well be harnessed for peaceful purposes, especially for the generation of cheap and plentiful electrical power. Today about 400 nuclear reactors are producing 16% world's electricity. In countries like France, 70% of electricity generated is nuclear.

Nuclear fission—the reaction responsible for the release of nuclear energy—has achieved the status of an epoch-making discovery, the harbinger of a new age wherein man has mastered a novel source of energy.

### The structure of the atom

The concept that all matter, though apparently continuous, was composed of tiny particles is a very old one. Democritus named them as 'atoma' (indivisible) while Hindu rishis called it 'anu' (smallest) and included it in the thousand names of Lord Vishnu. These ideas were however purely speculative. It was John Dalton (1809) an English teacher who placed this concept on a firm scientific footing. An important postulate of his atomic theory was that it is impossible to convert atoms of a given element into those of any other element. This was to counter the alchemists' search for a 'philosopher's stone' capable of converting baser metals into gold.

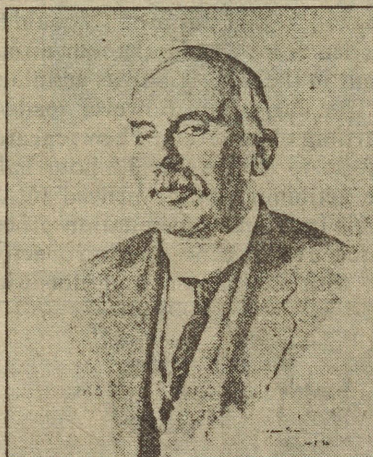
This assertion however received a big jolt from an entirely different direction. In 1898, Henry Becquerel discovered the phenomenon of radioactivity when he found that atoms of certain heavy elements disintegrate spontaneously with emission of alpha particles (nuclei of helium), beta particles (electrons),

and gamma rays (radiation of very short wavelength).

The loss of the charged particles resulted in the transformation of the atoms of the original element into those of neighbouring elements in the Periodic Table.

### Atomic number

Further work by J.J. Thomson, Lord Ernest Rutherford and T.H. Moseley led to the elucidation of the internal structure of the atom. Accordingly, the atom was characterised by its atomic number, i.e., the



Lord Rutherford

number of protons in its nucleus. The atoms of nitrogen differ from those of oxygen simply because the nucleus of latter contains just one more proton. The distinction between the two was not qualitative but merely quantitative. It was as if one could stretch Anil Kapoor a bit and end up with an Amitabh Bachan!

### Artificial transmutation

Scientists not merely aim at understanding nature but try to imitate and whenever possible improve upon it. Efforts were, therefore, immediately on to bring about a change in the atomic number of lighter elements. Lord Rutherford in fact did achieve in 1919 such an artificial transmutation when he bombarded nitrogen gas with energetic alpha particles to produce atoms of oxygen, releasing a proton in the process.

These novel nuclear reactions—changing one element made by Nature, into another—differed greatly from the familiar chemical reactions like, say, burning of a can-

dle to produce carbon dioxide and water. The energy released during the course of the former was much greater. For example, the interaction between a fast moving deuteron (nucleus of heavy hydrogen) and a single lithium nucleus produced about 22.5 million electron volts of energy, compared to about 4-5 electron volts per molecule in a chemical reaction. But there is a catch! Out of about  $10^8$  deuterons used for bombardment, only one can succeed in bringing about this nuclear reaction!

One of the obstacles in this regard was a natural one. All nuclei possess a positive charge. Heavier the nucleus, higher is this charge. So when the positively charged proton approaches the nucleus, it experiences an increasing repulsive force since like charges repel each other. Only if the kinetic energy of the proton is high enough, can it cross this barrier and crash-land on to the nucleus. This problem however got solved in 1932 with the discovery of a neutral particle, the neutron,—by the English physicist, James Chadwick.

### Neutron induced reactions

When alpha particles emitted during natural radioactive disintegrations react with metallic beryllium, a stream of neutrons emerges. Using these beams, Enrico Fermi in Rome embarked upon a systematic investigation of nuclear reactions initiated by neutrons.

In such reactions, an inactive atom, say, sodium ( $^{23}\text{Na}$ ) would normally capture a neutron to become radioactive sodium ( $^{24}\text{Na}$ ). Being inherently unstable it would throw out a beta particle and get converted to the next neighbouring element, magnesium ( $^{24}\text{Mg}$ ). Fermi therefore extended this study to the heaviest known element, uranium to see whether elements beyond uranium which do not exist naturally on the surface of the earth could be 'manufactured' in the laboratory.

The irradiation of uranium with slow neutrons did actually produce a variety of new atoms which could be distinguished by their characteristic half-lives (time in which half the original number of radioactive atoms disintegrate). Two groups got actively

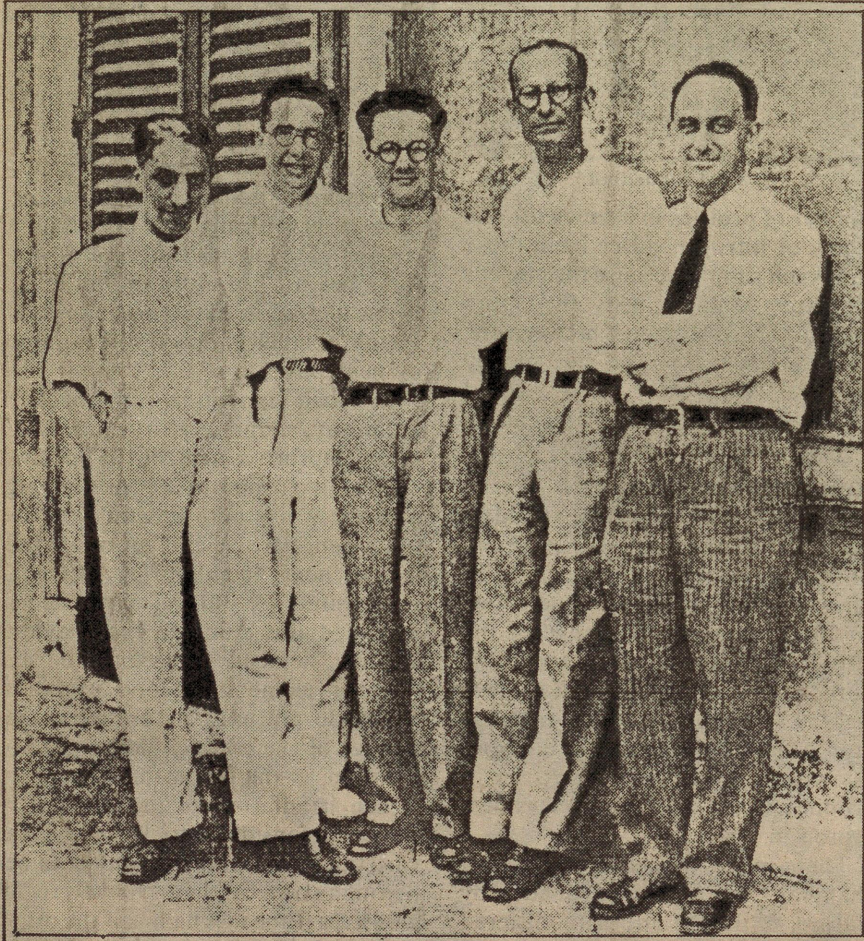
involved in the investigation of these new transuranic elements. The Berlin group consisted of Otto Hahn, Lise Meitner and Fritz Strassmann, while the Paris group included Frederic Joliot, his wife, Irene (daughter of Madam Curie) and Savich. Both groups employed the so-called 'Carrier' technique to separate and identify these 'alleged transuranic elements. In this method, large amounts of an inactive element, the carrier, were added to the element bombarded by neutrons. Conditions were then created for precipitation of the carrier. The latter carried along with it traces of the new elements formed if any.

#### Radium or barium

The Berlin team found that one of these elements precipitated along with a barium carrier. They naturally concluded that the new radioelement must be an isotope of radium which

belongs to the same group in periodic table as barium. This was rather unusual because the formation of radium (at. no. 88) from uranium would require the simultaneous emission of two alpha particles, a most unlikely event for which there was no evidence. They also observed that this radium isotope decayed by beta emission to produce a radioelement with a 3.5-hour half-life. This 'daughter' was naturally assumed to be an isotope of actinium (element next to radium, having atomic number 89). This supposition was strengthened by the fact that this product could be carried down with lanthanum, an element in the same group as actinium.

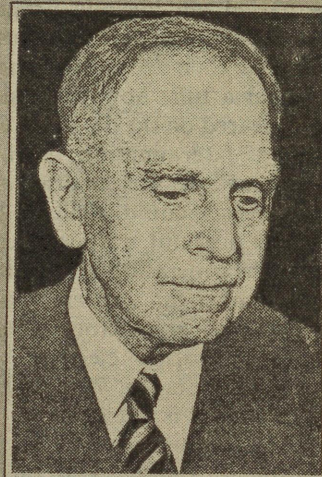
The Paris team however made a startling observation. Their repeated efforts to isolate this 3.5-hour half-life actinium isotope proved futile. Their fractional precipitation procedure led to the concentration of activity with lanthanum and not with



Enrico Fermi's group in Rome, 1934. (Left to Right) Oscar D. Agostino, Emilio Segre, Edoardo Amaldi, Franco Rasetti and Fermi

#### From chemical weapons to nuclear fission

**I**N January 1915, Sergeant Otto Hahn, while on active service on the Western Front, had come to Brussels for rest. He was not to return to the trenches for he had received orders to report



to Fritz Haber, Director of the Kaiser-Wilhelm Institute for Physical Chemistry where Hahn himself headed the sister Institute for Chemistry. The purpose: Development of chemical weapons for Germany. Such weapons were in fact banned by the Hague Convention of 1899 whose declaration was ratified by all the major European countries. Hahn therefore objected to Haber's proposal but was finally persuaded to actively participate in the project by one argument: Use of poisonous gas could bring the war to a much speedier end—thus ultimately saving lives.

About thirty years later, the same argument was used for the rapid termination of the Second World War by deploying atomic weapons produced by making use of Otto Hahn's own discovery of 'nuclear fission'. Hahn was awarded the 1944 Nobel Prize in Chemistry for his pioneering work on nuclear fission. His collaborators were left out.

actinium. Hahn in Berlin received these findings with great dismay, astonishment and outright consternation. For a moment, he doubted their veracity and remarked that Irene's exalted parentage did not necessarily qualify her for accurate

## Lise Meitner—an ignored talent

**T**HE discovery of nuclear fission is closely intertwined with the somewhat sorrowful story of the woman scientist, Lise Meitner. An Austrian Jewess, Meitner was one of the first women to obtain a doctorate in physics at the University of Vienna.

When she came to Berlin to pursue a research career, she had great difficulty in finding a job. The Germans believed that a woman's work should be strictly restricted to the care of 'kriche und kinder' (kitchen and child). It was on the personal recommendation of Max Planck (originator of the quantum theory) that Emil Fischer agreed to let her work in the carpentry shop located in the basement of his institute. She was strictly forbidden to ascend the stairs to the laboratories on the upper floors where male scientists worked. Meitner however took all this in her stride and continued her work cheerfully and with a single-minded devotion. For many years, she was considered an intruder in a man's world. Readers of her articles in learned journals assumed she was a



man. An editor once expressed a desire that Mr. Meitner should write for his Encyclopedia but promptly withdrew the request on being informed that Meitner was a woman. Once when she lectured on the problems of Cosmic Physics, the local press published the title as 'Problems of Cosmetic Physics'.

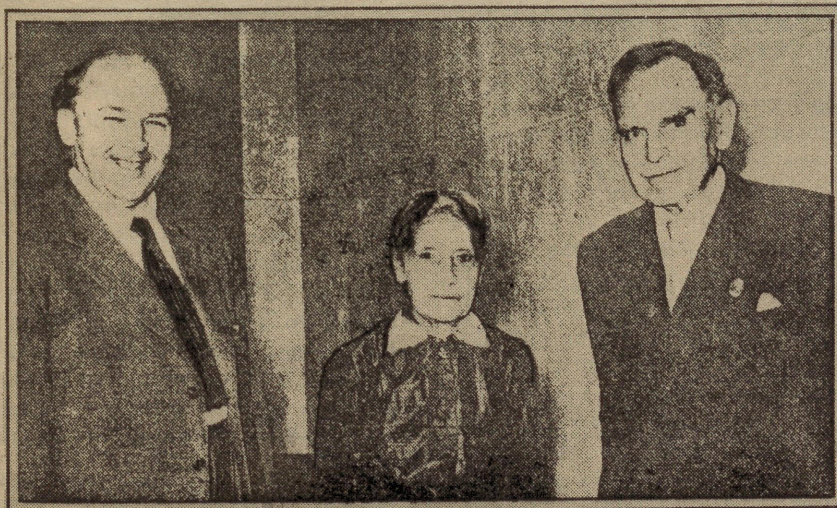
After the annexation of her country in March 1939, her position in the virulently anti-semitic Nazi regime in Germany became precarious and

and reliable chemical work!

But he also realised that if the so-called actinium did really turn out to be lanthanum, then its mother, the so-called radium, may well be barium.

As a conscientious scientist, he hurried down to his laboratory—

leaving behind an unfinished cigar—to repeat his experiments and again to his great surprise found that his radium isotope was inseparable from barium, although it could be isolated from radio thorium—a known isotope of radium.



Fritz Strassmann (Left) with Meitner and Hahn in Mainz, 1956

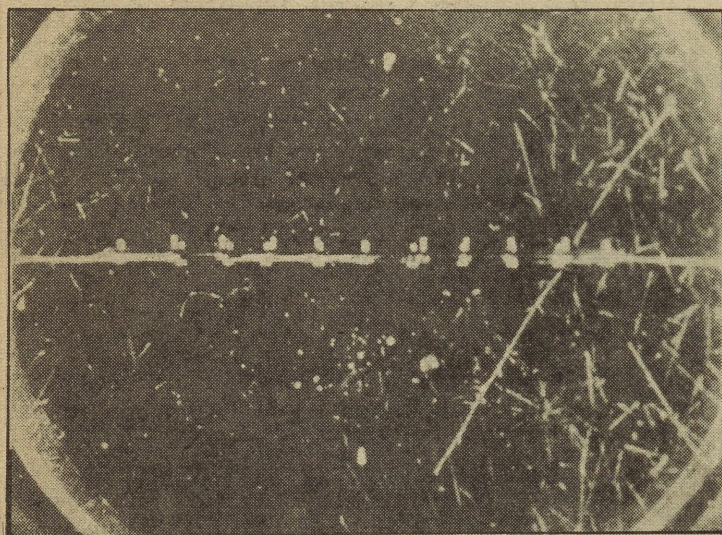
her colleagues, at great risk, arranged her escape to Sweden.

Though Meitner was deprived of her credit for her contribution to the discovery of fission by the Nobel Committee, the U.S. Atomic Energy Commission, in 1966, chose all the three scientists of the Berlin team for its Enrico Fermi Award. It was the first time that the prize went to a non-U.S. citizen—and that too, to a woman!

Surprisingly another woman, Ida Noddack at the University of Freiburg in Germany, had about four years earlier hinted at the possibility of nuclear fission. In *Zeit Schrift fur Angewandte Chemie*, she wrote about Fermi's experiments. "It would be conceivable that when heavy nuclei are bombarded with neutrons, they might break into pieces which would be isotopes of known elements but not neighbours of elements subjected to radiation". By a strange quirk of fate, scientists at that time (1934) thought it fit to reject her suggestion. If her idea had been vigorously pursued then, the Second World War might have turned into a nuclear holocaust.

In their historic paper, written on December 19, 1938 (published on January 6, 1939) Hahn and Strassmann therefore wrote "we have come to the conclusion that our 'radium isotope' have the properties of barium. As chemists, we should replace the symbols, Ra and Ac in our scheme by Ba and La, although as nuclear chemists closely associated with physics, we cannot decide to take this step in contradiction to all previous experience in nuclear physics". Though not explicit in its assertion, this paper is considered to be first published evidence of nuclear fission wherein the bulky uranium nucleus on bombardment with slow neutrons breaks up into smaller fragments one of which is barium.

Prof. Hahn's misgivings and prevarication in this regard is easy to understand. The early part of the 20th century was the golden age of atomic physics and Lord Rutherford was its uncrowned king. His famous



Cloud-chamber picture of uranium fission showing paths of fission fragments

crack "All science is either physics or stamp collecting" must have unnerved workers in other disciplines. To atomic physicists, the idea of a barium nucleus emerging from uranium was inconceivable (See BOX). The concept of complete disruption of the massive uranium nucleus only invited their ridicule. To them, the conclusion that a slow neutron of energy as small as 0.03 electron volts splits the uranium nucleus was as ludicrous as stating that an impregnable fortress wall is shattered by the impact of a ping pong ball!

#### A woman to the rescue

It was then left to the intuition and courage of a woman, the former associate of Hahn but then in exile, to suggest in clear terms that the slow neutrons do indeed break the uranium nucleus into two light nuclei of roughly equal size. Her paper (in collaboration with Otto Frisch) sent to the British journal *Nature* on January 16, 1939 (published on February 11, 1939) marked the first clear and unambiguous statement on the new and startling phenomenon of nuclear fission.

In early 1938, Hahn, an organic chemist turned radiochemist, had lost his closest collaborator, Lise Meitner, the physicist in their team. It was actually Meitner who had initiated the work on transuranic elements and persuaded Hahn to associate himself with her work. Hahn, however managed to keep in constant

touch with his erstwhile colleague and had hastened to despatch his manuscript of December 1938 to her.

#### Tunnelling through

A positively charged projectile is strongly repelled by the target nucleus, but at extremely short distances it comes under the influence of attractive nuclear forces. One can thus imagine the particles in the nucleus—nucleons—to be residing in a sort of a potential well (Fig. 1). An approaching charged particle must possess sufficient energy to overcome the potential barrier before it can fall into the nucleus. Similarly, nucleons must possess very high energy (of the order of 25 Mev)

She was at that time holidaying in the small township of Kungelöv near Goteberg in Sweden. Her nephew Otto Frisch had come on a visit to cheer her up during her first Christmas in exile.

Hahn's letter had stirred up a great storm in her mind and she was keen to discuss the topic with some duly qualified scientist and fortunately Frisch, a student of Niels Bohr, was at hand. But he was in a holiday mood and donned a pair of skis to literally run away from his aunt's scientific expositions. Meitner was, however, made of sterner stuff. She promptly overtook him and during their skiing tour on ice, bombarded him with her novel and inspiring ideas which finally led to their paper of January 16. It was finally Frisch, who named the splitting process 'fission' at the suggestion of one of his colleagues, the American biologist,

before they can surmount the top of the well and come out of the nucleus. But because of the wave nature of the nuclear particles they can, at times, in spite of their smaller energies can 'leak across' or 'tunnel' through the barrier. It turns out that nothing bigger than an alpha particle can escape from the confines of the nuclear well even by such a tunnelling mechanism. The emergence of a barium nucleus from irradiated uranium was therefore completely ruled out.

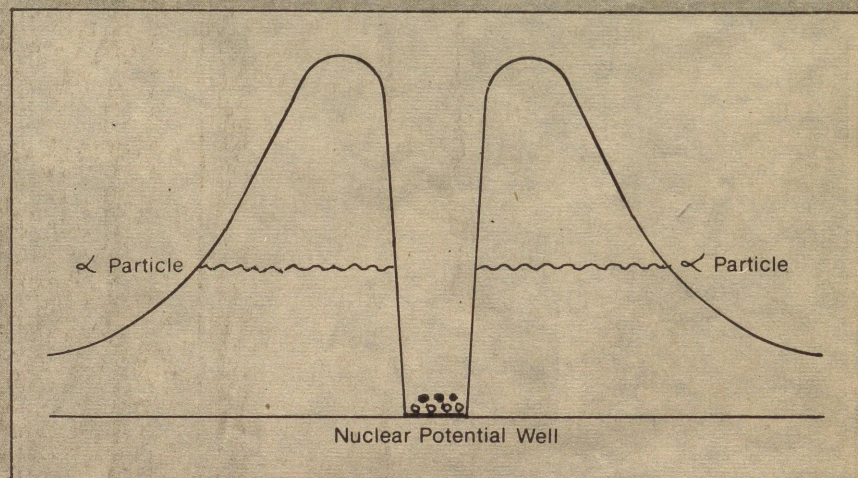
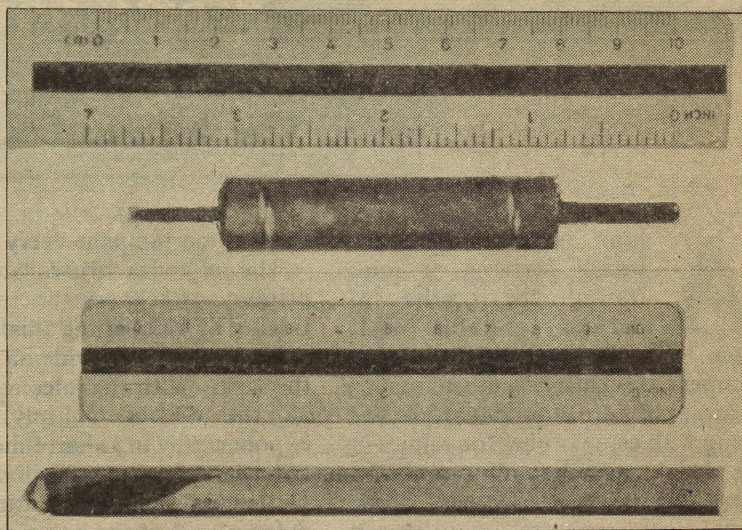


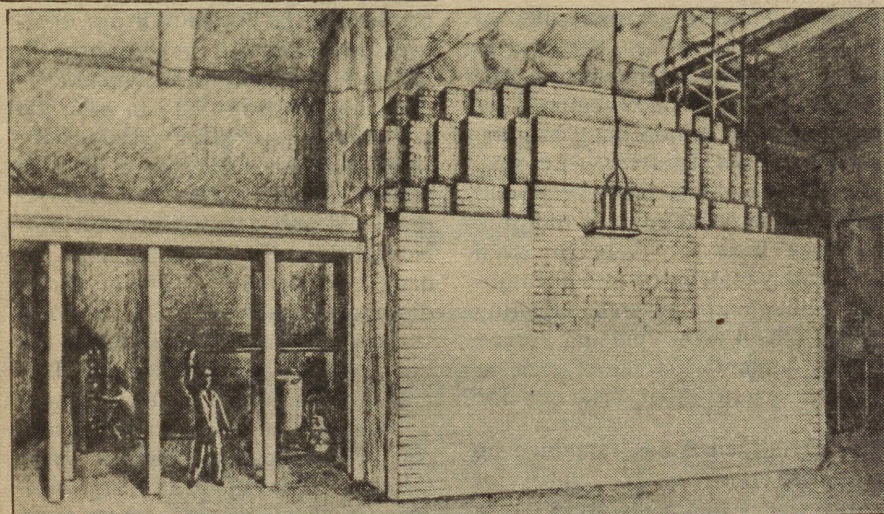
Fig. 1

### Superfluous neutrons

**W**ITH hindsight, it is now easy to understand why neutron emission is a 'must' for the fission process. For light elements, the number of neutrons and protons in the nucleus is nearly the same. For heavier elements, the number of protons in the nucleus increases and many more neutrons are needed to counter the inter-proton electrostatic repulsion. Uranium-235 contains 92 protons but as many as 143 neutrons. When this nucleus splits to produce two lighter fragments, the excess neutrons become superfluous and are set free in the fission process.



Geiger counter used by Fermi in 1930s



World's first nuclear reactor built at the University of Chicago, U.S.A.

James Arnold (February 18, 1939).

#### The birth date

The exact date of the discovery of nuclear fission thus becomes a somewhat moot point. Is it something like fixing a child's birthday. Is the baby supposed to be born at the time of conception, delivery or baptism? Nuclear fission was conceived on December 19, 1938, born on January 16, 1939 and baptised on February 18, 1939. The societies of Nuclear Scientists world over thought it fit to choose December 19, 1938, and celebrated the golden jubilee of nuclear fission on December 19, 1988.

#### The chain reaction

The main character in the final act of the drama which began in the holy

city of Rome in 1934 was Leo Szilard, a Hungarian scientist who had emigrated to the U.S. to escape Nazi persecution.

Fission would normally have gone down as just another nuclear reaction of the lithium-deuterium type in which large energy is released in an event of very low probability. Actually the energy release of about 200 million electron volts in a single fission, though sounds bombastic, is in fact very small. It is equivalent to  $3.6 \times 10^9$  Joules whereas a single unit of electricity—the kilowatt hour—is as much as  $3.6 \times 10^6$  Joules!

But it was realised that during fission, alongwith fission fragments, 2-3 neutrons are simultaneously liberated. It was Szilard who grasped this

notable feature of the fission reaction. Such neutron emission could lead to a fast multiplying chain reaction, resulting in the explosive release of an enormous amount of energy in a short time! The fearful consequences of such a possibility so unnerved him that he wrote to his fellow scientists not to publish their results on neutron emission during fission. Joliot and his team in France, however, chose to ignore his request for voluntary censorship. They believed in the average scientist's dictum, 'Publish or perish'. Their results on liberation of neutrons during fission were published soon after with an eye on a fat research grant from the French Government for their important contribution in this very promising area.

Thus shortly before commencement of hostilities in the Second World War, scientists in warring countries were aware of the possible horrendous end-result of their purely academic and intellectual pursuit.

It was finally Szilard who persuaded Einstein to write to President Roosevelt hinting at the possibility of the construction of a highly explosive nuclear device. A nod from the President launched the gigantic Manhattan Project culminating in the complete obliteration of Hiroshima and Nagasaki in August 1945.

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The blues of the flu

**A** long awaited monsoon brings torrents of rain, raising the spirits of old and young alike. What often follows the early showers dampens this enthusiasm and makes us aware of our vulnerable selves; for along with us, microbes too rejoice in the heightened humidity and the inevitable hosts of some of these microorganisms are us, human beings. The infection that is rampant in the wet weather causes high fever, followed by weakness and is identified by clinicians as 'viral influenza', an irritant that puts a healthy person out of gear for a couple of weeks and does more harm to the spirit than to the body. A normally stimulating wind results in shivering, bodyache and soaring body temperature. With cross infections common, the whole family takes a turn at sneezing and coughing, and (provided matters do not become worse by secondary infections) by the time the family limps back to health, a perfectly glorious monsoon is reduced to a morbid season of ailments.

Not long ago, influenza was attributed to an unfavourable alignment of stars. The word 'influenza' is of Italian origin, suggesting 'influence' of evil environment resulting from unlucky heavenly alliances. The name continues to convey its meaning even today—'influence', no doubt, of an 'evil environment' probably not because of stars but because of the accumulating dumps of garbage that dot the roads of over-populated cities. In the late nineteenth century, influenza was thought to be caused by bacteria, 'influenza bacillus' (*Hemophilus influenzae*). With the turn of the century, with more precise diagnosis possible, W. Smith, Andrews and P. Laidlaw, a team of English scientists, suggested a viral etiology of the affliction. A group of heterogeneous viruses, known as myxo-viruses, are the micro-villains

that are on rampage every year!

The influenza viruses launch their primary attack on the respiratory tract. The cells lining this tract, the epithelial cells, provide an abode to the virus. With the infection settling in, the viruses multiply, increase exponentially in a short time and destroy the very cells that lodge them. Destruction of cells attracts the defence cells of the body, the phagocytic leucocytes, which themselves throw out 'messenger molecules' or 'pyrogens' that affect the centres which control body temperature. The obligatory rise in body temperature follows—often to alarming heights—especially in children. If no other opportune bacteria take the advantage of the susceptible condition, influenza lasts for three to seven days, rarely blowing up into pneumonia. Though not severely affecting individuals, it is the epidemic spread of this ailment, year after year, in varying severity that cries out for relief!

Viral influenza has remained an enigma to clinicians and scientists for a long time. Attempts to prevent it by offering the traditional immunological approach fails, for the virus presents itself in several forms, each slightly different from the other. Therefore, there appears to be a limited scope for expecting a well defined vaccine that could guarantee prevention of the infection. Another promising alternative was antiviral agents. In the early sixties, a wave of enthusiasm ran through people looking for antiviral agents especially for influenza. 'Interferons', the magic molecules that showed definite antiviral activity, were discovered by A. Isaacs and J. Lindenmann of National Institute of Medical Research, England. Interferons are set of proteins and glycoproteins produced by cells of the defence organization of the body that protect them (cells) from viral infection. Three

major types of interferons can effectively sabotage the viral life cycle in various cells. A rapid progress in biotechnology has helped studies on these molecules and their manufacture in bulk by gene cloning. What holds 'interferon' from fulfilling its promise is the discomfort that follows when interferons are administered in doses that can offer protection.

Another probable answer to the problem is the design of drugs. Failure is more obvious in this approach, for no antiviral agent is available to clinicians. A drug that can meet the tall order of acting on viruses exclusively, without interfering at all with other normal cells, has as yet remained only a dream of clinicians. Nonetheless, there is some hope for drug designers. The three-dimensional structure of the viral surface molecules that attach to the host cells has been worked out. This molecule is a haemagglutinin glycoprotein, which plays an obligatory role in initiating the infection. Using the technique of X-ray crystallography, W. Weis and others from Massachusetts, U.S.A., recently reported the details of the structure of haemagglutinin protein. What is now sought is a drug, a small molecule which would fit precisely in the topography of this viral protein and create a molecular block. This could effectively render the virus without an anchor point and thus prevent it from finding a home to flourish in.

There is hope and the fight is on in several directions. We may win the battle in due course! In the meantime, we have learnt to smile through our monsoon blues.

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## In the world of BASIC-II

**I**N the first part, the reader was given a general introduction to computers. Now how to get the system started (or boot the system as it is called) will be discussed. Only after this is understood one can proceed to programming. Meanwhile one should operate a computer for some time daily and carry out some operations.

### Booting the system

Get hold of the manual of the computer system and go through it. Different systems have different arrangement of various switches, knobs, keys, etc. Commands differ only when a computer system is of a totally different type. For instance, when DOS 3.2 and Basic compiler are used, the commands will be the same irrespective of whether one is

using a Siva PC or WIPRO PC. This is what is known as compatibility. But to avoid confusion throughout the remainder of this serial, whatever commands and operations are mentioned will be for WIPRO PC/XT. In the end commands for others will also be pointed out.

Normally, there are two or three main switches, an On-Off switch for printer, and a piano type knob at the back of the instrument. Besides, on the right side of cabinet housing the screen there are two circular knobs. All the switches are put "on" in the correct order and then the piano type knob is pressed. A small beep sound may be heard. The two circular knobs are then turned on. If there is a Printer, it has a different switch (at the side) and this is also put "on" if a printout is desired. First, a RAM

count (Random Access Memory) will appear on the screen and then the DOS version will come. Subsequently, the following symbol will appear: C >

The C > (C greater than or C prompt as it is referred to) indicates that the system is ready for operation. This completes the booting of the system. Now a specific command is typed to bring the system into Basic Mode. This depends on the type of compiler or interpreter in use under which Basic Program has been loaded and can be easily noted by seeing the Directory. In due course, C > prompt disappears and the word OK or READY appears at the left hand top corner of the screen and beneath it a small rectangular flickering light. The exact version of the Basic including the copyright version



One should operate a computer for some time daily

may appear at the top. The flickering light is called 'Cursor' and indicates the position on the screen where the typed text will appear. The OK or READY indicates that the system is ready.

The system is now ready and programs can be typed into it. If one wants to work on a program stored in a floppy drive a small point should be remembered. As the floppy does not operate in the C>prompt mode and usually works in the A>prompt mode, one should load the program in the A>prompt mode.

### Keyboard layout

Information is fed into the computer through the keyboard. The keyboard has three blocks, a bigger one on the left and two smaller ones to its right. The bigger one also consists of two separate units, a central one which resembles a typewriter and two smaller ones on either side; the latter have slightly larger keys and carry names such as Return, Shift and so on. A Keyboard has what are called Alphanumeric Keys, Control Keys, Cursor Control/Numeric Pad Keys and Function Keys.

The left console has a central block resembling a typewriter and two smaller ones containing piano type marked keys. The typewriter frame has the following keys: (i) 26 alphabetical characters from A to Z; (ii) ten numerals from 0 to 9 (note that the number zero is marked as Ø to distin-

guish it from the letter O); (iii) notations for grammatical symbols and other special characters. As some of them serve the dual purpose of both grammatical symbols and Basic Commands, they are explained together (Table 1). The left and right portions of this console have the following keys:

(i) CAPS LOCK. It locks the system so that capital letters get typed. The lock gets released on pressing it again.

(ii) SHIFT. It serves two purposes; firstly, where alphabets are concerned capital letters will be typed and, secondly, where there are two characters on the same key the upper ones will be typed (whereas without pressing this key the lower ones are typed).

(iii) RETURN. This guides the cursor to the beginning of the next line. But more important, it serves the most useful function in a computer. For entering a line or giving various commands this has to be pressed. In a few systems ENTER located on the right console performs this function.

(iv) CTRL. This is used for breaking a program or stopping the screen from rolling over. In the first case for breaking a program this knob and SCROLL LOCK (located on the right console) have to be simultaneously pressed. To stop the screen from rolling, this knob and NUM LOCK have to be simultaneously

pressed. Pressing CTRL and S also stops the screen from rolling and pressing the same again restarts it.

(v) BACK SPACE. For moving the cursor backwards this knob has to be pressed. However, it does not erase the character.

(vi) TAB. This is used for inserting spaces during typing. However, the real advantage of using it is that the cursor can be manipulated very fast—pressing TAB advances the cursor by 8 or 10 spaces.

The Right Console has the following keys:

(i) - sign and + sign marked knobs.

(ii) Numerals from 1 to 9 and horizontal or vertical arrows or knobs marked as HOME, END, DEL, SCROLL LOCK, and NUM LOCK. The + and - sign are for addition and subtraction, while the horizontal and vertical arrows are used for manipulating the cursor. The idea of having numerals separately has its own advantages.

(iii) NUM LOCK. This is for choosing the option of typing numerals or of manipulating the cursor movement; by keeping this knob pressed, numerals appear whereas otherwise the cursor will be guided.

(iv) INSERT and DEL. These keys are used for inserting or deleting something in a typed matter.

(vi) HOME. This key is used to bring the cursor to Home Position (left hand top corner of the screen).

The Function keys are marked F1, F2, F3 and so on and serve the purpose of RUNNING, LISTING, etc. They will be covered separately. Activating the F2 key will issue the command 'RUN'. To learn the keyboard operations thoroughly, one has to type at random using all the keys. Perhaps at the end of a line, a cryptic message 'Syntax Error' will appear. One can ignore it for the time being and continue the typing. The actual programming can start now which will be taken up in the next part.

**Table 1. Keyboard symbols**

! Exclamation Mark	\$ Dollar Sign
@ Ampersand	% Per cent
? Question Mark	& And
# Hash	. Full stop & Decimal Point
( Open Bracket	- Hyphen
) Closed Bracket	" Inverted Commas or Quotes
: Colon	, Comma
; Semicolon	' Inverted Comma
= Equal To (Assignment Symbol)	< Less Than
> Greater Than	{ } Paranthesis
* Asterisk (Multiplication Symbol)	- Subtraction Symbol
/ Division Symbol or Slash	
\ Inverse Slash	
+ Addition Symbol	
^ Raised To The Power Symbol	

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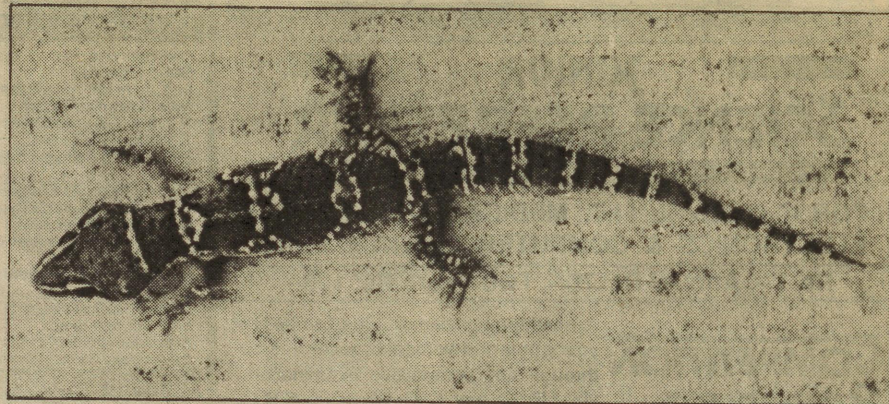
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Lizards are a fascinating group of reptiles that dominated the earth nearly 150 million years ago. Some 3,000 species of lizards are known from all over the world



1. Blotched House-Gecko

2. Fat-tailed Desert Gecko



ing the wriggling tail behind to elude its pursuer/captor.

Lizards, in general, shed their skin periodically in fragments while some like the slow worms shed in one piece like snakes. Lizards are nature's gifted artists of colour changes which are mostly influenced by light, temperature and the mood of the

animal. Males in the breeding season are brilliantly coloured and combats among them are common. Majority of the lizards produce by laying eggs while a few bring forth their young alive. Like fishes, amphibians and other reptiles, the lizards are ectothermic, which means they are incapable of regulating their temperature of their own. Barring the only two venomous lizards of the United States and Mexico, all lizards are nonvenomous. In size, lizards range from a 50 mm skink to the 3 metre long Komodo dragon of Indonesia, the largest and heaviest lizard of the world.

#### Indian lizards

Some 150 species belonging to the eight families, viz., Gekkonidae

(Geckos), Agamids (Garden Lizards), Chamaelonidae (Chameleons), Scincidae (Skinks), Dibamidae (Worm Lizards), Lacertidae (Lacertids), Anguidae (Glass Snakes), and Varanidae (Monitor Lizards) inhabit India. The commonest and well known representatives of each group are described.

#### Geckos

They are small, gentle lizards characterised by a soft dull skin and large unblinking eyes. Some have "clinging pads" on the underside of their toes which enable them to climb smooth surfaces. Geckos are found in the houses, on the ground, in the forests and on tree tops. They are the only

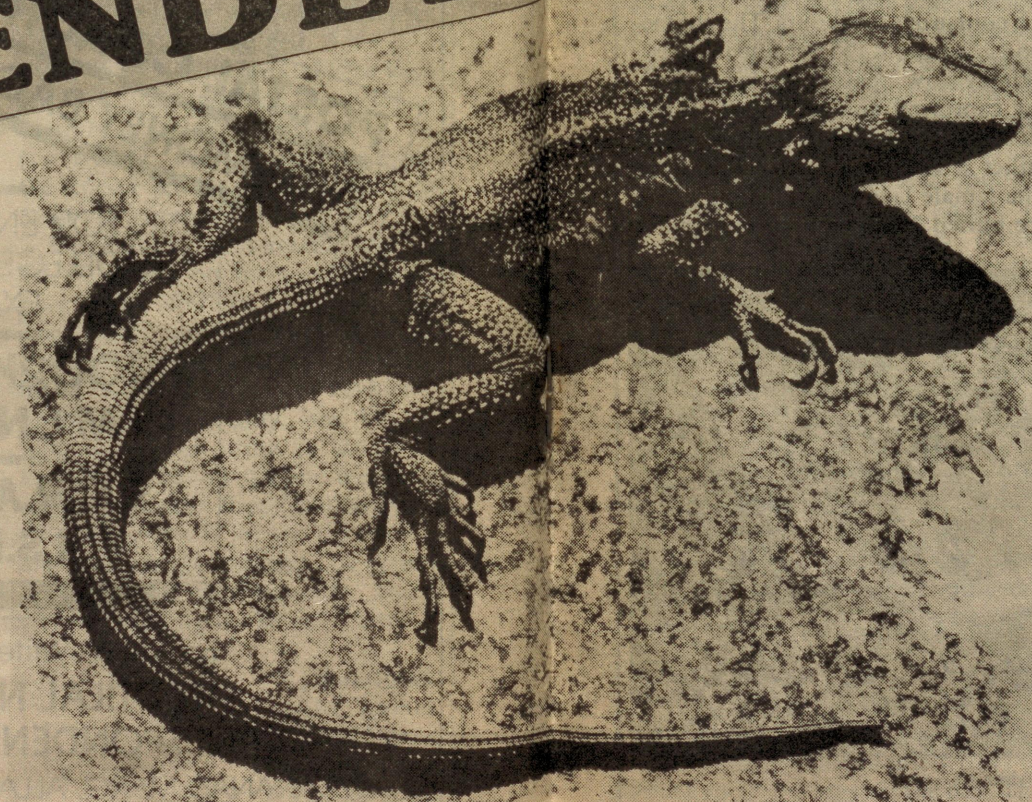
has flaps of skin on the head and the body which serve as a kind of parachute. The Great House-gecko (*Gekko gekko*) of north-east India is a giant among geckos reaching a length over 25cm. This red or orange-spotted house lizard occasionally gulps down a rat or bird in its nocturnal wanderings. When annoyed, it raises its body and growls, holding its jaws wide open in defense! Its guttural sounds are very loud and remarkably audible even from a distance.

#### Garden lizards

It is a large group of lizards

# THE FRIENDLY LIZARDS

T.S.N. MURTHY



3. Himalayan Rock-Lizard

**L**IZARDS are characterised by a short body with four well-developed limbs, a short flat tongue and an external ear-opening. Some lizards which superficially resemble snakes can be distinguished by their movable eyelids and the united halves of the lower jaws resulting in a restricted opening of the mouth. The scalation of lizards is varied and provides a clue to separate the vast assemblage of these creatures. Some have coarse, overlapping scales while some are coated with smooth scales. Yet oth-

ers, like the degenerate worm-like species, have lost their scales which are replaced by rings of skins encircling the body. The tongue of a lizard is employed as a sensory organ and also as a device for lapping up prey. Lizards drink with the tongue at a slow pace. A vast majority prey upon insects and small animals while some feed on vegetable matter. In locating their prey lizards are helped by their keen eyesight and acute sense of hearing. The tail of lacertids, anguids, geckos and skinks is shed when seized and is regrown later. This is but a protective mechanism by which the lizard can escape from its enemy leav-

reptiles to have developed a true voice matching the calling notes of frogs and birds. All geckos are egg layers but not more than two eggs are laid by a female which are deposited in the crevices of trees or under the ceilings of houses or stones on the ground. Geckos hide in their retreats during the day and become active at night when they are seen hunting for their prey—insects.

The most common house-geckos are the Spotted House-gecko (*Hemidactylus brooki*) and the Southern House-gecko (*Hemidactylus frenatus*). The Bark gecko (*Hemidactylus leschenaulti*), as its common name suggests, is a tree-dweller. The Fat-tailed gecko (*Eublepharis macularius*) is an inhabitant of the arid tracts of north-western India. It is strictly a nocturnal reptile and a voracious feeder. Several kinds of geckos are found in the forests of India. The Andaman green gecko (*Phelsuma andamanense*) found in and around Port Blair, Andamans is arboreal and diurnal in its habits. It occasionally enters the human dwellings. Another interesting gecko is the so-called 'Flying gecko' (*Ptychozoon kuhli*) of Nicobar Islands which

adapted to a diversified life on trees, on the ground and rocks. The terrestrial species have a flat body while those living on trees have streamlined bodies. The skin is covered with overlapping scales and the eyes are movable. The tail is long but is not shed easily as in other lizards. Majority of the garden lizards are insectivorous while some are entirely herbivorous. They reproduce by laying eggs.

The best known Indian garden lizard (*Calotes versicolor*) is misappropriately called a 'blood sucker' because colour of its throat changes from pale yellow to scarlet when excited. It is often found near human dwellings. This lizard lives upon insects found in the bushes and on the trees. The Rock lizard (*Psammophilus dorsalis*) of South India is often seen basking on bare rocks during mid-day. Despite the stout body, it is very agile and disappears on the first approach. The male is gorgeously coloured during the breeding season. Another beautiful rock agamid is the Himalayan rock lizard (*Agama tuberculata*). The throat and belly of the breeding male is marbled with bright blue. The 200 mm long pretty agamids *Dracos* of the forests of South India and Assam have earned the dubious distinction of being the "Flying Dragons" because they can

glide with the aid of large, loose folds of skin along the sides of the body. The toad-head Agamas (*Phrynocephalus*) are small and rather unlovely lizards of the Indian desert. They are recognised by the excessively flattened bodies, toad-like heads, and

succession when the reptile is excited.

#### Chameleon

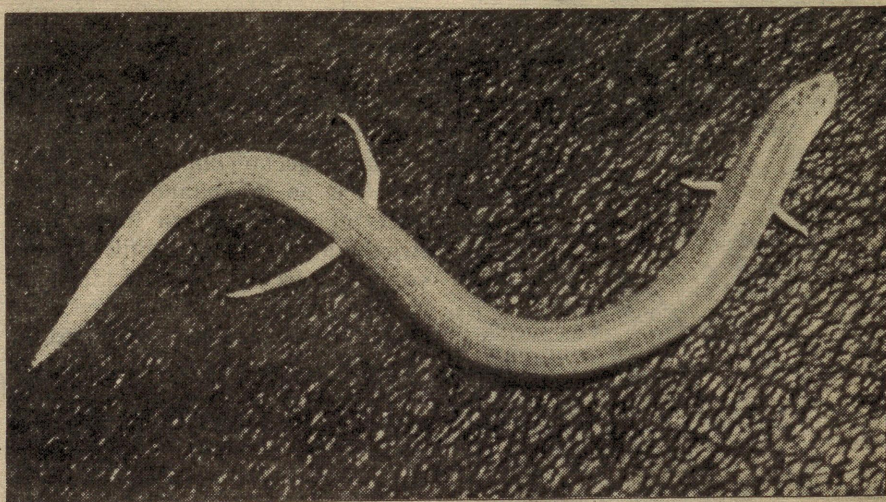
The Indian chameleon (*Chamaeleo zeylanicus*), found in the wooded districts of Peninsular India, is recognised by its compressed body,

watchspring-like tail, helmet-like knob on the head and the round bulging eyes which together give it a grotesque shape among Indian lizards. Certain of its unique features like its feet, vision, shooting tongue and the capacity to change colour deserve to be highlighted. The feet of a chameleon are like the jaws of pliers and are used for effective grasping of the twigs of trees, the animal's abode. The chameleon can shoot out its sticky tongue to catch its prey comprising mostly of insects in a lightning speed. Most spectacular is the ability of a chameleon to move each of its eyes wholly independent of the other so that the animal can see forward with one eye whilst looking sideways or backwards with the other. The popular expression "Changeable as a chameleon" is associated with this lizard's remarkable ability to change its colour. A chameleon can change its colour from green and brown to yellow, white and black, and differently on both sides of the body so much so that it is impossible to tell the colour of the animal precisely as the same individual may appear in the garb of no less than half-a-dozen shades in the course of a few hours. The chameleon grows upto 155 mm and is a provokingly slow creature, making it easy for capturing and taming it. When picked up, it hisses, inflates and can inflict a harmless but painful bite. The female lays 12 to 30 eggs which are buried 30 cm below the ground.

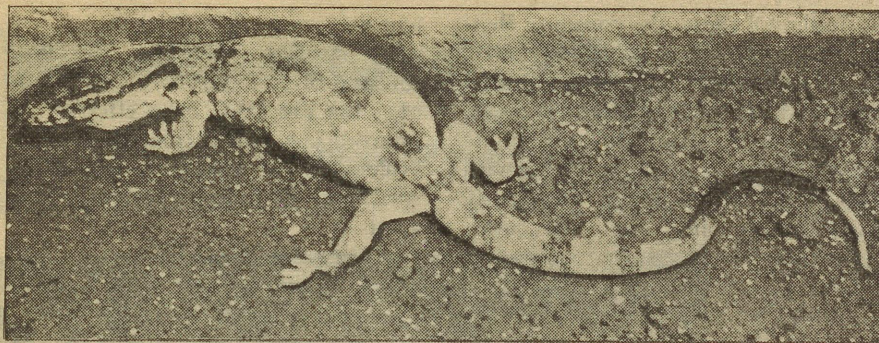


4. Striped Grass Skink

slender, tapering tails. They run at great speed and bury as quickly in loose sand. Of all the desert-living lizards, the curious, burrowing spiny-tail. (*Uromastix hardwickii*) is better known. It avoids the sun during the hottest part of the day by retiring into a burrow. Its food includes insects, flowers, plants and fruits. It defends by lashing out with its spiny tail. The ground-dwelling Sita's Lizard (*Sitana ponticeriana*) looks like a small-sized garden lizard. However, it lacks the comb of spiny scales on the back and has a very long, slender tail. The most remarkable feature of this lizard is that it has only four toes on the hind foot instead of the usual five toes. The male has a throat fan which is folded and unfolded in quick



5. Indian Sand Swimmer

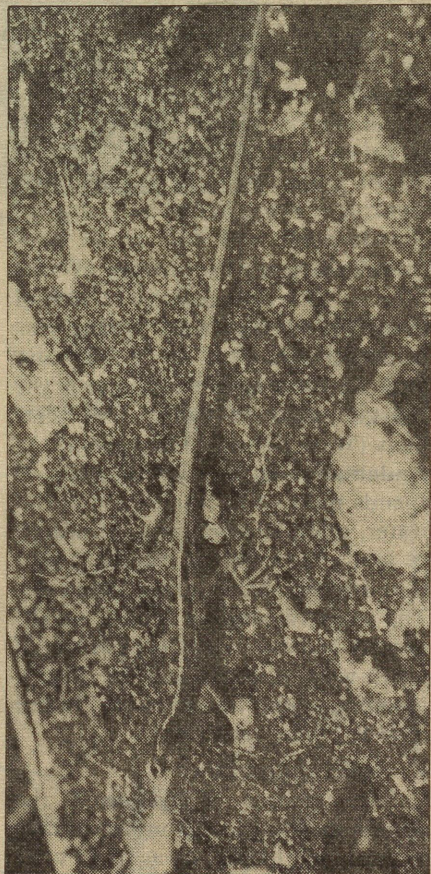


6. Desert Monitor

### Skinks

Skinks are mostly ground dwelling or burrowing lizards found throughout India but are less familiar because of their secretive habits. They are recognised by their overlapping smooth and shiny scales with symmetrical shields on the head, a broad flat tongue, and movable eyelids. Some have blunt heads which is an adaptation for their subterranean life. The tail may be long or short but snaps off to distract the enemy. The limbs may be very minute or entirely absent. Because of the pronounced reduction of limbs and elongation of the body, the skinks are often mistaken for snakes. A unique feature of some skinks is that their lower eyelids have transparent discs or 'windows' so that their vision is not obscured when the eyes are closed. Further, this disc prevents foreign particles from entering the eye. Several skinks are striped, cross-barred and spotted. Though they lack the ability to change colour, the male skinks acquire red or orange hues during the breeding season. Skinks mostly feed upon insects. Majority of them are egg-layers but a few are live bearers.

The limbless skink (*Barkudia insularis*) found on Barkuda Island, off Chilka Lake (Orissa) is a rare species. It burrows rapidly in loose soil. Striped skinks of the genus *Mabuya* are common. These small to medium-sized lizards can move with remarkable speed when pursued. Each species is characterised by a definite pattern of stripes or lines on the back and the sides. The Yellow-bellied mole skink of Kashmir (*Eumeces taeniolatus*) is a secretive lizard which remains hidden in burrows or under rocks for most of the day. The



7. Fan-throated Lizard

Indian Sand-swimmer (*Ophiomorus tridactylus*), a denizen of the desert, literally 'swims' its way under the surface of the sand and hence its Punjabi name 'ret-mahi' which means a sand fish. It can burrow upto 30 cm under the sand and emerges after sunrise. The Himalayan skink (*Leiolopisma himalayanum*) is common in Kashmir, Punjab and U.P. It shuns light and lives in rather damp situations. It brings forth its young alive—3 or 4 at a time.

### Worm-lizards

The glassy scaled Indian worm-lizard (*Dibamus novae-guineae*) found in the Nicobar Islands is a degenerate type of skink. To the layman, this 225 mm long lizard appears as a slender worm. In tune with its subterranean existence, it is blind and devoid of fore-limbs which are modified into scaly flaps in the male. The head is blunt and conical with a large cuplike shield on the snout. The tail is short and cannot be detached. The origin of this lowly reptile is a mystery and nothing is known of its life-history.

### Lacertids

Lacertids are typical lizards because of their slender bodies, well-developed legs, and long, pointed tails. Among them are neither specialised nor degenerate species. They are met with in the sandy, grassy and rocky areas. The fragile tail is easily shed and the broken part is regrown. Majority of the lacertids are insectivorous while a few are cannibalistic. All Indian lacertids are egg-layers.

The Indian Fringe-toed lizard (*Acanthodactylus cantoris*) has

Lacertids are typical lizards because of their slender bodies, well developed legs, and long pointed tails

scales on its digits that project along the sides to form a comb-like fringe. This lacertid, met with in the sandy tracts of northern India, is brightly marked while young. It lives in burrows under bushes and comes out on a bright day. It is a very agile lizard, disappearing quickly into bushes on the slightest alarm. The Race-runner lizards of the genus *Ophisops* (*O. jerdoni* and *O. beddomei*), are found in the northern as well as the southern India. These moderately sized lacer-

tids have transparent discs in the centre of the lower eyelids. The Long-tailed Grass lacertid (*Takydromus sexlineatus khasiensis*) has its home in the Khasi Hills. This six-lined lacertid is nearly 175 mm long of which the tail accounts for 120 mm.

#### Glass-snake lizard

The Glass-snake lizard (*Ophisaurus gracilis*), the sole representative of the family *Auguidae* in India is found in Darjeeling and the Khasi Hills (Eastern Himalayas), often at high elevations ranging from 820 m to 1500 m. The glass-snake is so called because of its brittle tail and the lack of limbs. It glides like a serpent by lateral undulations. It probes its way by employing its blackish tongue in a truly snake-like fashion. However, the lizard's identity can be established by its movable eyelids and an ear-opening which are quite unusual features in the serpents. The body is coated with ring-like overlapping scales. It is a terrestrial species and hides under logs and stones for most of the day. It is sluggish in disposition but gets active at night when it wanders in search of food mostly comprising of insects. Despite its superficial resemblance to a serpent, the glass snake is quite harmless and does not bite when handled. When first picked up, it feigns death. The female lays 4 to 6 eggs.

#### Monitor lizards

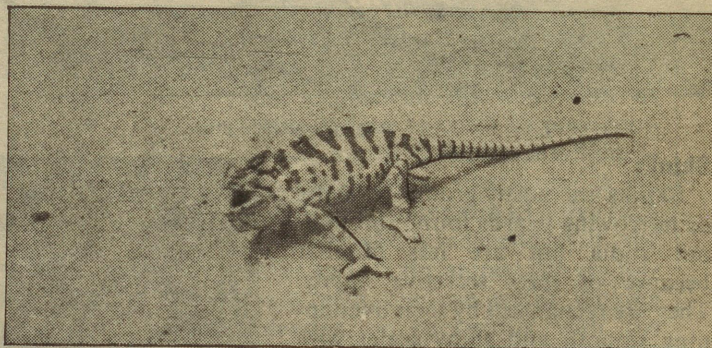
They are the largest and heaviest members among lizards. They have a distinctive appearance because of an elongated head, an unusually long neck and tail, and a snake-like forked tongue. A large monitor, if cornered, will inflate its body, hiss loudly, lashes its tail vigorously and puts out its sharp claws. Despite their stout bodies, monitors are good climbers, runners and swimmers too. All are predaceous animals, eating any animal that they can overcome. They are fond of the eggs of birds and other reptiles. A monitor does not chew or crush its food as other lizards do but swallows the prey whole or in large chunks. The eggs numbering 15 to 30 are deposited in the termite mounds or other such secluded spots.

Four kinds of monitors are found

in India. Of these, the common Bengal Monitor (*Varanus bengalensis*) is met with in the forested areas and on the outskirts of the cities and villages. It escapes detection because of its brownish hue which harmonises with the surroundings. It is frequently seen during and after the rains.

lent and sweet, like chicken.

Preparations made from the fat of this and other desert dwelling lizards of India are said to be effective as aphrodisiacs. Oil extracted from the visceral fat of monitors is used for treatment of failing eyesight in the aged.



8. A chameleon in an angry mood

India's largest lizard, the Water Monitor (*Varanus salvator*) is second in size only to the Komodo dragon as it reaches a length of 2.6 m. This rare and protected species is found in the coastal mangrove regions of Sunderbans (West Bengal), Orissa, and the Andaman and Nicobar Islands. It spends most of its time near to or in water, often climbing trees in search of its food consisting mostly of reptiles, rodents, fishes, crabs, snails etc. The other two Indian species are the Desert Monitor (*Varanus griseus*) of north-western India and the Yellow Monitor (*Varanus flavescens*) found in U.P., Bihar and Orissa.

#### Economic importance

The presence of geckos in the human dwellings is to our advantage as these little lizards are as effective as birds in destroying harmful insects and pests. Particularly the monitor lizards serve not only as useful scavengers but also as destroyers of coconut pests like crabs, beetles and snails. Further, the diet of these lizards includes rodents such as squirrels and rats.

The eggs of monitors are a great delicacy and the animals themselves provide a full meal. The spiny-tailed lizard is captured in large numbers by the desert people for its flesh. The head and feet are not eaten, but the spiny tail is considered a great delicacy, and the meat is said to be excel-

The leather of monitors has been much sought after because of its reputedly high wearing quality, infinite variety of pattern and texture. Moreover, they can be finished off in any colour. In the year 1957-58 about 1,625,021 skins valued at Rs. 31,66,039 were exported. The skins of the water monitor have become rare.

All the Indian four monitor lizards and certain lizards like the chameleon and spiny-tails are now protected under the Wild Life Act of 1972 (Schedule I).

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## Fishy Parasites

**M**YXOSPOREANS are a small group of sporozoan parasites belonging to the phylum protozoa. They usually infect the lower vertebrates especially fishes—both fresh and marine water.

Myxosporean parasites comprise hundreds of species belonging to 20 genera. Many of them, particularly those which develop in the viscera (comprising the heart, lungs, liver and other large organs), produce serious diseases in their hosts. Such diseases may be fatal, like “whirling or twist” disease of salmon and trout in the Pacific, which is due to a myxosporean *Myxosoma cerebralis*. This parasite invades the head cartilage, particularly around the auditory cap-

sule of the trout. The cartilage may be extensively damaged, causing deformities and impairment of balance. Hence the infected fish swims in a characteristic whirling manner in which is based the name of the disease. Many other species infect the skin and muscles of their hosts; “tapir-oca” disease of salmon in the Pacific caused by *Henneguya salmincola* in the muscles, is an example. In India nearly 115 species belonging to 16 genera are known to occur in various edible fishes. The occurrence of this parasite among fishes in India is shown in Fig. 1.

A typical myxosporean parasite body, known as spore, comprises a protoplasmic mass with one or two nuclei well protected externally by

1-6 (mostly 2) valves. The valves are joined in a variously sinuous, straight, often thickened suture. At the front end of the body, the shell valves enclose 1-6 (mostly 2) sac-like bodies called polar capsules, each of which encloses a highly coiled filament. The number of shell valves, polar capsules and polar filaments may vary from species to species. The spore body measures  $10\ \mu\text{m}$ - $15\ \mu\text{m}$  in length,  $6\ \mu\text{m}$ - $9\ \mu\text{m}$  in width and  $4.5\ \mu\text{m}$ - $8\ \mu\text{m}$  in thickness. The role of filament in this tiny parasite is not known. However, it is believed that they may play some role in transmission from one host to another by serving as an adhesive hold fast. It is also thought that once the spores enter the fish host the polar filaments are everted to serve as an “anchor”. Some of the common myxosporean genera encountered in fishes are shown in Fig. 2.

The life cycle, host-parasite relations and pathology of myxosporeans are not fully known. However, it is believed that fish get infected by ingestion of spores which hatch in the intestine. After hatching the sporoplasm becomes amoeboid, penetrates the intestinal epithelium and somehow (possibly via the blood stream) reaches the appropriate host organ or tissue. Meanwhile the amoebula grows to form a trophozoite (vegetative form) which can grow inside or outside the cell in different organs. By repeated nuclear divisions and growth the trophozoite becomes a large, macroscopic, multicellular body surrounded by a host tissue capsule to form a stationary cyst containing hundreds of spores. In the forms which inhabit body cavities (coelozoic species), such as gall or kidney tubules, the cysts lie entirely free. In the forms which inhabit tissues (histozoic species), the cysts are embedded in the tissue (muscle, skin, cartilage, liver, spleen, kidney etc.) but are apparently extracellular. As the spores ripen, the cysts may rupture and release the spores into the environment. However, the spores of species whose cysts develop in tissues are presumably dependant upon the death of the host for

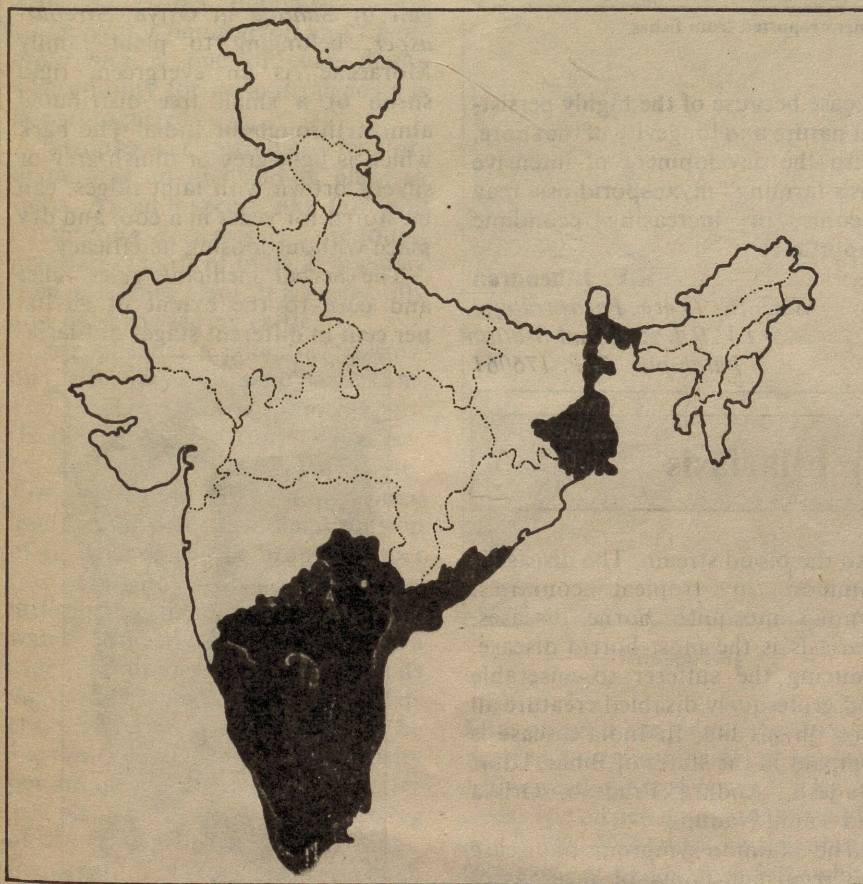


Fig. 1. Reported distribution of myxosporean parasites among fishes in India

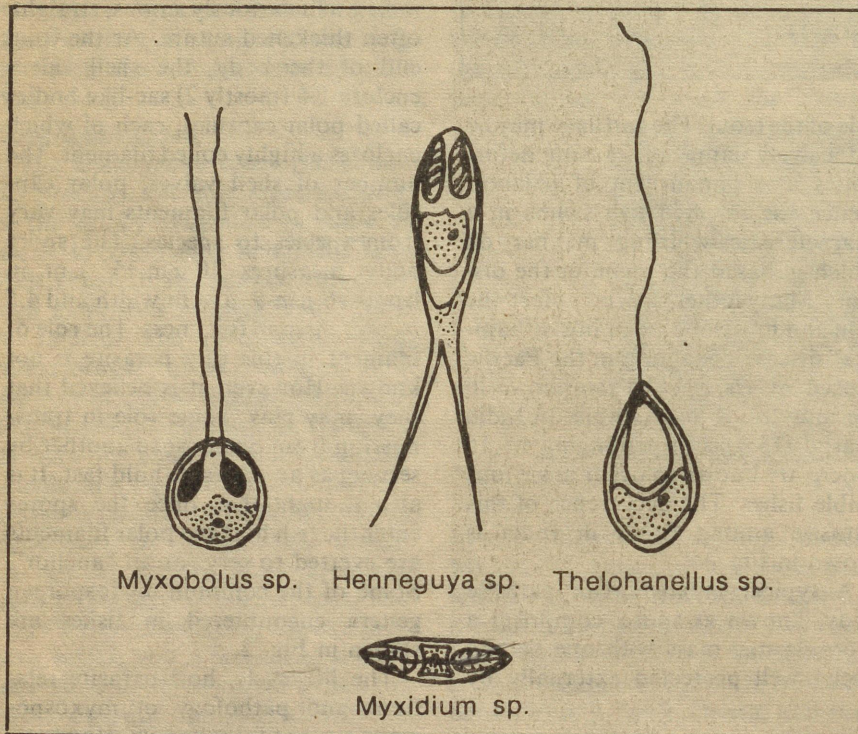


Fig. 2. Common myxosporean genera reported from fishes

dissemination.

Myxosporean infections are diagnosed by identifying the characteristic spores in fresh or stained smears, or in sections, from infected organs. Nothing is known regarding treatment. However furazolidone and stovarsol have shown promising results for twist disease among salmonids. It is extremely difficult to eliminate the

disease because of the highly persistent nature and longevity of the spore. With the development of intensive "fish farming" myxosporidiosis may become of increasing economic importance.

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### Herbal Cure for Filariasis

**F**ILARIASIS is a human parasitic disease caused by nematodes *Wuchereria bancrofti* and *Brugia malayi*. The infection is conveyed to human beings by mosquito bites, chiefly by *Culex fatigans*. The female mosquito introduces the nematode embryo into the human body and they pass to the lymph vessels and nodes where they develop into adult worms. The female worm produces a large number of embryos which pass

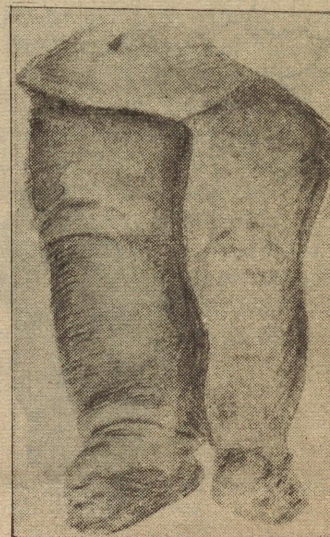
into the blood stream. The disease is common in tropical countries. Among mosquito borne diseases, filariasis is the most horrid disease, reducing the sufferer to miserable and grotesquely disabled creature all thro gh his life. In India disease is rampant in the states of Bihar, Uttar Pradesh, Andhra Pradesh, Orissa and Tamil Nadu.

The common symptoms of disease are recurrent bouts of fever associated with redness, pain and tender-

ness, followed by oedema and formation of ulcers and tubercles, with thickening and discolouration of skin in the affected parts of the body because of the obstructions in lymphatic system. This finally leads to 'Elephantiasis' the most dreaded stage of the disease. Legs and external genitals are principally affected. There is no effective treatment in medical sciences to remove the obstructions caused in lymphatic vessels by filarial worms leading to the last horrifying stage of the disease. Allopathic medicine 'Heterazen' gives some relief by killing the worms but this treatment is followed by allergic reactions to dying worms.

Recently *Shakotaka*, a herbal drug, obtained from the bark of *Streblus asper* Lour., has been reported to be most effective herbal filaricidal drug. (Singh, V.K. & Ram, E.R., *New Botanist*, 1988 15, 201). Known as *Siora* or *Karchanua* in Hindi, *Sehora* in Bengali or *Sahuda* in Oriya, *Streblus asper*, belonging to plant family Moraceae, is an evergreen, rigid shrub or a small tree distributed almost throughout India. The bark which is light-grey or bluish grey or silvery brown with faint ridges, can be stored for years in a cool and dry place without loosing its efficacy.

The herbal medicine gives relief and cure to the extent of 90-100 per cent in different stages of filaria-



Primary lymph-oedema of the right leg

sis. The drug is most effective in removing the obstructions of lymph vessels caused by the disease and is recommended to be given at the earlier stage of the disease preferably at filarial lymphoedema and allied stages where it works most efficiently and thereby stops the development of Elephantiasis. During 1970-87 using 'filacid', a commercial name of the stem bark preparation of *Streblus asper*, over 5000 patients

have been cured at Filaria Research Clinic at Varanasi. The remarkable feature of the drug is that it is totally devoid of side effects and calls for its inclusion in the treatment to combat the disease.

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## Multifaceted *Jatropha*

**T**HE nature is abundant in many resources living and non-living which are useful for man for various purposes. Man is yet to realize the importance of many of them. But he is slowly unveiling them one by one. *Jatropha curcas* popularly called *Ratanjyoti*, *Chandrajyoti* and *Chandraprabha* is one of such plants whose utility for various purposes is now recognized.

*Jatropha* was introduced by Portuguese as an oil yielding plant in India. About 9 species like *Jatropha gossipifolia*, *J. curcas*, etc., are found in different parts of India. It is widely used as a fence plant. It is hardy, oily and not browsed by cattle.

*Jatropha* has a potential to grow on low fertility soils, sandy loams and arid to semi-arid environments, but the plant grows vigorously under better soil and moisture condition. Presently about 90 million hectare land is lying waste in India. A portion of such lands can be brought under this semi-wild shrub which requires little management, soil fertility and water. Protective irrigations once a month in summer season maintain its vigour throughout the year. Inter-spacing between plants should be 1 m × 2 m × 2 m. Population density per hectare is an important factor. The plant can be grown on the setting of winter by propagation of cuttings. Propagation takes place through direct seedlings in the field. One

month old seedlings are transformed from the beds to the field. Flowering period is June-August and fruiting period September-December. It is slow growing in the beginning but grows vigorously after 8-9 months.



*Jatropha* twig

After one year the plant grows luxuriantly and reaches a height of 3m-4m. A five-year-old tree bears 2-3 kg of seeds. The oil percentage of the whole seed is 30%-40% and of kernels about 46%-58%. It yields 46%-58% white oil like castor oil.

The oil is extracted from the seed by solvent extraction method using simple screw or hydraulic screw press. The seeds (without seed coat) are roasted and crushed and then boiled with water until oil is separated. The oil floats as a layer on the water. This floating oil is separated out easily. It is slightly soluble in alcohol but freely miscible with hydrocarbons (light petroleum). Hence it is used directly for running the engine. It is an alternative for diesel engine oil and serves the purpose of petrol. The research on using *Jatropha curcas* oil as a substitute to diesel engine oil has been conducted in the Division of Agricultural Engineering in the Department of Agriculture, Government of Thailand at Bangkok. This oil also reduces environmental pollution as the exhaust fumes have less carbon mono-oxide content and less odour. Hence a large scale cultivation of plant might be helpful in bridging the gap of 8.50 million tonnes between demand and supply expansion as by the end of Seventh Five-Year Plan the demand of petroleum products is estimated to be 52.67 million tonnes against the existing capacity of 45.55 million tonnes at the end of a Sixth Five-Year Plan.

Apart from oil, its cakes are also used as a manure. The cake protein is used as a raw material for plastics and synthetic fibres. Latex, dye and tannin are extracted from the plant.

The latex is obtained by making cut in stem. On drying it becomes a bright reddish-brown brittle substance, resembling shellac which is used as a marking ink. From its bark, rich in tannin, dark blue dye is extracted. Its leaves are used for dyeing cloth and making fishing net and linen; as feed for Tassar silk worm and as a manure for coconut.

Its industrial uses are as an illuminant without smoke, as lubricant, for candles, varnish, etc.

The plant is equally important as a medicinal plant. Its oil is used externally for curing skin diseases—scabies, eczema, ringworm—and rheumatism. It is applied to hair as growth stimu-

lant. Its powdered seeds are mixed with molasses for curing stomach-ache and as an antidote for poisoning. Its leaves are rubefacient. The tender twigs are used for cleaning teeth. Its juice relieves toothache and strengthens gums. Besides these, other medicinal uses include treatment of sciatica, dropsy and paralysis.

At present the varieties grown are not high yielding. Their potential is to be raised. The genetic base of cultivars from exotic and indigenous

resources needs to be widened. Further research is being conducted on this crop by the ICAR under the 'All India Co-ordinated Research Project on Under Utilized and Under Exploited Plants' at various places.—Dantiwada, NBPGR Jodhpur, Delhi, Trichur and Hyderabad.

**Sudhir Pradhan**

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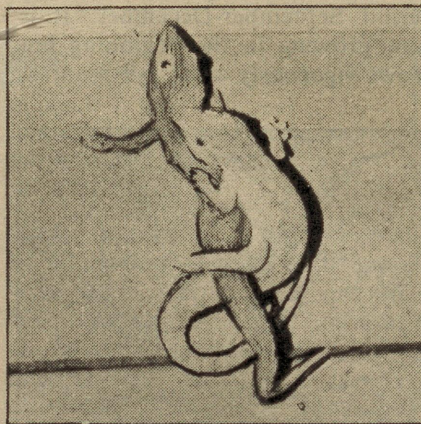
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## Sex life of lizards

**T**HE reproductive behaviour of the house gecko or the common wall lizard seems to be very interesting. During the breeding season, like other vertebrates the geckos involve in 'Territory formation'. The main purpose and function of territory formation is probably to prevent 'over crowding' and to assist in the dispersal of the species over a wide area. It may also have some subtle role in strengthening the sexual bond between male and the female. The geckos mark out their territories "acoustically" (by voices). Usually a male has one or two females in his territory. The rival males are chased off from the territory by fights, which involve 'lashing' of tails until the invading male runs away. The territorial fighting between male lizards often has a somewhat ritualistic character; the formidable teeth are seldom used and vanquished animal is unlikely to suffer serious injury. When the available space is little, only one dominant male becomes a 'despot' claiming the available territory and doing most of the courting of females. At times, female geckos also compete for scarce nesting sites.

The mating of lizards is usually preceded by some form of courtship which depends mostly on visual stimulus. It involves nodding' or 'bob-



bing' of the head. Usually the male approaches the female with body held low and tail moving from side to side. The sound is rather feeble and resembles a soft 'chick' or 'click' produced by the tongue when hit against the roof of the mouth. Some trans-

cribe these sounds as 'checko' and hence it got the name 'gecko'.

The male approaches the female, pokes her with his snout and licks her. In somecases, the female may also take the lead during courtship with the raised tail posture before a male which is followed by mating. The male seizes the female by the flank or neck with jaws. He then brings his rear against that of the female and twists the base of his tail beneath her cloaca. Male lizards possess a pair of organs of intromission known as hemipenes which lie in the base of the tail behind the cloaca. In some species, thickness of this region in males betrays the sex of the owner. During erection, the organ is turned inside out and protrudes from the cloaca. Only one of the hemipenes can be inserted and the process of intercourse or mating takes place for about 10 to 12 minutes.

After mating, the female gecko which is oviparous lays a clutch of two eggs which are globular or slightly oval. They are hard shelled and white in colour. The eggs are sticky when laid and adhere to each other and to the surface where they are laid. The female uses her hind legs to lay her eggs. The right temperature and moisture content are most important for incubation. After a period of about 50 to 60 days the young hatch fully developed and differ from their parents only in size and sometimes in colour.

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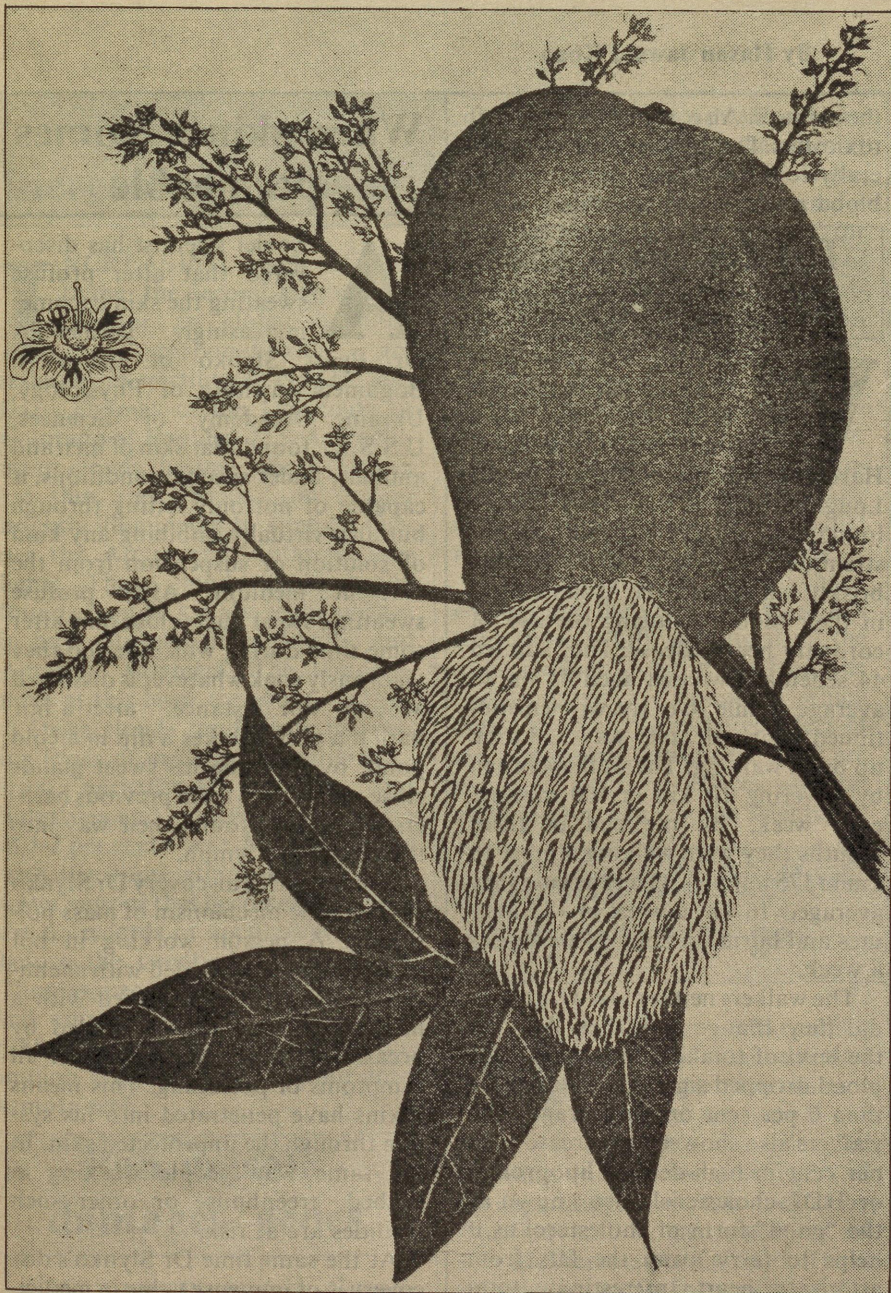
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## Mango stones as medicine

**M**ANGO (*Mangifera indica* Linn.) is the choicest and most popular fruit of India and occupies a prominent place among the best fruits of the world. The utiliza-

tion of unripe mangoes in pickles, chutneys, amchur and other culinary preparations and of ripe fruits in the manufacture of juice and squash, jams and jellies, etc., are well known. But the value of mango kernels or



Mango kernel

stones (Hindi—*Guhali*), which are generally thrown away as waste, is only known to villagers and tribals. Kernels, which have astringent taste, are roasted or boiled and eaten with curd by villagers to cure dysentery. Powdered kernels of ripe mangoes mixed with honey are given to persons suffering from asthma, diarrhoea, dysentery, leucorrhoea,

bleeding piles and painful, scanty menses. Kernel powder is sometimes mixed with *Bel* juice [*Aegle marmelos* (Linn.) Correa] and ginger and the mixture is administered to persons suffering from diarrhoea. It has also been reported that tribals eat kernels for flushing out worms and make a paste of kernels and apply it over cuts and burns. In times of scar-

city, tribals eat kernels as food and preserve them as pickles. Kernels are also utilized as animal and poultry feed. The hard coat is employed as fuel.

These folklore uses of kernels have prompted scientists to conduct studies on their food value. On the basis of pharmacological investigations, they have also ascertained some of their medicinal properties. So far as the food value is concerned, kernel flour is reported to have 5% protein, 6-7% crude fat, 1-2% crude fibre, 2-3% ash and 0.19-0.44% tannins. A good amount of starch present in kernels can be used in textile, jute, paper and other industries. Although the percentage of protein is low in kernels, its quality is good. As their tannin content is large, kernels and their flour are bitter in taste. But the bitterness can be eliminated after repeatedly soaking and washing the kernels in water. An edible oil from the mango kernel is also extracted.

To explore the medicinal uses of kernels, a team of chemists, pharmacologists and microbiologists headed by P.C. Das of Chemical Research Unit, C.C.R.A.S., University College of Science, Calcutta, conducted experiments on the alcoholic extracts of fresh kernels from unripe mangoes. Anti-inflammatory and antimicrobial activities of the extract were tested in male albino rats, gram positive and gram negative bacteria, and fungal stocks. Results so obtained confirm the validity of the ethnic use of kernels as an antimicrobial medicine for minor cuts and burns. The presence of anti-inflammatory activity recommend the use of kernels in rheumatic diseases associated with swellings, redness and pain. Kernels may also be effective in treating arthritis caused by fungi in joints.

Further pharmacological investigations on the stones of ripe and unripe mangoes are required for a complete assessment of the medicinal value of this waste product.

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By Hasan Jawaid Khan

## Damp homes promote moulds and ill health

**D**AMP homes harbour moulds which in turn have a direct link with the ill health their inmates generally suffer from. A study published in the *British Medical Journal* (vol. 298, p. 1673) points out that even if other possible reasons such as low income, smoking and overcrowding for poor health in homes which are damp are excluded, the link with health worsening as extent of damp and mould increases remains. Stephen Platt of Medical Research Council's epidemiology unit at Royal Edinburgh Hospital, Scotland, and colleagues at the Universities of Edinburgh and Strathclyde examined public housing in three cities and studied 597 households and more than 1100 children.

The researchers visited every house in April 1988 questioning the adults about their own symptoms and those of children in the previous two weeks. They also enquired about other factors such as smoking, type of heating, occupation and so on. From inside the rooms a surveyor took samples of moulds and of air. Lastly, a microbiologist estimated the spore counts from the samples and identified the fungi growing on the walls.

Children in damp and mouldy homes had significantly more wheezings, sore throats, persistent headaches, fevers and runny noses than children in dry homes. The adults too were likely to have symptoms of nausea, vomiting, constipation, blocked nose, breathlessness, backache, high blood pressure and bad nerves. In some homes the researchers found more than 15 species of moulds. They said that some allergenic varieties of fungal spores caused respiratory problems by inflaming and irritating

the airways. Also, some fungi give off toxic dust. Damp homes are also generally cold which may cause the high blood pressure and breathlessness.

## Take a walk and save your heart

**W**OMEN may take heart from a study that says a brisk walk can save their hearts. Adrienne Hardman and her colleagues at the Loughborough University have found that instead of going in for strenuous exercises, just walking briskly can lower levels of cholesterol in their blood, reducing the risk of coronary heart disease. They studied 44 sedentary women aged 45 on an average. While 16 of the women continued their sedentary ways, 28 took up brisk walking. The walkers began by covering 10 km in 100 minutes each week. By the end of three months they were walking almost 18 km in 175 minutes. Over the year they averaged 16 km a week in 155 minutes and burnt up about 860 calories a week.

The walkers neither lost weight nor did they change their diet. And yet the level of total cholesterol in their blood dropped significantly by more than 6 per cent on an average. The walkers also showed an increase of 27 per cent in high-density lipoprotein or HDL-cholesterol, also known as the "good" form of cholesterol as it helps to ferry away the fats from arteries of heart. Interestingly, total cholesterol decreased most in those who had the highest levels at the start of the study. So the women most at risk could especially benefit from this exercise.

For sedentary women brisk walking at about 60 per cent of their maximum aerobic power is enough for their heart to benefit. So the next time you come across a woman bogged down by the daunting idea of strenuous exertions to safeguard her heart, just tell her to take a walk.

## When skin becomes permeable

**A** Soviet scientist has discovered that after profuse sweating the skin becomes increasingly permeable. Dr Pyotr Slynko of the A.A. Bogomets Institute of Physiology, Ukraine Academy of Sciences, U.S.S.R., found that skin of men and animals, under specific conditions, is capable of not only letting through but also virtually imbibing any kind of solution or suspension from the ambient medium. After profuse sweating, sweat ducts close only after some time during which period they vigorously soak whatever is dissolved around. For instance, after a hot bath if a person takes a dip in a cold pond, by the time his sweat glands close up residues from previous bathers might have found their way into the blood and lymph.

In light of this discovery Dr Slynko explains the mechanism of mass poisoning. A person working in hot weather and surrounded with chemicals is apparently protected with a mask. But once slightly cooled by occasional breeze, he may show all symptoms of poisoning. This means toxins have penetrated into his system through the unprotected skin. In the same way people working in hotbed, greenhouse or other such facilities are at risk.

At the same time Dr Slynko's discovery is of immense value in medicinal baths. For example, after a steam bath, when the skin is in a position to imbibe substances from the surrounded air, a person may proceed directly to a special room where medicines he needs are sprayed in the required concentration. Similarly, the new discovery is also useful in mud-bath therapy in which a patient is covered with a coat of mud. This may not be of any use unless it is made sure that the patient is sweating under it, says Dr. Slynko.

## Clouds show increasing methane

**I**NCREASING levels of methane, the second largest contributor to global warming after carbon-dioxide, are reflected in noctilucent clouds, says Gary Thomas of the University of Colorado at Boulder, U.S.A. Noctilucent clouds, he says, consist of ice, are thin and fibrous, and remain brightly illuminated by sunlight during the Arctic and Antarctic twilights. These clouds are normally found about 80 km above the surface in high altitudes during Arctic and Antarctic summers. The temperatures at this level are about  $-143^{\circ}\text{C}$ .

These clouds result from increasing levels of methane that originates from agricultural practices and industries and is increasing at a rate of 1-2 per cent a year. Methane reacts with the upper atmosphere to form water vapour that becomes ice. There are no records of noctilucent clouds before the twentieth century, says Thomas, except perhaps in 1885 after the eruption of Krakatoa volcano (1883) that pumped an estimated 100 million tons of water vapour into atmosphere.

## Pan masala damages genes

**P**USHED by a vigorous advertising campaign, brands of pan masala are becoming increasingly popular not only among adults but equally among children. Earlier reports had hinted at the toxic effects of pan masala. And recently cancer researchers in Ahmedabad have confirmed that pan masala is genotoxic, that is, it damages the cell's chromosomes that contain genes. It was found to be genotoxic even at levels much lower than the average daily

consumption by a pan masala addict.

S.G. Adhvaryu and colleagues at the Cell Biology Division of the Gujarat Cancer Research Institute used a popular brand of pan masala for their study. They mixed an extract of the pan masala with a test-tube culture containing the growing ovarian cells of a Chinese hamster. They observed chromosomal changes in hamster cells treated with extract from as little as 1.1 mg of pan masala. The small pouch of pan masala contains about 5000 mg and the daily average consumption of an addict ranges from 6000 mg to 8000 mg.

The fact that while tobacco chewers spit out the juice, pan masala is consumed in full, making it all the more damaging. So, apart from the chromosomal damage, which depends on the cumulative effect of the pan masala consumed, there are likely to be local effects on oral mucosa also, caution the scientists.

## An aircraft fuelled by natural gas

**W**ITH the world running out of conventional fuels, attention has now centred on natural gas which is available in plentiful amounts. In Moscow, test flights of an experimental aircraft fuelled by liquefied natural gas began on 14 July at Sheremetyevo airport. These aeroplanes can fly from existing airports without the need for special facilities on ground. Besides, its designers believe that a plane flying on liquefied natural gas which is largely methane will save the equivalent of 9 tonnes of kerosene over 2000 km. This will more than compensate for the increase of between 20 and 35 per cent in the cost of handling it on the ground.

The plane is an adapted TU-155, a version of Aeroflot's TU-154 passenger aircraft. It has been fitted with

a tank with a capacity of 18 cu m. This sits inside the body of the aircraft and is insulated and hermetically sealed. The tank can maintain the compressed methane at  $-160$  degrees celsius up to 3 days.

## Ozone loss will cause soybean loss

**W**E have already released enough chemicals into the atmosphere which would slowly wear away the ozone shield bit by bit over the next several decades. And as the ozone layer thins, from 5 to 20 per cent more ultraviolet radiation will reach populated areas in the next 40 years. Food crops will be the worst affected. Higher levels of ultraviolet radiation will impair the normal growth process of plants and trigger off chemical reactions in the lower atmosphere which will lead to the creation of a plant-damaging pollutant. According to Cynthia Pollock Shea of the Worldwatch Institute of the USA, already ozone loss over the world's most productive agricultural regions averages 3 per cent.

Experiments with more than 200 different plant species have confirmed that one out of every five crops tested was extremely sensitive to increased ultraviolet radiation. These included members of the bean, cabbage, melon, and spinach families. And one of the most vulnerable plants is also the world's largest protein crop—soybean. Studies conducted by Alan Teramura, a botanist at the University of Maryland, show that a simulated ozone loss of 25 per cent reduces the yield of one widely used soybean species by as much as 25 per cent. Not only would it amount to an enormous loss in economic terms the world over, it would also mean an increased number of people suffering from malnutrition.

## William Shockley : Switch from Semiconductors to Discredited Eugenics

ONE of the co-inventors of the transistor, which ushered in the transistor revolution in the 1950s, and, in turn, the information revolution in the 1980s, died at Stanford on 12 August, of cancer of the prostate. William Bradford Shockley shared the 1956 Nobel Prize in physics with his collaborators John Bardeen (who went on to win another Nobel) and Walter Brattain (who died recently).

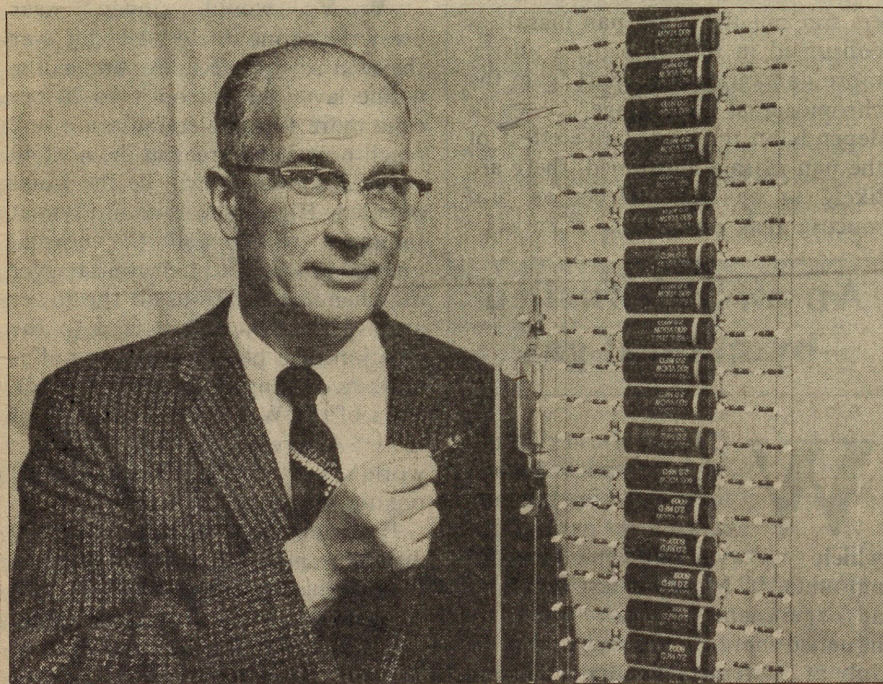
foundation of his career research.

The Second World War provided impetus to semiconductor research. Thermionic valves had evolved to the point of providing battle-winning tricks like the radar, airborne navigation, radio communication, and so on. But their drawbacks like big size, short life, unreliability, fragility and heavy power consumption prevented further applications. The prime need then was to find a material which

suggested replacing the point contacts with rectifying junctions between p-type (excess holes) and n-type (excess electrons) in the crystal. This was the p-n junction transistor, which largely replaced the point-contact transistor because the former was easy to manufacture and showed superior performance. In the junction transistor, rectification and amplification occur, not on the surface, but inside the crystal.

The transistor's advantages over the vacuum tube are many: smaller size, elimination of a hot cathode (which consumes power and requires a warm-up time), lower level of operation (especially suitable for computers), ruggedness, and longer service life.

The transistor now appears in various guises and is made of a multitude of materials through sophisticated techniques. Field-effect transistor, for example, is yet another version, which is also credited by Bardeen to Shockley. In the form of MOS (metal oxide semiconductor) memory circuits, one of the most revolutionary progeny of the original transistor, it can be made of such a microscopic size that millions of transistors can be packed in a silicon chip less than one square centimetre in size. It was Shockley who laid the theoretical foundations for the technological advances in semiconductors. There is however an ironical tinge to the cyclical nature of techno-scientific advances. The turn of the century may bring back the transistor's predecessor—the old-fashioned valve—but in the form of vacuum microelectronics. The new valves do not glow or need high temperatures to work. Like transistors, a million valves can be squeezed into a square centimetre and they operate at up to 20 times the speed of the best solid-state chips.



William Shockley (U.S.I.S.)

Born in London, on 13 February 1910, of American parents, Shockley obtained his B.S. in 1932 from the California Institute of Technology and Ph.D. in 1936 from the Massachusetts Institute of Technology for his thesis 'Calculations of Wave Functions for Electrons in Sodium Chloride Crystals'. The solid-state physics he learned at MIT and his work on crystals proved to be the

through its semiconducting properties would permit tiny currents to control larger currents in very low power dissipation. This challenge was taken up by the trio at Bell Labs under the direction of Shockley.

In 1947 Bardeen and Brattain made the first successful amplifying semiconductor device, or transistor (*transfer plus resistor*). This was the point-contact transistor. Shockley

## NEWS AND NOTES

Shockley's academic career was equally distinguished. He started lecturing at Stanford University in 1956, became Alexander M. Poniatoff Professor of engineering and applied sciences in 1963, and was professor emeritus at the time of his death. In 1962 he became a member of the U.S. President's Science Advisory Committee on Scientific and Technical Manpower. He also served on the Scientific and Technical Advisory Committee for the National Aeronautics and Space Administration. During World War II, he was engaged in military projects. One of them was the electronic design of radar equipment at a Bell Labs field station. From 1942 to 1944 he was research director of the Antisubmarine Warfare Operations Research Group of the Navy Department, and was expert consultant to the Office of the Secretary of War.

The list of honours Shockley received is pretty long. Starting from the Medal for Merit of the United States government (1946) he was named to the Inventor's Hall of Fame (1974) and California Inventor's Hall of Fame (1983), to mention just three. With more than 90 patents standing to his credit, he was author of *Electrons and Holes in Semicon-*

*ductors*, and *Mechanics* and editor of *Imperfections of Nearly Perfect Crystals*.

Shockley's switch from theoretical physics to genetics (rather eugenics) proved to be his nemesis. In 1970s he began to publish bitterly resented theories of eugenics purporting to show that blacks were genetically inferior to whites. His theory set off a debate in the USA over the use and applicability of IQ tests. Stanford University said after his death that Shockley himself regarded his work on race more important than his discovery of the transistor. According to his wife, Shockley was busy sifting data and preparing papers on it until a few days before his death. He is the author of the widely discredited "retrogressive evolution". According to him, blacks, because of their genetically inferior intelligence, are reproducing faster than whites. This he termed as retrogression in human evolution. His peers feel that Shockley's racial theories are intellectually dubious, scientifically imprecise, and socially divisive. In 1978 the Nobel Laureate contributed his sperm to a California sperm bank to propagate the genetic quality of "geniuses".

Shockley has another dubious distinction. Uncritically pleased with his

own successes in semiconductor research in 1950s, he tried to become a Ford but ended up as an undistinguished businessman. He founded a company named after himself to manufacture semiconductors. But the rebel group left him to found Fairchild Semiconductor, which spawned the phenomenon of Silicon Valley.

How do his contemporaries assess him? John Bardeen, the co-inventor of the transistor, said in an interview after Shockley's death that Shockley was a "very, very bright, very, very ingenious fellow", who was "quick to grasp new ideas". "In the field of semiconductor physics, Shockley was a towering intellect," opines Ian Mackintosh. The technical, economic and social progress which we have witnessed since about 1950s, Mackintosh feels, is because of his contribution to the betterment of man's condition, rather than his racial theories, "that I shall savour the memory of once knowing the complicated and brilliant man". "He merely forgot that man remained the measure of everything, driverless or not," was the *The Guardian's* cryptic remark in its obituary.

P.S. Shankar

### Environmental Influences on Seed Germination Mechanism

**A** national symposium on "Environmental Influences on seed and germination mechanism—recent advances in research and technology" is being organised by the Department of Botany, University of Jodhpur. It will be held from January 27 to 29, 1990. The objectives of the symposium are: (a) Seed morphol-

ogy, polymorphism and their ecological significance; (b) Soil seed reserve, its dynamics in arable land, and seedling demography; (c) Seed dormancy, germination behaviour, and quantification of germination; (d) Halophytic seeds and their germination strategies; (e) Physiological and biochemical changes during germination; (f) Bioregulators on germi-

nation mechanism in crop seeds, (g) Seed pathology, seed testing and plant quarantine; and (h) *In vitro* embryogenesis.

Further details may please be obtained from Prof. David N. Sen, Director, Professor & Head, P.O. Box 14, Department of Botany, University of Jodhpur, Jodhpur 342001, India.

## George Adamson— Father of Lions

**T**HOSE who have seen the marvellous film *Born Free* must have noticed the tall, muscular man (impersonated by Bill Travers in the film) who assisted Joy Adamson (impersonated by Virginia McKenna) in raising lion cubs, especially Elsa which grew up into a beautiful lioness in their company. The man, George Adamson, always remained in the background in the film. In fact, throughout his life he remained tied to his work which was of raising lions during their cubhood and then releasing them into the wild. He did not care for publicity either in his favour or against him because his first love was lions. Although *Born Free* showed the world that it was possible to develop an emotional relationship between man and beast, Adamson showed that Elsa's case was not unique. He himself set up several models for such a relationship. He believed in the freedom of lions despite the threats of death to him from time to time. Since 1970 till the day he was shot last August he released more than 20 lions into the wild which mated with each other and wild lions to grow to 80 in number. Indeed, the day before he was shot, about 15 lions came to say "Good-bye" to him. In his death lions all over the world lost a father and a guardian.

George Adamson—popular as "Baba a Simba" in Swahili, the Father of lions—was born at Etawah, Uttar Pradesh, India, in 1906. His father was in the Royal Navy and his mother belonged to an old English family settled in India. From the childhood young Adamson had a keen desire to become a big game hunter. In fact, his greatest ambition then was to shoot a bear, which he could never attain in his life. When his father was in the service of the Raja of Dholpur, one Sergeant Major taught him how to use a rifle. On the retirement of his father from

service, the family instead of going back to its native Scotland shifted to Kenya which his father had fallen in love with. He set up a coffee plantation near Nairobi. Meanwhile, young Adamson and his brother Terence had their education in England. The lure of big game hunting brought



George Adamson (Photo : B.J.S.)

## SCIENCE FOR THE YOUNG

them in 1924 to Kenya after their basic education. However, young Adamson soon lost interest in the coffee plantation when he found one coffee bean 'exactly like another'. Thereafter he changed jobs as one changes one's clothes. He took to building roads, traded in goat's milk, bees' wax, resins, tobacco, etc. He also started hunting big animals. He shot deer, leopard, rhino, buffalo, elephant, and lion. He even sold rhino horns and elephant tusks! He had soon become an expert in understanding the role of wind, scent, sound and footprints in hunting and how to interpret sex, age and condition of an animal from them.

In 1934, Adamson along with his brother and friends went in for gold prospecting to the legendary Queen of Sheba Mines but returned empty-handed! During his adventures in the wild he had a lease of life twice. On one occasion, an elephant would have trampled him or tossed him into air but for the timely shot of a tracker who kept cool head. On another occasion, a man-eating lion would have done him to death. The lion had otherwise mauled him so badly that he fell ill. When the Second World War started and embroiled the African continent in the war, Adamson secured a regular job for the first time. He spied on the movement of Italian troops for the Allied forces. After the war he got a job in the Game Warden Department of Kenya, when the African continent was teeming with wild animals. His job was to keep an eye on poachers, kill man-eating lions, or elephants that raid crops, or any wild animal that became a source of worry for cattle or people. To become familiar with the ways of wild animals and to learn how to hunt them safely without creating much mess, he also read plenty of books on wildlife. He became a walking encyclopedia of animal lore later.

The event which turned him into a staunch conservationist was apparently mundane. Once while accompanying a wildlife photographer on a safari he saw a lioness sitting majesti-

cally atop a rock. Whether it was the lighting effect or the mood in which he saw her is not clear. He suddenly realised the immense beauty of a lioness which he felt nature had taken several millions of years to evolve. Thereafter he felt the need to conserve nature and wildlife. He became a staunch conservationist and never shot an animal without purpose.

With a secure job Adamson had settled down in life and was thinking of marriage when he met Joy, a painter of plants and tribals, who had a series of unfortunate incidents in her life. Both felt they were made for each other and so they married in 1944. For some years, life was uneventful. Joy kept herself occupied with painting flowers and different tribals of Kenya. She also visited London to

exhibit her paintings. On occasions she accompanied Adamson on safaris into the wild. Their life would have continued thus had not a single incident changed it forever. In February 1956, Adamson shot a lioness which was harassing cattle in the region. When some weak cries were heard from the neighbouring crevices, Joy, who was accompanying him, found to her utter happiness three lion cubs there. Having no child herself and being fond of pets, Joy decided to adopt them. Adamson readily lent her a helping hand. Both decided to bring up the cubs until they became grown up enough to be on their own. But no guidance was available on how to manage them.

Soon, the cubs began to romp with children, to drag blankets as an adult



George Adamson and his lions

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lion drags its kill, and to stalk other pet animals. However, on the advice of one friend, two cubs were sent to a zoo. The youngest, a female cub, Elsa, which was the prettiest of the lot, was retained. Both Joy and George were keen that Elsa should not land up in a zoo. They wanted to give her the freedom of the wild where she originally belonged. In course of time, Elsa began to behave like a dog. She would give company to Joy and Adamson in their walks. When she would hear a shot fired, she would run, pick up the shot bird, and bring it back to Adamson. A loud "No!" or a light smack with a stick was enough to keep her from any mischief. Friends and conservationists told Joy and George that just as they had made Elsa familiar with human beings they had to acquaint the humanized Elsa with the wild of her kind. Thus began the tedious process of introducing Elsa to the wild in a step-by-step manner in Massai Mara Reserve.

Animals were shot and fed to Elsa because initially she could not relate her food with the animals about her! Slowly, she was assisted in hunting animals. Soon her natural instincts began to assert themselves. She began to open her kill to eat it, started concealing the remains to keep them away from vultures and also began to defend her kill from hyenas, jackals, etc. In the beginning she was allowed to stay out in the wild for a night, then for a few days and later for weeks. When she became three years old and came into season, Joy and George made all efforts to help her in selecting a partner and mate. In fact, she did join a pride of lions but starved in their company. Eventually, she became pregnant and gave birth to three cubs in the wild. The relationship between Elsa and the Adamsons had become so affectionate that she would appear in their midst as soon as she heard a shot fired by George. However, before the first birth anniversary of her cubs, she died of a fatal disease common among lions. The orphaned cubs began to harass the local cattle.

Adamson therefore made traps to catch them and transferred them to the wild of Serengeti. This entire fascinating story of the upbringing of Elsa and of her later life in the wild was graphically written in a series of books by Joy, of which the first, *Born Free*, received tremendous acclaim. In 1965 it was made into a beautiful film of the same title.

In 1961, Adamson retired from the Game Warden Department of Kenya. However, he had developed a passionate interest in lions. Seeing the fast depleting wildlife of Kenya over the decades, he decided to raise abandoned or zoo lions and introduce them into the wild. After *Born Free* was made, he adopted two zoo lions, one male and another female, which had been brought to Kenya for the film from some European zoo

that they could live and fight for survival together. He therefore procured two more cubs which were found helpless after their mother was shot by a tracker because she had become a menace to cattle. Meanwhile, Joy's books and later the film had become a roaring success and money started pouring in. Joy therefore raised a trust "Elsa Wild Animal Appeal" in the memory of the lioness to conserve the wildlife of Africa. With the money in plenty she decided to raise Cheetah cubs because this animal is on the verge of extinction. She set up her camp in Shaba Game Reserve, about 320 kilometers north of Nairobi, and was keen that George should join her. But George was interested in lions. Moreover, cheetahs and lions cannot live together in the same area because both have



George Adamson with Joy Adamson

and would have been returned to them. He was keen to give them the freedom of the wild. Several friends and conservationists advised him against this decision but Adamson was adamant. Seeing his enthusiasm for lions, some wildlife experts suggested to him not to keep one or two lions but create a pride of lions so

same preys and kill each other's young. As a result, Adamson had to live away from Joy and continue the task of raising lions.

As Adamson's lions often harassed cattle and tribals living in the neighbourhood, the authorities often warned him against keeping lions. Eventually, in 1971, Adamson

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bought on a lease of £ 750 per year about 1,250 square kilometers of land, called Kora Nature Reserve, about 320 kilometers north of Nairobi. Here he set up his camp to raise lions. The camp, which became famous in Swahili as "Kampi Ya Simba", however, consisted of only half a dozen wooden structures. His own thatched hut had only one room containing books, a strong box for ammunition, a typewriter, and some basic necessities of life. His dining room was open to air and was often frequented by squirrels, lizards, hornbills, ravens and even vultures. A wireless set, binoculars, a hat, a lamp and a torch always hung from its thatched roof for handy use. In raising the camp and subsequent assistance, Adamson received support of his brother Terence and a committed Englishman, Tony Fitzjohn. Initially, roads were built through the Kora reserve. An airstrip was also prepared for visitors with a warning sign—"Lions on road. Buzz camp and wait".

No fence encircled the camp in the beginning. But Adamson soon found that the lions that he had released into the wild entered the camp in the night and some even troubled him in his bed! A three-meter high fence was therefore put around the camp. Besides, Adamson had to face a variety of problems from time to time. For instance, the marauding wild lions would sometimes trouble his lions, even kill cubs; once, a cub simply disappeared, probably mauled by a crocodile; thrice his own lions mauled some members of his staff; once he had even to shoot his favourite lion because it killed a visitor to the camp; and so on. There was occasional criticism of his work in the press highlighting the incidents of mauling by lions, but fortunately the authorities did not take a serious note of the incidents. Even Joy was against his displaying lions to visitors. But Adamson did not heed to any one. Based on his missionary zeal of releasing lions into the wild. Bill Travers made two documentary

films, *The Lions Are Free* and *Christian the Lion*. Meanwhile, in 1980, Joy was fatally stabbed by one of her staff workers when she sacked him. For some time Adamson felt alone but soon his affection shifted totally to his lions.

Adamson's own assessment of lions is that they are of as many diverse characters as human beings. Some can be generous, some possessive, some affectionate, and some impulsive. Most of them are intelligent and inquisitive. Lions are otherwise the laziest animals in the world, but when they are hungry they would pounce upon their victims. Lions are extremely sensitive to sounds and can even detect a sound about 10 kilometers away. While voice has a major role to play in their social life and roaring is employed to declare territorial rights, they use their urine to mark their territory, exchange information, and throw challenges and insults at each other. Though meticulously neat and clean in the matters of defecation, they however do not mind passing their urine anywhere because it contains a very strong disinfectant. A lion often rolls itself in the dung of an elephant or antelope to mask its own smells before tracking an animal on hoofs. A pride of lions disperses when it becomes too big to stay together due to internal rivalries. Adamson felt sorry that though lions have been shot off and on, not a single skeleton had been preserved in Kenya so that it could work as a model for repairing any bones of an injured lion. In fact, he himself faced this situation when one of his lions broke its legs while encountering a buffalo.

Adamson claimed that the best way to develop a relationship with a lion is to take it on daily long walks. It was his daily schedule to take long walks with lions in the morning. With a pipe in his mouth and a stick in his hand he would read "Jungle news" of footprints and spoor written on the ground and bushes. In the afternoon he would await the return of the lions and after shutting them up for night in the evening he would retire to his

room after meal where he would write down his entries of the day. If there be any need, he could call his lions living in the wild by simply calling them over a megaphone! His only source of income to maintain himself and his staff was his pension, royalties for his two books *Bwana Game* and *My Pride and Joy*, and some funds he used to receive from the Trust that Joy had set up. He himself lived like a saint. In fact, in the company of lions he had begun to look like a lion. It was his greatest desire to raise a lion from the day it opens its eyes to see the world to the day when it gives birth to their young. But this desire of his was never fulfilled.

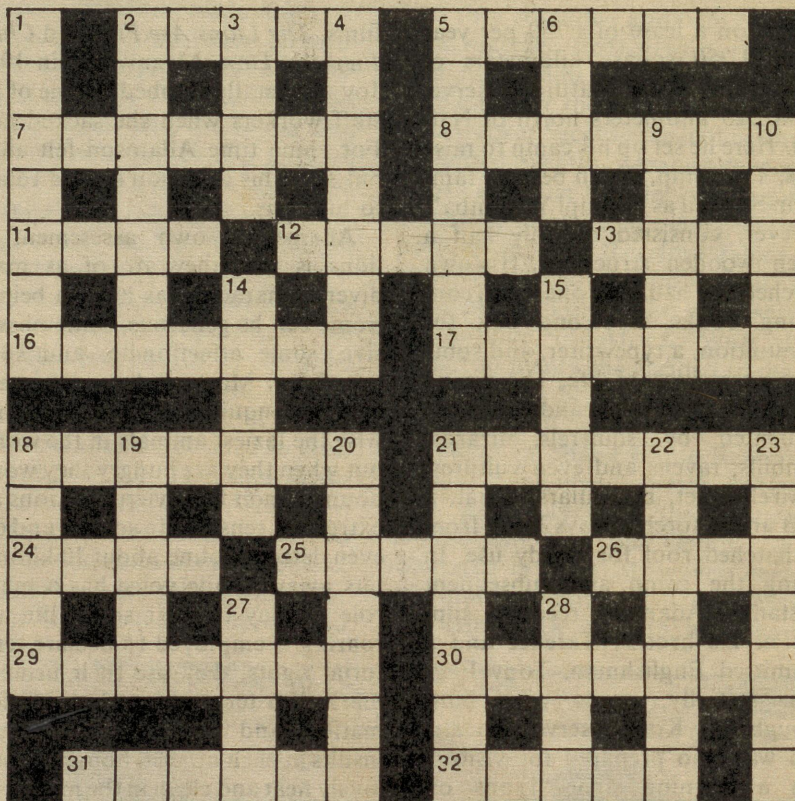
When Adamson was shot dead on August 20, 1989, the conservationists of the world were not at all surprised. Earlier, in 1983, a plot was hatched to murder him but nothing came of it. As and when Adamson was warned about the danger to his life, he always waved it off saying that his lions were sufficient to protect him. He was never afraid of death but the thing which worried him most was the fate of his lions after his death. In recent years, Somali bandits have become active in the Kora Reserve region. Moreover, tribesmen wanted to get rid of Adamson because his lions often worried their cattle and camels. However, Adamson died in the bid to protect one of his visitors to his camp who was being robbed by Somali bandits. He was laid to rest next to the grave of his brother Terence and favourite lion Boy. Only three days before his death, his own brain-child, Kora National Reserve, was declared a national park where wildlife could roam freely under state protection. It was a battle Adamson had been fighting for a long time but could not see it flower and prosper. Today, the park has been named in his memory. His second-in-command, Tony Fitzjohn intends to pursue his work one step further in Mkomazi game reserve by rehabilitating cheetahs and wild dogs.

Dilip M. Salwi

Crossword Puzzle

Across

- 2. One of the four cardinal points of the compass. (5)
- 5. Surname of the U.S. chemist who was awarded the Nobel Prize in chemistry in the field of enzymes. (6)
- 7. The science of the history of earth as shown by its rocks, crusts, etc. (7)
- 8. Abnormal dryness, e.g., of the skin. (7)
- 11. Name of a constellation. (4)
- 12. A substance having ductility, malleability, lustre, good electrical and thermal conductivity, etc. (5)
- 13. Organ of respiration. (4)
- 16. A special type of diffusion in which water moves from a dilute to a concentrated solution through a selectively permeable membrane. (7)
- 17. A cartilaginous tube extending from the larynx to the bronchi. (7)
- 18. Surname of an English scientist noted for his cathoderay studies. (7)
- 21. The biological processes being carried in 'glass' rather than in the living organism. (2, 5)
- 24. This is what Triton is for Neptune. (4)
- 25. The medium that was assumed to fill all space in order to explain the propagation of electromagnetic waves. (5)
- 26. A unit of speed equal to one nautical mile per hour. (4)
- 29. A loudspeaker designed to reproduce the higher audio-frequencies. (7)
- 30. A type of steam engine in which all driving parts rotate. (7)
- 31. A blue dye-stuff which is turned red by acids but remains blue in presence of alkalis. (6)
- 32. Forename of a scientist from Indian sub-continent who was awarded the Nobel Prize in physics for his theory that electromagnetism and the 'weak' force, which causes radioactive decay in some atomic nuclei, are facets of the same phenomenon. (5)



Down

- 1. A dynamo provided with a spark-coil used for ignition in I.C. engines. (7)
- 2. Also known as columbium—an element discovered in 1801. (7)
- 3. Part of the plant that grows downwards into the soil. (4)
- 4. Surname of the Dutch scientist who developed the wave theory of light. (7)
- 5. An instrument for measuring angles between two objects in any plane. (7)
- 6. Nix Olympica a volcanic mountain, three times as high as Mt. Everest, is the highest point of this planet. (4)
- 9. Lying to the right of a person facing sunrise. (5)
- 10. Greek letter denoting summation in algebra. (5)
- 14. The Japanese Nobel Laureate whose theories advanced and expanded the field of miniature electronics. (5)
- 15. A reddish-violet dye—the first organic dye to be prepared artificially. (5)
- 18. Luminous celestial body moving under the gravitational influence of the sun. (5)
- 19. A bluish gas, very active chemically, and is formed when air or oxygen is subjected to an electric discharge. (5)
- 20. Catgut, nylon, thread, etc., used to sew a wound. (7)
- 21. The tendency of a body to preserve its state of rest or uniform motion. (7)
- 22. Two small glands on either side of the throat at the opening of the pharynx. (7)
- 23. An annual cereal grass used mainly in porridge. (7)
- 27. Smallest unit of an element that can take part in a chemical reaction. (4)
- 28. A system of high tension cables by which electrical power is distributed. (4)

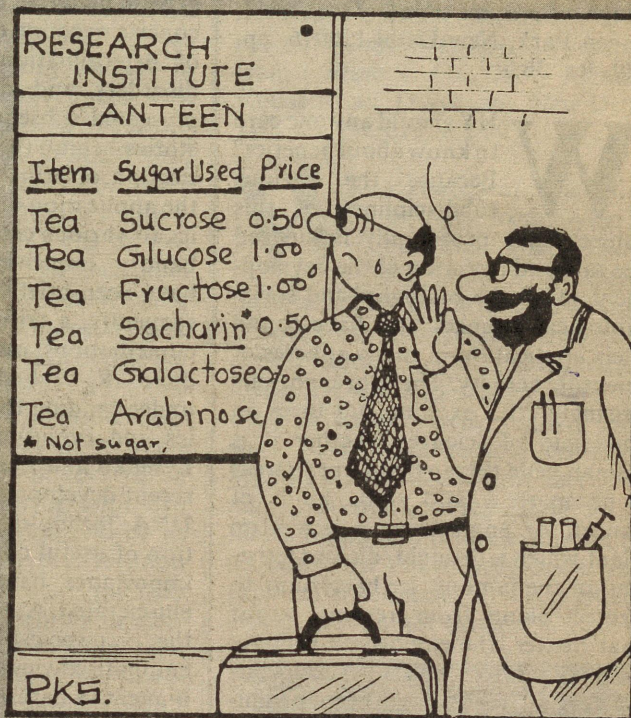
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 23L, Sector IV  
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 Shahid Bhagat Singh Marg  
 New Delhi-110001  
 (Solution Next Month)

# CARTOONS

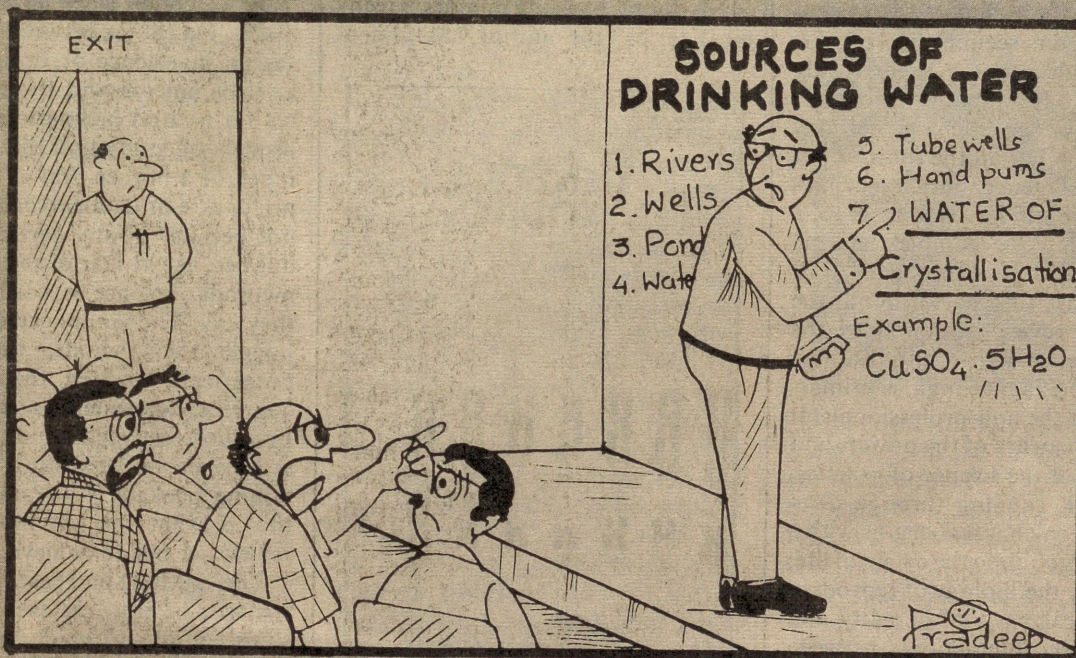
By Pradeep K. Srivastava



"Those project reports, files, registers and papers! I removed everything from here Sir, Now you can find 'Records' both LP & EP of film songs, Ghazals, Classical music, Instrumental Music etc. etc."



"You want to know what progress we have made in Research & Development? I think, by seeing this board only you will be quite convinced that how much advanced we are."



"Of course! He has good suggestions but he is going too far. See the last point."

## BOOK REVIEWS

**GENETICS TODAY** by Jagjit Singh, *National Book Trust, A-5, Green Park, New Delhi-110016, pp. 229, Rs. 36/-*

**W**HY should any one care to know about genetics? Because the various subdisciplines of this subject have profoundly influenced the rate and direction of the development of all the biological and socio-biological sciences and have found their application in many spheres of scientific activity. Therefore, not surprisingly, the exciting advances in this field of science, whether it is human gene therapy concept to treat bone marrow and some kinds of cancer; or engineering a new crop plant which is drought/disease resistant; or the famous 'Ice bacterium' to protect plants from freezing; or for that matter, the engineered bacteria being used to clean up hazardous wastes, all these have been prominently discussed on the front pages of newspapers and in TV feature reports. But, then, the science of genetic engineering has unwittingly generated several controversies too. Sometimes, the claims of such scientific endeavours seem to be unrealistic, though not theoretically impossible. No matter however emphatically a genetic engineer may claim that he has all the tools to put human intelligence into a gorilla's brain, we are still far away from fully understanding the complex genetic manifestations of either gorilla or man. Against this background the book under review authored by the prolific science writer and Kalinga Prize winner, Jagjit Singh, is primarily aimed at the non-professionals. It makes them aware of the powers and limitations of the science of genetics.

The book running through altogether sixteen chapters begins with a brief introduction to the origin of life, followed by the biology of reproduction, physical basis of heredity and the complex interactions between heredity and environment. After giv-

ing the classic principles of these aspects, the famous laws of Gregor Mendel, chromosome linkage and crossing over, genes and DNA as genetic material, etc., are outlined. A concise account of the genetic basis of determination of sex, inherited disorders and diseases have been presented subsequently. The success stories behind the origin and domestication of principal food crops and the application of principles of genetics to various crops and animal husbandry improvement programmes have been briefly summarized. Subsequently, a critical appraisal of the contributions made by J.B.S. Haldane, R.A. Fisher and others in understanding the population genetics and evolutionary viewpoints of Lysenko and Lamarck is given. The recent developments in recombinant DNA technology vis-a-vis production of useful compounds of human importance have also been briefly enumerated. At the end are discussed the 'socio-biologists' over-emphasised view on the role of environment in natural selection, Richard Dawkin's controversial work on selfish gene theory, the genetics behind human evolution, IQ, formation of races and genetic hazards of nuclear radiation.

No doubt, by using minimum technical terms, the author has under-

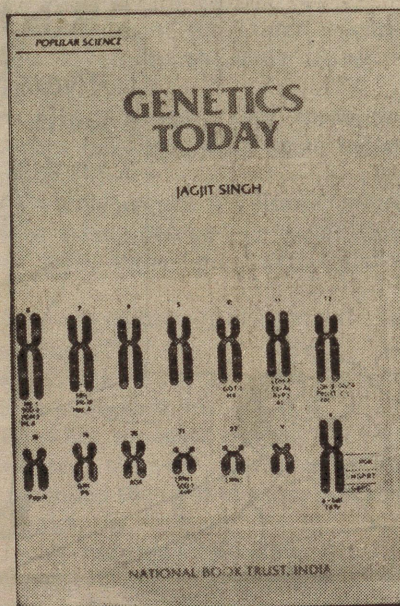
taken enormous pains to make the general reader understand the subject matter without any previous knowledge of genetics. But the language is sometimes tough and contains many difficult words and avoidable Latin phrases. The proof-reading is poor. Although most of the chapters are written well they could have been supported with some more neat diagrams and illustrations. A glossary of technical terms at the end of the book would have been very useful for the lay reader. Collectively, however, the book is a pleasure reading and conveys the essential elements of pragmatism involved in the science of genetics.

P.K. Panda

**SCIENCE TEASERS** and **MORE SCIENCE TEASERS** both by Dilip M. Salwi, *Konark Publishers, A-149, Main Vikas Marg, Delhi-110092, Pp. 121 each, Rs 95 (hardbound), Rs. 30 (softcover) each.*

**T**HE most crucial moment in a child's academic career comes when he has to make a choice between pursuing a career in science or opting for the arts, commerce and the like. Many with a natural inclination for either branch of study find this stage not much of a bother. But of those who prefer arts or commerce, many do so not because of any particular liking but because of fear of science and its methods. Science is hard and dull, they say. The complicated formulae boggle their minds, the difficult numericals frighten them and the complex experiments confuse them. For such confused minds, delivering science in an interesting and entertaining package is the answer. And this is what the two books under review set out to achieve.

The author of these books has written several children's popular science books, of which two have also won awards. The purpose in bringing



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out these books, as the author says, is to popularise science—win those children and teenagers back to science who find their classroom lessons dull or hard and stimulate those for further studies who have already come under the spell of science.

The books have covered all aspects of science—right from purely physical, chemical and biological sciences to environment, computers, agriculture, space and science fiction. There are hidden animals to be searched for, abbreviations to be deciphered, laboratory apparatuses to be identified, planets to be guessed, jumbled words to be set in order, proverbs to be unravelled, crosswords to be filled in and lots of photographs to be identified and much more. And then there are the exploits of Dr Vaigyanik who, once, devises a way to send a secret message; at another time he manages to make out an efficient raincoat out of some old clothes.

It's all a brainy exercise in a light style. The writing, which is at times humorous, is combined with a lot of figures and photographs to make the two books eminently readable. Although basically aimed at children and teenagers in the age group of 8 to 18, anyone from 8 to 80 interested in science would find them equally enlightening and entertaining. In fact, the books have managed to achieve a highly unlikely objective—relaxing with science!

**Hasan Jawaid Khan**

**SURFACE MOUNTED ASSEMBLIES** by J.F. Pawling, *Electrochemical Publications Limited*, Scotland, pp. 263, Price not mentioned

**T**HE evolution of electronics industry took place with the birth of thermionic triode valve in 1906. For the next fifty years the valve reigned supreme

and the other components of electronic systems moulded themselves as per its requirements. The thermionic valve was relatively expensive with limited working life. It was always considered bulky, though in later years its size was reduced with successive research and development. Soon after the Second World War, the advent of transistor broke the dominance of thermionic valve. Also came along with it the printed circuit board (PCB). The electronics industry took off with much wider and innovative applications because of the unique combination of tiny but very efficient transistors and the two dimensional concept of printed circuit board. More or less at the same time, many scientists advocated an integrated manufacturing approach which, later on, was recognised as thin and thick film hybrid technology. These technologies gradually made possible the assembly of electronic circuits in a space smaller than that required for conventional components mounted on a printed circuit board. The technology of surface mounted assembly has evolved out of a synthesis of hybrid thin and thick film techniques and Printed Circuit Board Assemblies. This technique is instrumental for miniaturisation of electronic devices and is cost-effective too.

The book under review is an excellent account of all the major aspects of the applications of surface mounted technology. The volume is edited by a leading expert in the field with eleven chapters contributed by five other research workers who, as described in the beginning of the book, are in close touch with production engineering and designing of electronic equipment. It aims at providing full details of the practical aspects of the surface mounted assembly, including its future. It will be invaluable to those who want to keep themselves abreast with the development of electronics and electrical components. The book is well illustrated, easy to read, and has a number of references for further study.

**B. Banerjee**

**INHERIT THE STARS** by James P. Hogan, *Grafton Books* (Available from : *Rupa & Co.*, 3831, Pataudi House Road, Daryaganj, New Delhi 110002), pp. 239, £ 2.99

**W**HO are we? Where did we come from? What is our final goal? These are some of the questions which have concerned mankind almost from its inception; and over the centuries, religions, philosophies, literature, art and science have all tried to answer them in their own ways. Science fiction, too, has never been able to resist the lure; there are many speculations regarding mankind's origin and future evolution in its pages. In the present book, the problem is addressed in a very interesting, though not original manner.



The novel starts at a time about 50 years or so in the future; the era of war and nationalism is over. There is almost total disarmament and technological talents released are absorbed in an extensive UN organised space programme. There are substantial bases on the moon; lots of planetary explorations in progress; but there is as yet no interstellar programme. On the moon, a

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human corpse has been discovered in a cave. The body does not come from any of the national or international bases on the moon; subsequent carbon-14 dating reveals that the person died around 50,000 years ago, a time when no human being on earth was beyond the stone age. The space-suit provided further surprises; it was far in advance of anything that the human race could produce at the time. It contained, among other things, a microminiaturised nuclear power plant, completely corrosion and heat-resistant layered fabric, helmet with built-in antiglare visor impervious to high intensities of all kinds of radiation from microwave to gamma rays, built-in video display, and so on. The suit also contained a water and air recycling system, standard power and communication systems etc., and the tool kit found in the pocket was equally marvellous. The body was enzymatically identical with modern human beings; that is to say, totally and absolutely human. The age of 50,000 years for the corpse (nicknamed "Charlie") was confirmed by an independent dating from the decay products of the nuclear power plant; this left the researchers in a total dilemma. If Charlie came from a previously unknown human civilisation on earth, how is it that no traces at all of this civilisation were ever discovered on earth? If he had a non-terrestrial origin, how is it that he is so unmistakably human? No possible independent evolution could ever produce two biochemically identical species. The resolution of this impasse forms the remainder of the story.

After the discovery of "Charlie", further evidence of the "Lunarian" civilisation that he came from are discovered on the moon; some of the lunar craters show evidence of being formed as a result of extensive weapons use; the remnants of a life-bearing planet (named "Minerva") were discovered in the asteroidal belt; and an alien spaceship, presumably interstellar, is discovered under the frozen ice fields of Ganymede, one of the moons of Jupiter. The spaceship

contains, in addition to the skeletons of its non-human owners and their paraphernalia, a selection of flora and fauna that existed on earth about 25 million years ago. The tangled webs of the story line are all cleared up at the end. It is established that there was a planet with life and civilisation on it between Mars and Jupiter in the Solar System; a higher civilisation named "Ganymedian" with interstellar capabilities existed on it; they imported flora and fauna from earth about 25 million years ago, presumably in an effort to offset the rise in the level of carbon dioxide from the planet's interior but the attempt failed and the Ganymedians had to leave the planet. The imported life forms flourished however, and eventually evolved into human beings who produced a highly technical civilisation but one which was exceedingly aggressive. They had established military bases on their moon, but had no further space capability when they had a planet-busting war. The explosion created by some superweapon destroyed the planet completely whose remnants became the asteroidal belt. Their moon was flung out of orbit, and finally was captured by the earth to become our moon. Some humans survived this and from their bases on the moon migrated to earth. They could exist comfortably there since they had evolved from earth stock brought to Minerva 25 million years ago. So the mystery of human existence is finally resolved. There is enough scope for sequels to this novel, and in fact, two have been published already.

The novel is entertaining and is a good example of "hard" science fiction, (that is, one with some technological theme as opposed to the "soft" or sociological themes). But there are some wide gaps in the "science" portrayed here. The idea that the asteroids are the remnants of a pre-existing planet in the Mars-Jupiter gap, which eventually broke up in some cataclysmic happening has been given up for about three decades now, since it has been established that the gravitational pull of the giant planet Jupiter precludes the

coalescence of a terrestrial type planet. It is almost totally impossible for a moon to flung out of the orbit of one planet to be captured by another inner planet, due to the increasing gravitational field of the sun. Evidence of lunar tides exists in fossil records for many hundreds of millions of years, so the moon could not have been captured a mere 50,000 years ago. The possibility of any group of species isolated for 25 million years from earth producing species as closely related as humans are biochemically to the other members of the genus such as *Homo Erectus*, Neanderthal Man, etc., is remote. In any case, 25 million years ago, the primate line had not actually differentiated into the lemur and monkey lines. And so on.

None of this detracts one from enjoying the story. But one of the hallmarks of good "hard" science fiction is that it is truly consistent with all existing scientific data at the time of writing. This is what distinguishes Hogan from the truly great authors of this genre like Arthur Clarke, Robert L. Forward or Larry Niven.

S. Mohan

**ELEMENTS OF ELECTRICAL SCIENCE** by P. Mukhopadhyay, A.K. Pant, D.S. Chitore and Vinod Kumar, *Nem Chand & Bros.*, Civil Lines, Roorkee-247667, Pp. 272, price not mentioned

**T**HE Core Course in Electrical Science is a compulsory course for undergraduate students of all branches of engineering. However, to get the entire course material, students have to strive hard and consult various text-books. Therefore, the need for a compact, tailor-made book has long been felt by students. The book under review, it is hoped, will be able to fulfil that need. It includes chapters on electric circuits, magnetic circuits, transformers, electrical instruments,

## BOOK REVIEWS

d.c. machines, induction and synchronous machines, and electrothermal energy conversion which finds applications in industrial heating.

The book has been written in a lucid manner and in an easy-to-follow style. The SI system of units has been adopted in the book. A large number of numerical problems, solved as well as unsolved, along with multiple-choice questions have been included in various chapters of the book. This makes the book useful for engineering entrance examination. The book suffers from printing mistakes. The get-up of the book, including its cover, also leaves much to be desired. The book will nevertheless serve the purpose of those students for whom it is intended.

P. K. Mukherjee

ices giving units of selected physical quantities, universal physical constants, fundamental equations relating to electromagnetism, etc.

Although the handbook does not claim to replace a textbook or a special guide in physics, the various concepts and laws have been presented in a clear, concise and compact manner. The handbook covers almost all the branches of elementary physics. It will prove useful to students and teachers alike.

P.K. Mukherjee

sions, viz. (a) Systematics, morphology and anatomy, (b) Zoogeography, general and technique, (c) Biology and Ecology, (d) Control measures in agriculture, and (e) Cytology and Cytogenetics, the sequence of selected papers included in the proceedings do not reflect any classified arrangement. However, the papers deal with aphid studies on cotton, mustard, potato, prunus, pulse and safflower crops. The focus is restricted to studies on the biology including measures of control (about 22 papers), cytology (5 papers) and distribution (3 papers). The recommendations of the symposium, which were appended to the proceeding, also enumerate the thrust areas in aphidological research.

The first national symposium on aphids was held in June 1979 at Bhubaneswar and the organisation of the second symposium within six years is an indicator of the surge of interest in aphid studies in India. The proceedings deserve the attention of all serious entomologists interested in gauging the pace and pattern of progress of work in this group of insects in the country.

D. Sarveswara Rao  
Soam Prakash

**HANDBOOK OF ELEMENTARY PHYSICS** by N.I. Koshkin and M.G. Shirkevich, *Mir Publishers*, Moscow (Available from: *USSR Book Centre*, Connaught Place, New Delhi-110001), Pp. 272, Rs. 17.25.

**T**HERE is a dearth of good handbooks on physics. Therefore, the publication of the handbook under review is a welcome gesture. The six chapters of the handbook, cover respectively, Mechanics, Heat and Molecular Physics, Mechanical Oscillations and Waves, Electricity, Optics, and Structure of the Atom and Elementary particles. Each chapter is further divided into various sections.

Each chapter, or section thereof, consists of two parts. The first gives a brief idea of the fundamental concepts and laws, and the second contains reference tables and graphs. In the end of the book are eight append-

**PROCEEDINGS OF THE SECOND NATIONAL SYMPOSIUM ON RECENT TRENDS IN APHIDOLOGICAL STUDIES (1986)**, by S.P. Kurl (ed.), Department of Zoology, M.M. Postgraduate College, Modinagar-201204, pp. 331 (price not mentioned).

**C**REAL, oilseed, pulse and vegetable crops of India suffer extensive damage by aphids which constitute about 716 species belonging to 208 genera, of which nearly 50% are endemic to this country. Unfortunately, serious gaps exist in our knowledge of geographical distribution, taxonomy, biology, including control measures and cytogenetics of the aphid fauna of India, particularly those affecting the economic plants. The proceedings under review present about thirtyfive selected papers following the keynote address and two guest papers of the second National Symposium on Recent Trends in Aphidological Studies (September 26-29, 1985) held at M.M. Postgraduate College, Modinagar.

Even though the symposium itself was organised in five separate ses-

### Books Received

1. **A MANUAL OF FRESH-WATER ECOLOGY** by R. Santhanam, P. Velayutham and G. Jegatheesan, *Daya Publishing House*, 1302, Vaid Wara, Nai Sarak, Delhi-110006, Pp. 134, Rs. 130.00
2. **CLIMATE OF KERALA** by P.A. Menon and C.K. Rajan, *Classic Publishing House*, Cochin-682507, Pp. 136, Rs. 40.00
3. **HIGH TECHNOLOGY—MANAGERIAL CONSIDERATIONS** by P.D. Malgavkar, *Oxford & IBH Publishing Co. Pvt. Ltd.*, Janpath, New Delhi-110001, Pp. 214, Rs. 96.00

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