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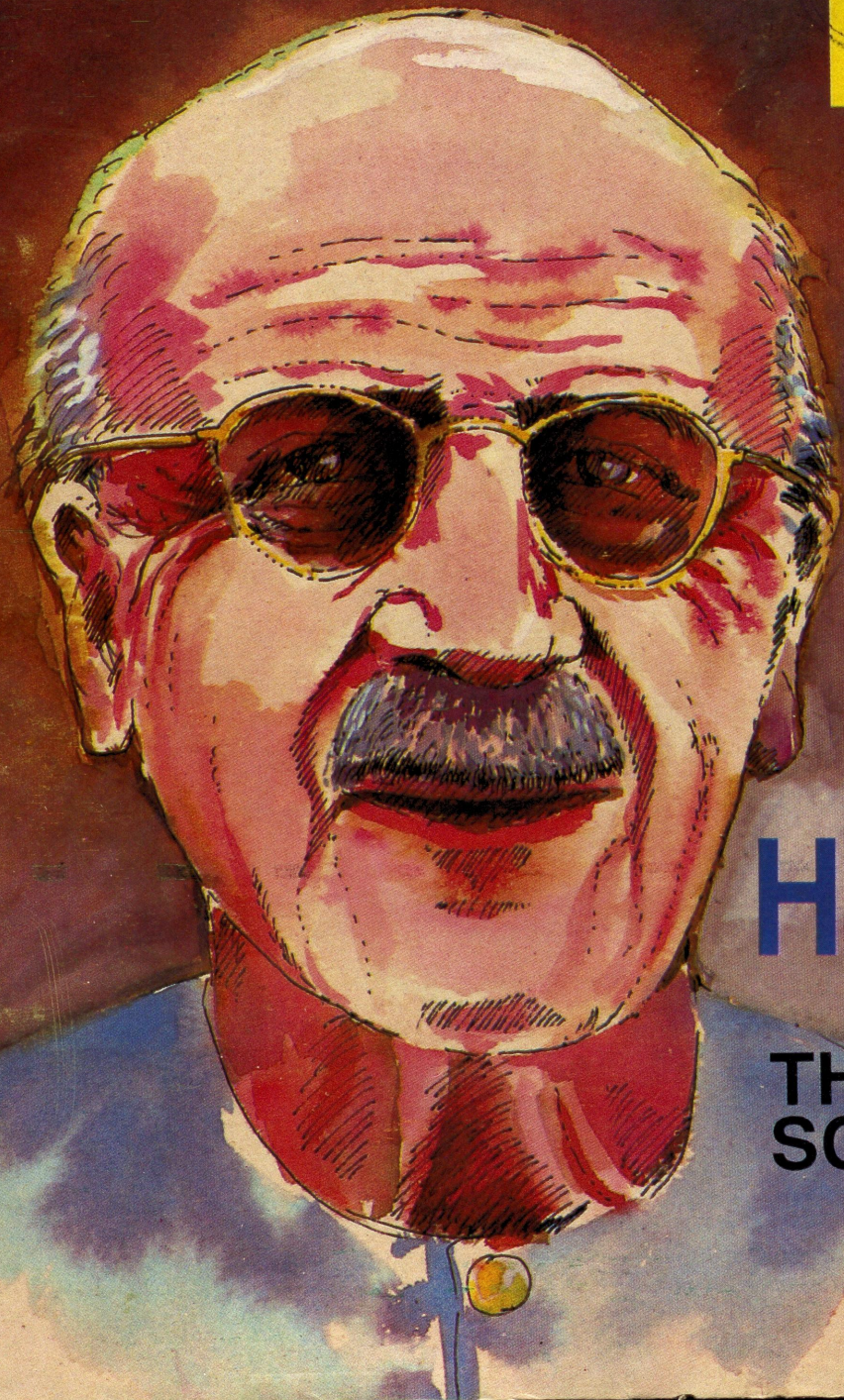
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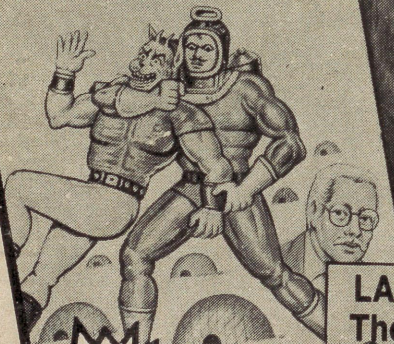
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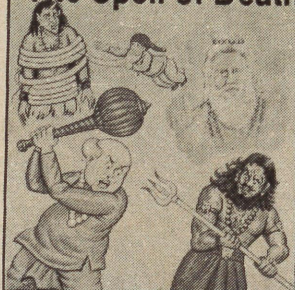


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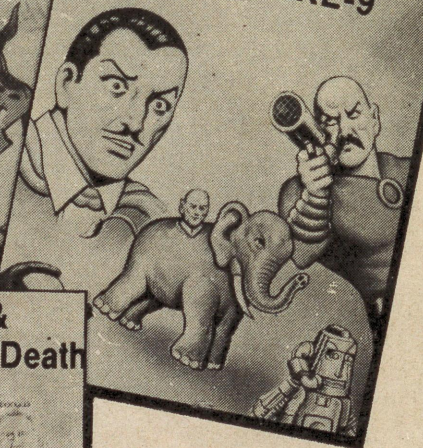
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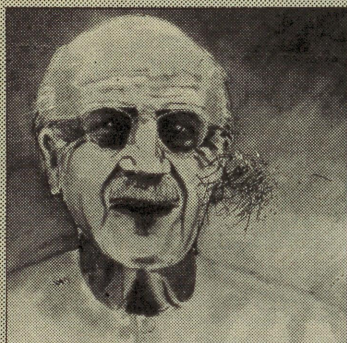


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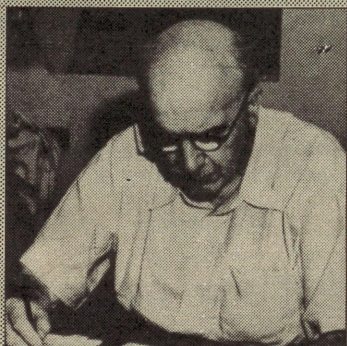
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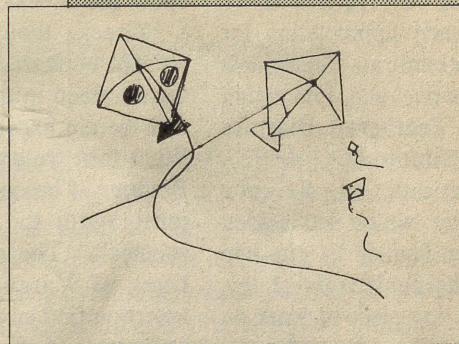
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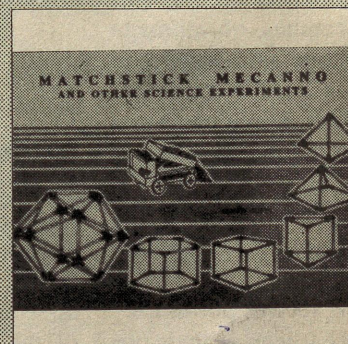
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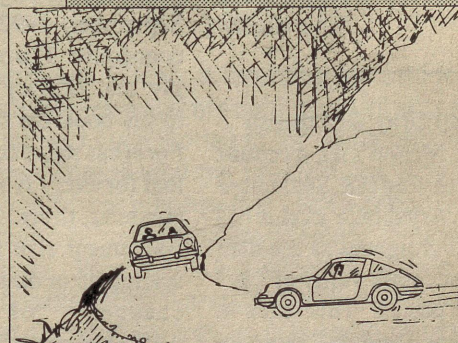
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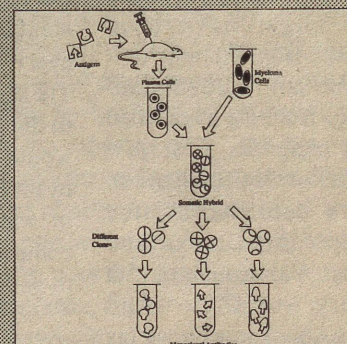
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Enthralling Piece

My hearty appreciation for Ramachandran Nambiar's informative and interesting article **Feathered Disguise** (SR, September, 1992). Salutations to Science Reporter which has added another feather in its cap with the publication of this enthralling piece of work on bird nature.

The detailed explanation with coloured photographs and sketches of plumage colouration and pattern in birds of different topographical regions was a delight for the eyes and a feast for the brains. The article also throws light on the natural protection in the form of camouflage that one of the weakest species possesses.

More articles on these line would be welcome.

Kamal Kishore Garg
Chandigarh

Counting Accounts

In S.K. Menon's **An Account Of Counting** (SR, September 1992), Aryabhata's value has been highlighted as the then most accurate value of π upto 5 places. This value in fact was used by Ptolemy (150 A.D), three centuries earlier. Thus Aryabhata's value might have been borrowed from Ptolemy or it may be an independent finding. It should be recalled that during the first few centuries of the Christian era, culture contacts existed between the Greeks and Indians. Varahamihira (5th Century A.D.), who presumably knew Greek (as the historian Vincent Smith asserts), has this much to say

about the Greeks:

"Greeks though impure must be honoured since they were trained in the sciences and therein excelled others. What then we are to say of Brahmin if he combines his purity with the height of science". The concluding lines of Varahamihira's assertion find an echo in the epilogue of Bankim Chandra's novel 'Anandamath'.

Prasanta Choudhury
Calcutta (W.B.)

Scaling Up And Down

In **Brains Trust** Pallava Bagla has mentioned that an ant can carry many times its weight whereas a man cannot do so and also that if the size of the animal increases its strength does not increase proportionately (SR, September, 1992). In this connection I would like to say that D'Arcy Thompson in his book *On Growth and Form* has stated convincingly that for every type of animal (insect) there is a most convenient size and a large scaling up or down implies a change of form.

If a human were to acquire brobdignian stature then the natural force of gravity would break his thigh bones every time he took a step. The same person if contracted to the lilliputian size of a fly, would possibly be drowned, by the force of surface tension of water, if he ventured to come so close to water so as to get wet.

S.K. Gurtu
Delhi

Tearful Onions

With reference to the answer given to the question "Why do tears run out of our eyes while cutting onions?" (**Brains Trust**, SR, September 1992), I would like to add the following.

The main volatile sulfur compound present in onion and responsible for irritation is Ally-propyl-disulfide ($\text{CH}_2 = \text{CH} \text{CH}_2\text{SSCH}_2 \text{CH}_2\text{CH}$). It gets released into the atmosphere by squeezing or crushing of the cells while cutting. The weak bond of disulphide breaks on hydrolysis when it comes in contact with the moisture of the eyes and produces sulphuric acid which causes irritation, stimulating the tear glands to produce tears.

C.M. Panda
Sundargarh

Unborn Evidence

Although Dr. Anil Aggrawal's article **Born Dead** (SR, September, 1992) was informative I would like to share some additional information with readers of SR.

In addition to the methods described by Dr. Aggrawal, a very reliable indication regarding the status of a dead child, that is, whether the child was viable or not, can be obtained by observing the lower end of the femur, which is the bone of the thigh.

In the prenatal life, the femur originates in the foetus as a cartilaginous cast which

gradually begins turning into bone from the 7th week of foetal life onwards. This process of bone laying in the cartilage model is known as ossification. Without going into technical details, it can be said that this process of ossification proceeds from certain well defined 'centres'. The shaft of the bone ossifies from a 'primary centre' and the ends ossify from 'secondary centres'.

The secondary centre in the lower end of the femur, that is, the end which forms the knee joint, appears immediately before birth of the child. So, if the secondary centre of ossification is found to be present in the lower end, the medical jurist can reliably conclude that the dead child was viable, that is, it was born alive and was capable of independent existence. Absence of the centre in the femur of the dead child indicates that it was stillborn.

Sudipto Chakravarty
Udaipur (Rajasthan)

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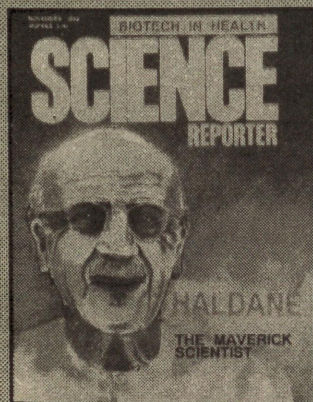
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Inadmissible Evidence

Finality of opinion is a luxury rarely indulged in by scientists. This is because the method of science inculcates in them the desirability to keep an open mind on every issue, should a compelling evidence in favour of an alternate hypothesis emerge. That is why continuous reassessment of evidence and consequent revision of conclusions characterize the scientific endeavour. And yet there are issues that have reached the stage of being beyond any grain of doubt. The concepts of heliocentric universe, round earth or non-spontaneous generation of life may be cited in this context. All possible alternate theories in respect of these concepts have been examined and admissible evidence weighed in the minutest detail before reaching these conclusions.

Doors are thus shut on these issues. To pry open these even a wee bit ajar would need the strongest of fresh evidence which can withstand the most rigorous tests to which it will no doubt be subjected. That is why science journals would not readily consent to publish a heretic view unless it has come through the strenuous peer review with flying colours. That is not all. If this initial reopening of an issue does not find substantiation and support in the subsequent analysis, it gets dropped like a hot potato and the slightly ajar door gets shut with even greater firmness.

Unfortunately, the secular press follows different tenets and is not averse to provide scarce space to views that are contrary to all accepted thoughts. It does not even subject such stories to the usual principles of checks and counterchecks. That is why the creationist's view that attacks Darwin's theory of evolution or theories that cock a snook at the ultimate limit to speed laid down by Einstein find themselves prominently presented to the public at large. Worse, this is justified by stating that it is the primary duty of responsible press in secular, democratic society to draw attention to views that run contrary to those of the establishment, be the latter of any kind. That sounds righteous enough. But often times the practice does not follow, to the same degree, the sanctity of principles. The contrary views are not put in a crucible and subjected to an acid test to find out if it is real gold or something else that has an ersatz glitter. Since the reach of the secular press is much larger than that of the scientific press, such ordeal by fire should be mandatory before controversies that are rooted in science but may have branches spreading into sociopolitical territories are bared to public view. This will be, quite literally, playing with fire in the charged atmosphere of today. Even a little, seemingly innocuous, slip can let loose a whirlwind that can sweep us all. Giving help to those who play the devil's advocate in a casual manner would, to quote John Maddox, Editor of "Nature", "is not a service but a disservice to serious readers".

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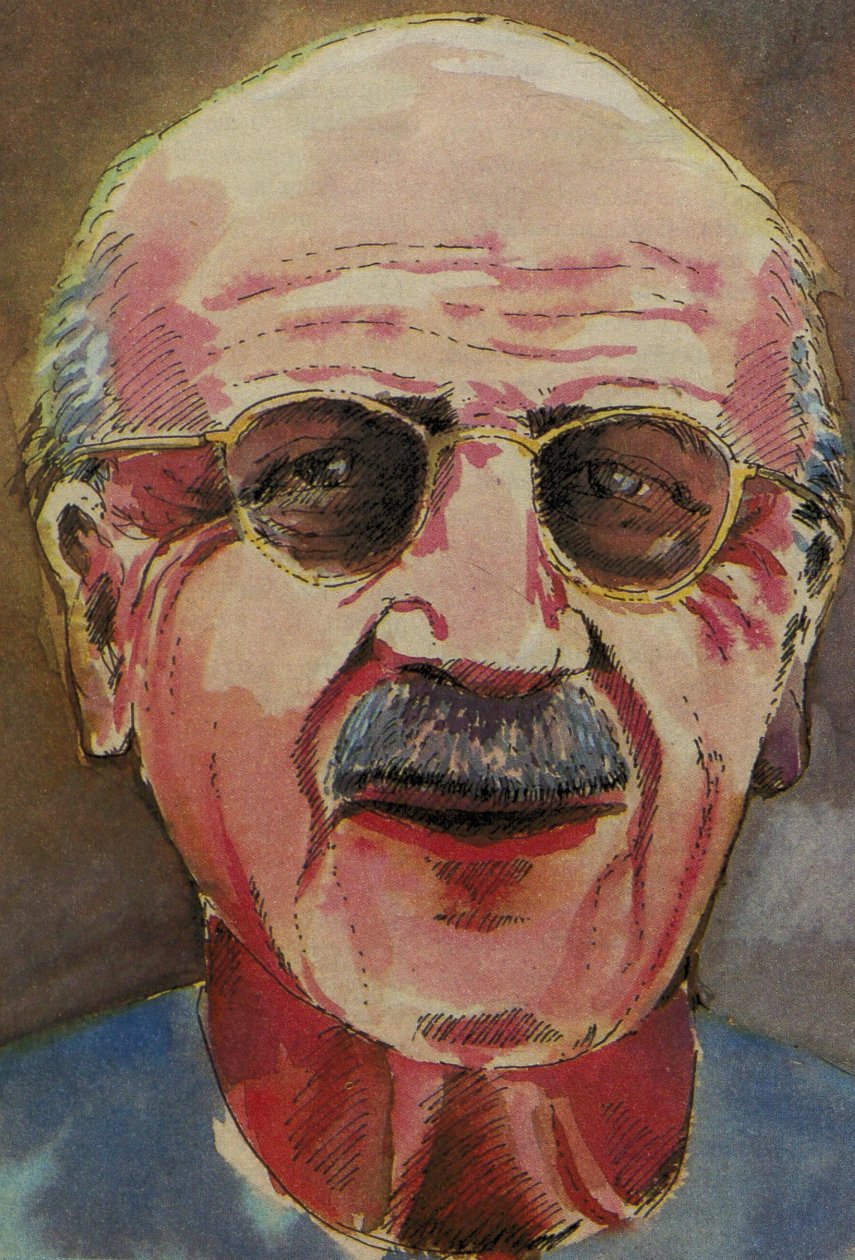
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J.B.S. Haldane:

Life Of A Prodigious Mind



Haldane has made so many contributions, that too in diverse fields. N.K. NOTANI outlines the life and times of this prodigious mind.



COVER STORY

I met J.B.S. Haldane only once in my life; but, of course, he was well-known to me through his reputation as a man with a prodigious mind. In population genetics, Ronald Fisher, Sewall Wright and JBS were the trinity that provided the mathematical foundations for Darwin's theory of natural selection. J.B.S., independently of the other pioneer A. Oparin, formulated the key ideas about the Origin of Life. Astoundingly, he may have presaged in 1941 the Meselson-Stahl experiment to answer the question of how the gene duplicates. Haldane was a socially-engaged person and his outspokenness on various issues became press correspondents' delight. He was a member of the Communist Party for some years which probably delayed the response expected from him in the matter of Vavilov and Lysenko. His 'casual' response in this regard, stigmatized his name a bit. He seemed to get peeved rather easily which in part may be responsible for his migration to India. A man of boundless imagination and phenomenal memory, he was equally at ease with literature, philosophy and science and picked up even Indian-lore with remarkable alacrity.

The outline of his life is easily told. Born on 5th November, 1892 (5th November is also Guy Fawkes day), to John Scott Haldane and Louisa Kathleen (nee) Trotter, he was brother of Naomi Mitchison, the writer. His academic career began in Oxford, then to Cambridge and finally at University College, London before he migrated to India. He was Chairman of the editorial board of the *Daily Worker*. His disenchantment with the Communist Party though late may have come after the Lysenko affair. He was greatly

outraged by the Suez invasion by Britain which together with his second wife Helen Spurway's brush with the police may have been responsible for their emigration to India, although in an article he has said that the opportunities for the kind of research he wanted to do were much better in India than in Britain. He changed two jobs before settling in Bhubaneswar, Orissa where he died shortly after moving there.

HALDANE has made so many contributions, that too in diverse fields, that it would be presumptuous on my part to attempt even a summary. James R. Newman has enumerated several "to biology, physiology, preventive medicine, botany, hematology, statistical theory, prevention of air-raid casualties, effects of various gases etc." I want to restrict myself to his contributions in genetics mainly population genetics. In 1964, Haldane wrote one of his last articles, "A Defense of Beanbag Genetics", which had been provoked by Ernst Mayr's book, *Animal Species and Evolution* in which Mayr seemed to discount the contribution of Fisher, Haldane and Wright to evolutionary theory. JBS was reviewing Mayr's book for his *Journal of Genetics*.

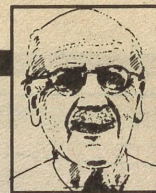
Haldane draws attention to page 263 and quotes Mayr: "The Mendelian was apt to compare the genetic contents of a population to a bag full of coloured beans. Mutation was the exchange of one kind of bean for another. This conceptualization has been referred to as 'beanbag genetics'. Work in population and development genetics has shown, however, that the thinking of beanbag genetics is in many ways quite misleading. To consider genes as independent units is meaningless from the physiological as well as the evolutionary point."

Elsewhere in the book, Mayr was more 'personal'. He said that Fisher, Wright and Haldane "have worked out an impressive mathematical theory of

genetical variation and evolutionary change. But what precisely has been the contribution of this mathematical school to evolutionary theory?" Mayr continued, "However, I should perhaps leave it to Fisher, Wright and Haldane to point out what they consider their major contributions."

Haldane took up the cudgels and drew the battleline. At the outset, however, he made what would seem like a sort of tactical retreat. He denied that the mathematical theory of population genetics was all that impressive and might have seemed so only to biologists. However, Haldane had calculated the equilibria between mutation of genes and selection against them. From this he could calculate the human mutation rates which was a byproduct of his mathematical work. This has importance as a benchmark and used even in estimating 'doubling-dose' etc. Selection and mutation must balance in the long run but how long does it take? Haldane showed mathematically that while harmful dominant and sex-linked recessives reach equilibrium fairly quickly, for autosomal recessives (after change in mutation rate), it may be thousands of generations, emphasizing the edge of mathematical over verbal formulation.

Haldane next plays his 'Indian' card. Hindus he says are either *Saivites* (followers of *Siva*) or *Vaishnavites* (followers of *Vishnu*) but both *Siva* and *Vishnu* are considered manifestations of the same Being. A biologist who is always a *Saiva* does not worry about how living organisms achieve internal harmony and adaptation to their environment and *Vaishnava* who takes organism as given does not worry about its evolutionary past and its success in competition. He adds that roughly-speaking, Darwin was a *Saiva* when he wrote on natural selection and *Vaishnava* when he wrote on the adaptation of plants. Haldane concludes that it is very difficult to combine the two approaches in one's thought at the same moment. It



Wright Stuff On Haldane's Contributions To Genetics

IN 1968, K.R. Dronamaraju, an erstwhile coworker of Haldane edited a volume dedicated to the memory of JBS. Sewall Wright, who along with JBS and R.A. Fisher was a founding father of evolutionary genetics of populations contributed a remarkably lucid article in which he paraphrased and highlighted the work of JBS. Wright starts by saying that Haldane's contribution was of a unique sort in genetics. He (JBS) himself did not conduct any systematic breeding experiments but contributed by critical analyses using statistical methods. JBS was the first to report along with A.D. Sprunt and his sister N.M. Haldane the first case of linkage between two gene loci in mammals. In 1919 he gave a formula for the relation of map distance to amount of recombination. His important and complex contribution was also in linkage theory for polyploids.

His most cited papers, however, were on, "The Mathematical Theory of Natural and Artificial Selection" on which subject he published 10 papers between 1924 and 1934. He gave the objective: A satisfactory theory of natural selection must be qualitative. In order to establish the view that natural selection is capable of accounting for the known facts of evolution, we must show not only that it can cause a species to change, but that it can cause it to change at a rate which will account for present

and past transmutation.

Haldane had some interest in estimating the amount of radiation that would be required to double the spontaneous rate in man and he felt that it could be as low as 3 rontgens. As is known now, the new estimates (of James Neel for example) put doubling dose figure at more than 100 rads. In retrospect it would seem that Haldane was wide off the mark because he assumed that all the natural mutations are due to background radiation. This seems unlikely as it is known now that maternal age at conception has a very large effect on the Down syndrome (a sort of chromosomal mutation) incidence at birth and implying a very large effect of 'internal' errors.

Haldane and Bell made the first estimate of partial linkage in man between two sex-linked genes hemophilia and colour blindness. Their first estimate of 5% was later revised to $10 \pm 4\%$. The physical distance between these two markers is now known and this has been estimated at more than 1 megabase. Thus, recombination data and physical data can now be correlated.

Haldane wrote several articles on eugenics. He was skeptical about doing positive eugenics because he was not convinced that anyone had sufficient wisdom to decide on the goals.

N.K.N

is to show what kind of numerical data are needed. In so far as Mayr succeeded in convincing the politicians and business executives who control research grants that beanbag genetics are misleading, we shall not get the data. As a final salvo, Haldane said, "Perhaps a future historian may write if Fisher, Wright, Kimura and Haldane had devoted more energy to exposition and less to algebraical acrobatics; American, British and Japanese genetics would not have been eclipsed by those of Cambodia and Nigeria about 2000." JBS had tried to ward off such a situation.

The article is ended by an informal acknowledgement that he had retired to a one-storied 'ivory tower' which had been provided to him by the Government of Orissa in 'the earthly paradise of Bhubaneshwar' and hoped to devote the remaining years largely to beanbag genetics.

HALDANE met Oparin for the first time in Florida in 1963. Haldane was very magnanimous. In response to the question who had first put forth the theory of origin of life, when Oparin said he had done so in 1924, Haldane said that therefore Oparin had priority over him and he was ashamed that he had not read Oparin's early work. He admitted that he did not publish his work until 1927 so that this may raise the question of plagiarism. Of course, everybody knew that Haldane was being modest.

One more idea of Haldane may be recounted here which was truly astounding. It is told by Judson that JBS in his 1941 book, *New Paths to Genetics* had already made the suggestion as to how the mechanism of gene duplication may be discerned. "How can one discern between the model (template?) and the copy? Perhaps, you could use heavy nitrogen atoms in the food supplied to

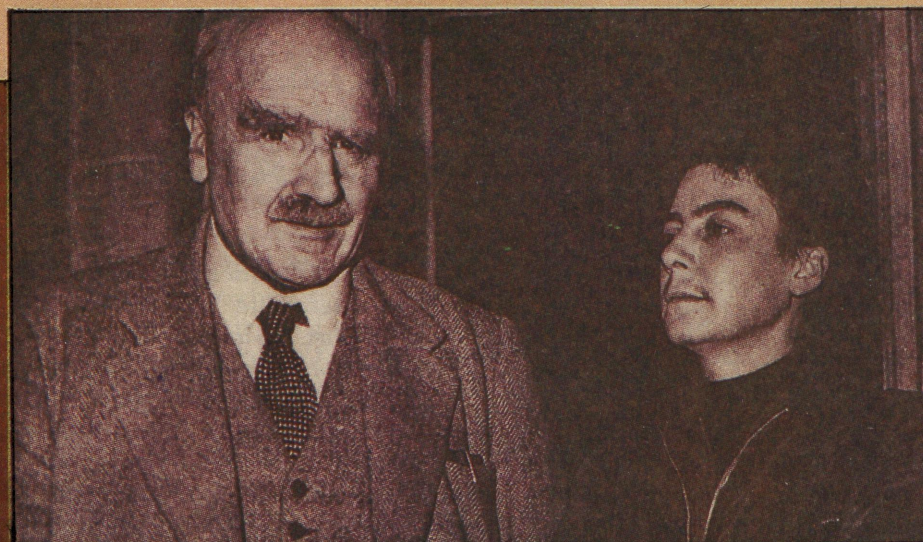
may be easier a century hence.

Finally, Haldane counterattacks and takes on one of Mayr's weak points of 'genetic cohesion'. Haldane argues, as an example, that if inter-caste marriages

in India became common various undesirable recessive characters will become rarer (as Mayr had said) but so may some desirable ones. One of the important functions of beanbag genetics

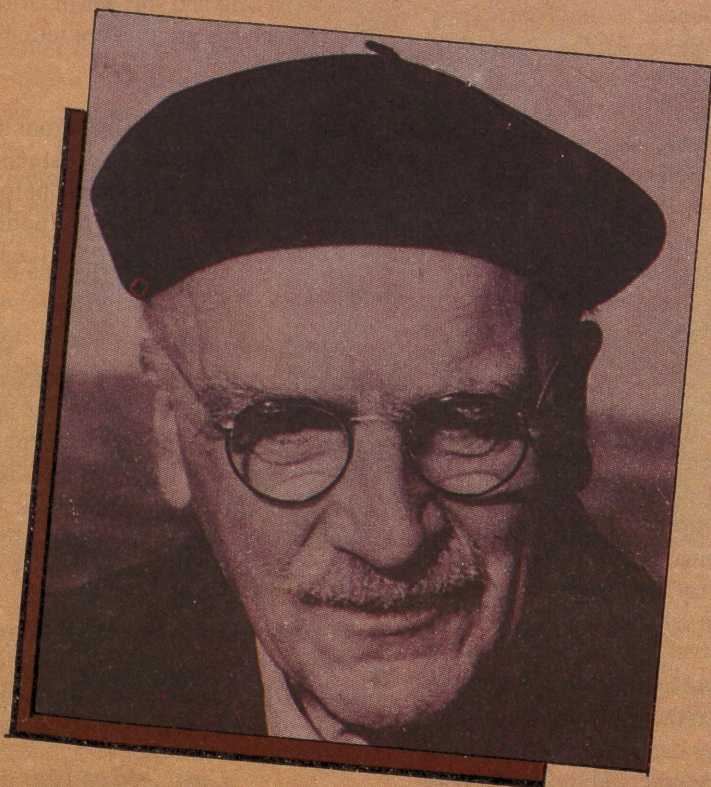


HALDANE ALBUM



Clockwise from top left:

- Haldane in his childhood days
- Young Haldane
- As a Black Watch Officer during the First World War
- A family affair
- In Indian clothes in Monaco in 1961
- An ageing Haldane with a beret cap on
- With wife Helen Spurway-Haldane





COVER STORY

your cell hoping that the 'copy' genes would contain while the models did not." As is known, that such experiments were attempted by Meselson and Stahl only in the late 1950's. When Judson asked Meselson about Haldane's 1941 suggestion, Meselson seemed unaware of it.

Mendelian genetics has had a chequered history in Eastern Europe. Founded by Gregor Mendel in 1865 in Brno, now in Czechoslovakia, it was promoted by Bateson in the English-speaking countries beginning in this Century and its development furthered by the American geneticist Thomas Hunt Morgan whose work paved the way for mapping genes on the chromosomes. Nikolai Vavilov, a Soviet geneticist had trained with Bateson and he too was an adherent of Mendelian genetics. He made the important contribution that the centres of origin of a species (including cultivated crops) had the greatest diversity for it. For a while he was doing quite well and in the 1920's he was the President of the Academy of Agricultural Sciences. But this was soon to end; generally due to the 'dictates' of dialectical materialism by which touchstone the science was to be conducted in the Soviet Union and its satellite countries; but in particular, due to the machinations of Trofim Lysenko. These problems were perhaps to be expected as has been pointed out by Jacques Monod in his *Chance and Necessity* that, "Although, he had a thorough acquaintance with the science of his day, (Friedrich) Engels himself had been led to reject in the name of dialectics, two of the greatest discoveries of the age; the second law of thermodynamics and (notwithstanding his admiration for Charles Darwin) the theory of natural selection. It was by virtue of these principles that Lenin assailed the epistemology of Mach, that later Zhadnov ordered Russian thinkers

to scourge the Copenhagen School for its 'devilish Kantian mischief', that Lysenko accused geneticists of maintaining a theory radically at odds with dialectical materialism and therefore necessarily false."

Vavilov considered Haldane a leader in genetics and in fact hosted his visit and lectures both in Moscow and Leningrad in 1928. Later Lysenko became the boss and Vavilov's persecution began and by 1942 he had been liquidated. Haldane's attitude in the Vavilov affair has been described as 'casual' by his biographer Ronald Clark. A reviewer of *Science Advances in Nature*, accused Haldane as having concern not for advancing science but communism. A.V. Hill was likewise critical of Haldane.

Things came to a boil in 1948 when at the Presidium meeting of the U.S.S.R. Academy of sciences, 12 resolutions were passed which abolished existing laboratories and asked for removal from Scientific Councils of those supporting 'Morgano-Weismannite' genetics. Although, Haldane now was less guided by his consideration for the Communist Party, he did not resign from the Soviet Academy of Sciences as was done by Sir Henry Dale, President of the Royal Society who did not want to condone the manner in which science was to be done in the Soviet Union. in Paris, Monod condemned the perversion of Science by Lysenko.

Actually, Lysenkoism was ludicrous in the extreme. In 1943, Lysenko published a booklet entitled, *Heredity and its variability*. C.D. Darlington has published some of the excerpts in his book, *Facts of Life*, from which the following are culled:

"Vegetative hybrids do not differ in principle from those obtained sexually. Any character can be transmitted from one breed to another through grafting as

well as sexually."

"The hereditary properties can be transmitted from the stock to the scion and *vice versa*." Further,

"The heredity is, as it were, the essence of the conditions of external environment assimilated by the plant organisms in a series of preceding generations."

The tolerance, if not acquiescing of this nonsense on the part of Haldane, would be puzzling. In 1948, Lysenko made the claim that would strain anybody's credulity:

"By two, three or four years of autumn sowing he had been able to change macaroni wheat *Triticum durum* with 28 chromosomes to bread wheat *T. vulgare* with 42 chromosomes."

In 1950, Lysenko declared that:

"Certain science workers and students in the field in hilly region discovered single grains of rye in the ears of both hard and soft wheat. More than 200 such rye grains were found in 1949."

Finally, Darlington quotes from the 1950 article, "In the seventeenth century, before Spallanzani, before Linnaeus, these things happened everywhere but such things (now) could happen only in our country!"

Haldane resigned from the Communist Party, perhaps in 1948, over the Lysenko affair. He probably had enough of it. He had given Lysenko the benefit of the doubt for much too long. J.D. Bernal kept quiet and makes no mention of this sordid affair in his four volume book on *Science in History*.

IN 1945, JBS Haldane was divorced by his first wife Charlotte on uncontested grounds of desertion. He then married Helen Spurway—a real soul-

(Continued on page 46)

Social Application Of Human Genetics

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Application of human genetics is often considered a double edged sword. But is it? J.B.S. HALDANE dispells many misconceptions about this important discipline.

●

A science, by which I mean a body of general statements about a set of natural events which can be verified in practice, or a superstition, by which I mean a set which cannot be so verified, can have two rather different results in society. In the first place, it may lead to improvements in production or destruction, or divert what could be productive effort into useless channels. Secondly, it may give no immediate increase in human control of matter, but conduce to a world view which does so, or have the contrary effect. Thus the wonderful development of astronomy in the last century has given us no control over the stars or even the tides. It has convinced educated people that the same kinds of matter with the same properties, exist throughout the universe, and have existed for thousands of millions of years. It has given us great confidence in dealing with matter, and suggested new ways of dealing with matter on earth. But the actual observation of stars is of less practical importance than it was a century ago, since radio signals have mainly replaced such observations in navigation.

to produce babies with superior endowment. I think our descendants will know how to do so, but that may be as far in the future as was human flight in Leonardo's time. The main result of human genetical research is to disprove a number of superstitions in the broad

sense of the word, that is to say including false beliefs not incorporated into a religion, but sometimes definitely forming part of an ideology and always at least compatible with it.

Let me try to summarize what seem to be the main conclusions of genetics. A higher organism consists of parts with specialized functions, such as muscles and chloroplasts (in which sunlight evokes sugar from carbon dioxide and water). It also contains information stores which determine to some extent how these organs will be formed and used. In the very simplest organisms there may be only one such store. In higher animals there are two such stores.

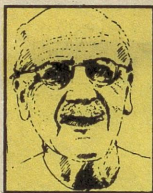
One is in the central nervous system, perhaps consisting of ribonucleic acid (RNA) and can be altered by any experience of the organism. Its function may be called memory. Probably all cells have got a



Genetic counselling is a major application of human genetics

Now human genetics has as yet given us very little accession of control. We know how it would be possible to prevent the births of some, but far from all, defective babies. We do not know how

nervous system, perhaps consisting of ribonucleic acid (RNA) and can be altered by any experience of the organism. Its function may be called memory. Probably all cells have got a



COVER STORY

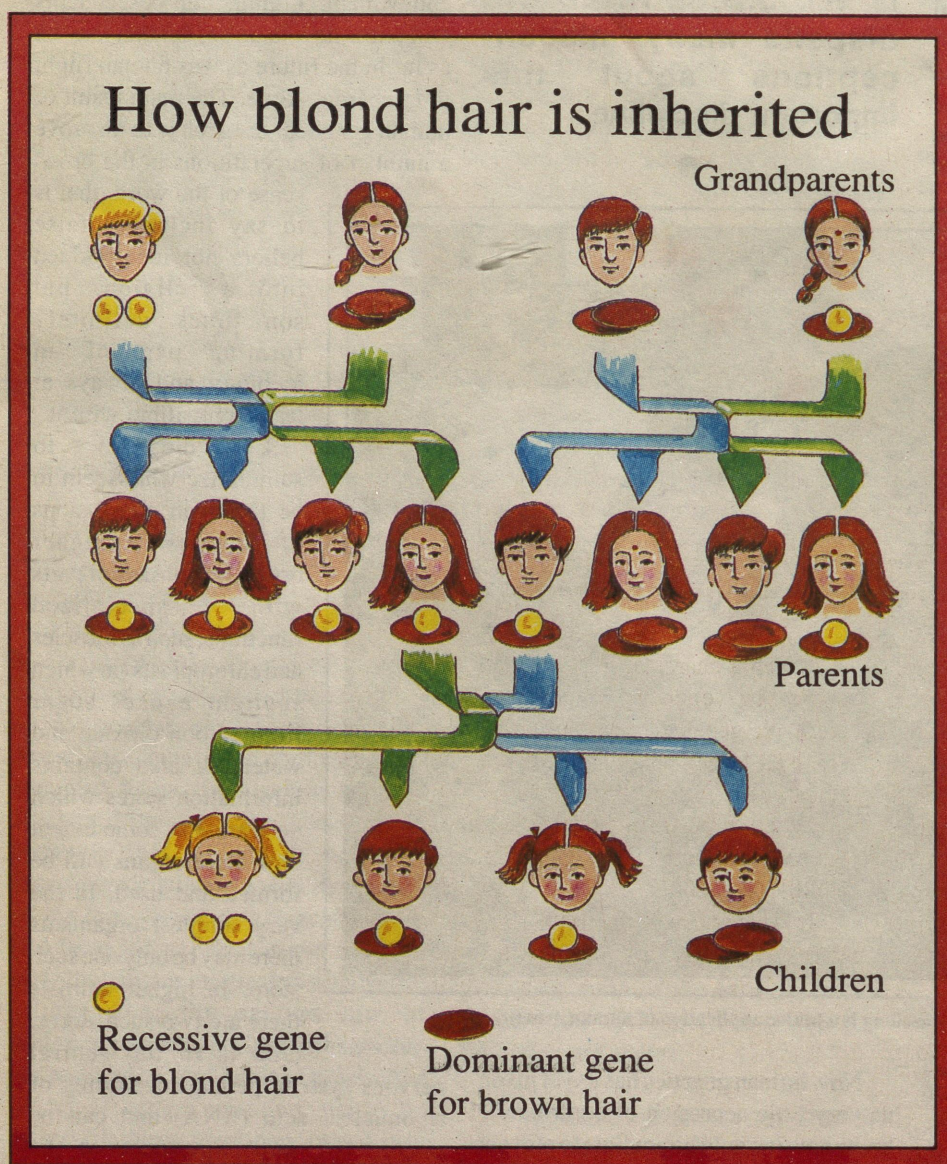
memory, but some brain cells are specialized for this function. There is another system consisting of deoxyribonucleic acid (DNA) found in the nucleus of every cell in the body, and it is much harder to alter. This system is mainly responsible for heredity, among other things. RNA and DNA both consist of chains of alternate sugar and phosphoric acid residues, with one of (usually) four bases attached to

each sugar. Both acids can be replicated from simpler molecules available in a cell, and the pattern of DNA can be transferred to RNA. Since each segment of DNA or RNA can include one of four bases, it can incorporate two bits (binary units) of information. A molecule weighing a million Daltons incorporates about 12,000 bits. The specialization is not absolute. It is as false to suppose that DNA is unalterable as that memory is infallible.

The DNA chain consists of sections

called genes, each of which can be copied as RNA, and these RNA patterns evoke specific proteins. The genetic code is probably no more arbitrary than the spectrum of an atom or molecule. Thus adult human haemoglobin is a compound of two proteins alpha and beta. A small change in the gene responsible for alpha evokes haemoglobin C instead of A. Haemoglobin C and the gene evoking it are common in West Africa, and those who have it are more resistant to one type of malaria than normal people with A. They are perhaps a little less healthy in the absence of malaria.

The chains of genes are called chromosomes. A normal human has twenty-three chromosomes derived from each parent, and between them they determine what proteins he or she makes. When new gametes (eggs and spermatozoa) are formed each contains only twenty-three chromosomes. But a chromosome in a gamete is not usually purely maternal or paternal. It contains sections from each parent. The fundamental rules according to which genes (and sometimes sections of genes) are usually distributed to the gametes are almost as simple as those of arithmetic. The deductions from them are as complicated as number theory. The normal copying process 'goes wrong' with measurable frequency. These 'errors' are called mutations. Most mutations are harmful in the sense that those in whose nuclei they are found have less chance than normal people of leaving offspring. However, a few are favourable in the same sense (at least in some environments), and evolution has proceeded by the natural selection of favourable mutants.



The passing down of genes through generations



A complication arises from recessivity. A person carrying in each nucleus a gene making a protein which does not perform some normal function may not be handicapped. Thus most people carry a gene from each parent, evoking in the liver cells a protein which catalyses the oxidation of phenylalanine to tyrosine. Both are amino acids found in most proteins. If he or she has only one this process occurs at about half the normal rate. If he has none the process goes on very slowly indeed, and such people are usually idiots and at the best mentally sub-normal. Such a condition is called recessive. Recessives are only born when both parents carry one abnormal gene, being called heterozygotes. Other genes show up in heterozygotes. They are sometimes miscalled dominants. But strictly speaking, a dominant gene is one such that two have an effect indistinguishable from one. No human gene except some which are quite common in

populations is known to be dominant in this sense, and it is better to avoid the use of this word. There is a further complication due to the fact that males are male because they carry at Y chromosome copies from their fathers, and an X from their mothers, while females have an X chromosome derived from each parent. Recessive genes in an X chromosome therefore show up in males but not in females. They are called sex-linked recessives.

We may now examine some commonly held beliefs.

1. *'Good and bad qualities are hereditary'*. If a character is due to a single non-recessive gene, then about

half the children of a person showing it will have the gene and the character. Such characters are extremely rare, and no socially desirable character so determined is yet known. Unless the determination of socially desirable human characters is much simpler than that of milk yield in cattle, such characters depend both on a favourable (not necessarily pleasant) environment and a considerable number of genes. If,



Human chromosomes, the carriers of genetic information

say, such a character depends on three non-recessive and two not very common recessive genes the probability that the son of a 'great' man would inherit his 'greatness' biologically would be $1/8 pq$, where p and q are the frequencies of the two recessive genes. This might be as little as 0.0001.

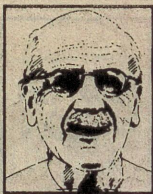
It is, of course, true that an exceptional man or woman is more likely to have children with similar capacities to his own than a man chosen at random. But the probability is small. If the 'hereditary principle' acts once in ten or a hundred trials it is not a suitable basis for social planning.

2. *'Higher social classes are*

congenially superior' This is probably true statistically for some abilities. To rise in the economic or social scale requires some abilities. To remain in it if born into it requires much less. But, on the whole, a larger fraction of children of the 'higher' classes do well in 'intelligence tests'. This is largely because they are better fed and protected from disease, and better educated in the kind of performances on which intelligence tests are based. However, when allowance has been made for these facts there is good evidence for some increased congenital ability. If this is so it is socially desirable that persons of the higher-income groups should have more children, and that social institutions which cause them to limit their families should be abolished. These include inherited wealth, and the possibility (or a belief in the possibility) of buying superior education for a small number of children. The causes

discussed by Kinsey and his colleagues may be equally or more important. They include a negative attitude to sexual activity which is inculcated along with higher education in many cultures.

3. *'Since the mean intelligence quotient is smaller in large families than in small, the mean I.Q. of the population is falling as the result of natural selection'*. This may be true in some countries. It is not true in Scotland, where very large-scale tests have been made with a generation between them. There is no reason why it should be true. The average height is also smaller, where it has been measured, in large than in small families; nevertheless average

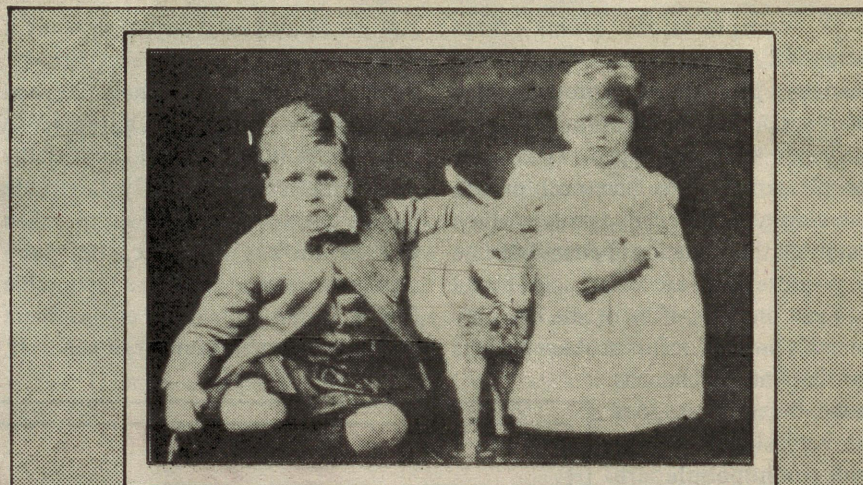


height is increasing in most populations. The most probable explanations are that children

in small families are better fed than in large ones, but the standard of nutrition, even in large families, has risen in the last forty years. The same argument clearly applies to education. But, some eugenists will say, these are superficial effects, the genetically determined capacity for developing intelligence must be falling. We cannot prove that it is not, but there is no obvious reason why it should. We now know that selection may be quite ineffective, for several reasons. One is dominance. Some races of stocks (*Mattheola incana*) produce rather over 50 per cent seedlings with 'double' and therefore sterile flowers. The minority of singles continues to give double progeny, though there is complete selection against doubles. This is an extreme case, but other characters persist indefinitely in the face of moderate selection against them.

4. 'The practice of medicine leads to the spread of harmful genes which would otherwise be eliminated by natural selection.' This is true, but the spread is extremely slow. The only process which can increase the frequency of such a gene is mutation, which can increase it by about one-hundred-thousandth per generation. This could have serious results in a few thousand years. But in a hundred years we should know how to counteract this process. We already know that resistance to malaria is favoured by genes which in its absence cause death or incapacity from several blood diseases. We have reason to suspect that other diseases have led to the spread of genes which are harmful in their absence. The eradication of an infectious disease reverses this process. It may be as important as the dysgenic effect of medicine, or more so.

5. 'Some human races are congenitally superior to others in respect of socially valuable innate characters.'



J.B.S. Haldane and sister Naomi Mitchison

25th August, 1992 twenty years.

Dear Dr Phondke

My son, Prof Avrion Mitchison, has passed on your letter to me, but I am afraid my brother, J.B.S. Haldane has left no photographs during the last part of his life. He really disliked having photographs taken. He even disliked having photos in which he was only one in a group, and even in that, I have nothing taken in the last

I wish I had a photograph myself, but he would never let me take one. I do not know of anyone who managed this. Perhaps he did not want his ideas to be in any way tied up with a particular person.

Yours sincerely

Naomi Mitchison
(Naomi Mitchison)

Nevertheless, we have been fortunate to find quite a few photographs of Haldane taken during his later life which are reproduced in this issue.

—Editor

This is no doubt formally true. If a million British and a million Chinese babies picked at random were brought up under the same conditions, doubtless a large fraction of one sample than the other would be able to pass at A level, to drive a car for ten years without an accident, and so on. We do not know which would prove superior. Intelligence tests on groups of different racial origin in the United States show little difference if home and school conditions were comparable. The superior performance of Jews may be due to greater parental encouragement in intellectual achievement. As for moral behaviour, one need only read

the *Anglo-Saxon Chronicle* to conclude that our ancestors twelve centuries ago were pretty blood-thirsty barbarians, though less so than the Scandinavians. Either the relevant genetical make-up has changed completely or, which seems to me much more probable, the changed moral tradition has had the observed effect. African Negroes have made considerable contributions to music and some to plastic art, but as yet none to mathematics, though they produced one 'lightning calculator.' Nor had Englishmen before A.D. 1500. Neither group had the environment in which an original mathematician could develop.

I do not doubt that statistical



differences exist. But they cannot be deduced from past performances any more than one can deduce that British wheat breeds surpass those of Canada because wheat yields per acre are higher

in Britain.

6. 'Racial crossing is harmful.' Groups of mixed racial origin, for example, Anglo-Chinese in Cardiff and Anglo-Indians in Calcutta, are often the

descendants of promiscuous and/or venal local women and lecherous foreign men.

Whatever their genetical endowment, their social traditions, during the first generation at least, were below the average of either parental group. Where this has not been true, as with the progeny of European women and Indian men in India, or where, as with the populations of Europe, the intermixture has occurred in the remote past, there is no evidence of deterioration, and some, though not at all conclusive evidence of superiority.

7. 'We now know enough human genetics to control our evolution if we wished to do so.' This is believed by some influential American geneticists. We could, without serious infringement of human liberty, reduce the frequency of congenitally sub-normal babies, though probably not by more than half. We could not, for the reasons given under (1.), greatly increase the number of babies with superior endowment. Any premature action taken for this end could lead to serious injustice, as Hitler's measures for racial improvement did, without achieving anything. This would lead to a distrust or even hatred of human genetics, and might possibly lead to genetic deterioration.

(Continued on page 48)

CANCER'S FUNNY THING

J.B.S. HALDANE

*I wish I had the voice of Homer
To sing of rectal carcinoma,
which kills a lot more chaps, in fact
Then were bumped off when Troy was
sacked.
Yet, thanks to modern surgeons' skills,
It can be killed before it kills
Upon a scientific basis
In nineteen out of twenty cases.*

*I noticed I was passing blood
(Only a few drops, not a flood)
So pausing on my homeward way
From Tallahassee to Bombay
I asked a doctor, now my friend
To peer into my hinder end,
To prove or to disprove the rumour
That I had a malignant tumour
They pumped in Ba (SO),
Till I could really stand no more,
And when sufficient had been pressed in,
They photographed my large intestine.
In order to decide the issue
They next scraped out some bits of tissue.
(Before they did so, some good pal
Had knowed me out with pentothal,
whose action is extremely quick,
And does not leave me feeling sick)*

*The microscope returned the answer
That I had certainly got cancer
So I was wheeled to the theatre
where holes were made to make me better.*

*One set is in my perineum
Where I can feel, but can't yet
see 'em.
Another made me like a kipper*

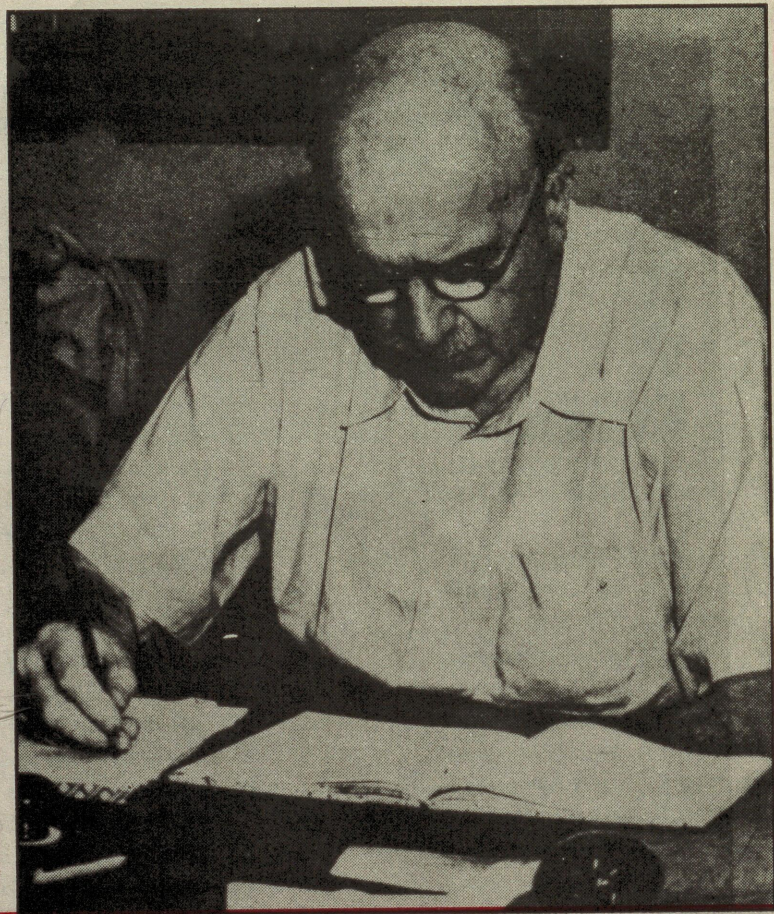
*Or female prey of Jack the Ripper.
Through this incision, I don't doubt
The neoplasm was taken out,
Along with colon, and lymph nodes
where cancer cells, might find abodes
A third much smaller hole is meant*

*To function as a ventral vent;
So now I am like two-faced Janus
The only god who sees his anus
I'll swear, without the risk of perjury,
It was a snappy bit of surgery.
My rectum is a serious loss to me
But I have a very neat colostomy,
and hope as soon as I am able,
To make it keep a fixed time-table.
So do not wait for aches and pains
To have a surgeon mend your drains
If he says "Cancer" you're a dunce
Unless you have it out at once,
For if you wait it's sure to swell,
And may have progeny as well.
My final word, before I'm done,*

*Is "Cancer can be rather fun".
Thanks to the nurses and Nye Bevan 5
The NHS is quite like heaven
provided one confronts the tumor
With a sufficient sense of humor.
I know that cancer often kills
But so do cars and sleeping pills;
And it can hurt one till one sweats
So can bad teeth and unpaid debts.*

*A spot of laughter, I am sure,
Often accelerates one's cure
So let us patients do our bit
To help the surgeons make us fit.*

Haldane was intimate but formal, elaborate and at the same time subtle, an unconventional but extraordinary teacher, says P. MEERA KHAN.



Remembering Haldane

DURING the Eleventh International Congress of Genetics held in September 1963 at The Hague in the Netherlands, Haldane concluded his plenary lecture on 'The Implications of Genetics to Human Society', with a few remarks, "I want to conclude with a plea for research in

human genetics throughout the world. It must, I think, be conducted mainly by people of the same race and tradition on their subjects India has many disadvantages. Birth, marriages and deaths are not fully registered, and laboratory facilities are very poor. But there are compensative advantages. I begin with a trivial one. Most of the body surface of Indian males, and the feet of most women, are open to

inspection. My colleague Ajit Ray, trained as an anthropologist, has just joined me. I suggested that he examine local people for colour vision. But I had evidently taught him a little genetics. For in his first three weeks, besides testing colour vision ..., he discovered three pedigrees of a foot deformity characterized by a short fourth toe, due to an incompletely penetrant autosomal dominant which shortens the fourth metatarsus

"Still more important are the



advantages offered by the prevalence of smallpox and other diseases, and in some rural districts, of malaria. It is still possible in India to study the effects, if any, of abnormal haemoglobins, thalassemia, and glucose-6-phosphate dehydrogenase deficiency on resistance to malaria. My colleague Dr. Meera Khan is doing so, and W.H.O. has promised to send out a party under Professor Siniscalco to collaborate with him

"In other parts of India inbreeding is commoner than in any large human populations so far investigated. Thus Dronamraju and Meera Khan found 7 per cent of uncle-niece marriages, and 16 per cent of first cousin marriages, in 2177 investigated in Andhra Pradesh, these figures being fairly representative for ten million or so people. They found a raised coefficient of inbreeding in cases of pulmonary tuberculosis. This interested S.D. Jayakar and myself sufficiently to stimulate us to produce a new test of significance for such cases."

In India, Haldane had only a selected number of associates working with him. On the occasion of his election as a foreign member of the US National Academy of Sciences, Haldane listed, in a letter of acceptance, six — T.A. Davis, K.R. Dronamraju, S.D. Jayakar, P. Meera Khan, Ajit K. Ray, and S.K. Roy — and stated, "Since I have done little independent work in the last seven years. I venture to hope that my election is in part a recognition of the research done by my colleagues in India. I regard the help which I have been able to give to young men of great ability who would have had little chance without me, as a service to science as important as, and perhaps more difficult than, the first estimation of a human mutation rate or the discovery that oxygen at seven atmospheres' pressure, has a taste."

OF his colleagues in India, Krishna R. Dronamraju was the second to join him at the Indian Statistical Institute (ISI), Calcutta. Dronamraju visited me in 1959 to explain a research programme

in which Haldane proposed to involve a medically qualified person as an active participant.

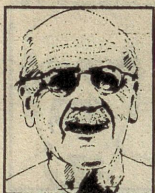
How did it all come about? Two years after Professor Haldane's migration to India his popular writings in *The Hindu*, became a regular feature of his teachings to hundreds of thousands of serious minded students of science in India. In one of his popular science articles Haldane described the work of his disciple Dronamraju on the pollinating behaviour of butterflies and its relevance to speciation. During the same year, Haldane visited Andhra Medical College at Visakhapatnam in Andhra Pradesh, and delivered a lecture on high altitude physiology and physiology of deep sea diving. As a student of that medical college I had the privilege of attending his lecture and the opportunity of learning more about Dronamraju. I wrote a congratulatory note to Krishna for his achievements. On his subsequent visit to Andhra Pradesh he came to see me. He was in Andhra Pradesh to gather data on the pattern of inheritance of hairy pinnae (hairiness of the auricles of the ears). He tried to explain the significance of that study. At the first narration his work on hairy pinna did not impress me, probably due to my "medical student's" general ignorance of human genetics in the year 1959. Moreover, I was busy with my final examinations; thus I was more concerned with peptic ulcers, muscular dystrophies, refractory anaemias, organ specific cancers, diabetes mellitus, hypertension and the like. In Andhra Pradesh we did not have genetics in our medical curriculum. Mendel's laws of inheritance I had learned from our botany teachers at P.R.G. College in the year 1953 did not help me to continue a reasonable conversation on hairy pinnae. Then our topic moved on to the widespread practice of consanguineous marriages (marriages between blood relatives) in Andhra Pradesh. Their relevance to the (recessively) inherited diseases made me rather enthusiastic. I

believe that, that was the seed which grew into the trees of our joint studies on the frequencies and the clinical effects of consanguineous marriages in Andhra Pradesh.

A few weeks later Dr. Helen Spurvey (Professor Haldane's wife) and Dronamraju visited Visakhapatnam and discussed the details of the research programme and the forms for the collection of clinical data together with the marriage information from individual patients being treated in the wards of King George Hospital at Visakhapatnam, the teaching hospital attached to Andhra Medical College. I was to continue at that hospital to work as an Intern and a House Surgeon for the next 18 months as was the practice in 1960. The discussions, especially with Mrs. Haldane, had been extremely clear, unambiguous, elaborate, critical and very educational. The clinical relevance of the project had highly motivated me to the extent of "total devotion and personal sacrifice."

After obtaining the required permissions from the appropriate authorities, and with the spontaneous and continuous help from both senior and junior colleagues in charge of individual patients in various wards of the nearly 1000-bedded hospital, I started the investigations during my spare time - my "spare time" included all the off-duty hours that comprised afternoons, evenings, nights, weekends, holidays and days of vacation. After the completion of my investigations on the first 143 cases I was invited to Calcutta. The visit was meant to discuss my data with Haldane and to analyse (or in Haldane's words, "to squeeze the maximum" out of) them in collaboration with Dronamraju.

The ever enthusiastic Mrs. Haldane and Dronamraju received me at the Howrah station and drove me directly to the Indian Statistical Institute (ISI). It was my first visit to ISI. On reaching the



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campus, while I was being introduced to the colleagues and the labs, the pile of my data sheets were quickly channelled to Haldane for inspection, prior to my meeting with him. Haldane joined us that afternoon in the library hall for a quick but delicious Indian lunch arranged by Mrs. Haldane. During that lunch, among other things, Haldane spoke about Julia Bell, his former collaborator during his London period, who gathered and analysed information on the incidence and effects of consanguineous marriages in England and Wales and mentioned briefly similar work by others elsewhere in the world. He enquired about the most common diseases in Andhra Pradesh and in particular among the in-patients of King George Hospital. He was interested in facilities of blood group serology and mentioned the importance of studies on blood groups and disease associations.

I stayed with the Haldanes, as I did on all my subsequent visits to them, also during their Bhubaneswar period. Mrs. Haldane was a fabulous hostess and Professor Haldane was extremely kind to all his guests. It was almost a 16 hours-a-day schedule, about 80% of which was either work, study or discussions with no tint of informality (that's how I felt, I believe). After that 4-day visit I returned home with 4 months'-full of fruitful experience. The first gifts I received from Mrs. Haldane were two books: one, Curt Stern's classical, *The Principles of Human Genetics* and another, equally classic, *Principles of Genetics* by Sinnott, Dunn and Dobzhansky.

My work on consanguinity continued

uninterruptedly till I completed my House Surgeoncy in July 1961. A few months earlier, in a letter to the A.P. Public Service Commission who were to consider my claim to a post as an

have discussed the work with him. I have no doubt that he understands clearly enough what he is doing, and can be trusted to develop it, to some extent at least, in new directions. I am also sure



Haldane in Rome to receive the Feltrinelli Prize; from left to right are JBS, Dr. (Mrs.) Helen Spurway-Haldane and Professor Marcello Siniscalco. (Courtesy: Prof. M. Siniscalco)

Assistant Surgeon in Andhra Pradesh Medical Services, Haldane wrote.: "Dr. P. Meera Khan, has been working on human genetics in his spare time for about a year, so far in conjunction with Mr. Krishna Rao Dronamraju. The discoveries which they have made in their first year are, in my opinion, the most important yet made in India in this field. He has *stayed in my house* and I

that he will be willing to discuss his work with me, and to consider suggestions which I may make for further work. I wish to add that neither in India nor in Britain would the vast majority of young medical men be capable of doing what he has done. They have neither the needed intelligence and intellectual integrity, nor the energy and ambition to do hard



Haldane On Disease Resistance

IN two different papers published in 1949 Haldane suggested that it is an advantage for a species to be biologically diverse, and even to be mutable as regards genes concerned in disease resistance. He suggested explicitly that genetic (serological and biochemical) diversity among species may play a part in disease resistance. Haldane believed that few of these ideas can be followed profitably except on the basis of much field work. Such studies were well on the way in several populations, including one in

Sardinia by Professor Marcello Siniscalco who was investigating the genetic basis for malaria resistance. Haldane realised that India can offer an excellent field where such work can profitably be performed, and believed that a collaboration with Siniscalco would be invaluable. Haldane admired Siniscalco's scientific abilities and organizational capabilities. He hoped that an eventual long range collaboration with him would make a substantial contribution to the establishment of human genetics in India.

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wrote, "Please don't think that this paper means either that I think your and his (Dronamraju's) way of marshalling the data is wrong, or that your conclusions are incorrect. What many Indians do not realise is that in Europe scientific papers are criticized fairly sharply. This is needed to keep up the standard. So don't think I don't admire your work. On the contrary, I propose to boast about it at Monaco in May."

Inspired by the ideas and convinced by the arguments of Haldane, I joined the Andhra Pradesh Government Medical Services to work in a rural area where I would continue my earlier studies on the clinical effects of consanguinity and initiate a number of medically relevant genetical studies.

Within a few weeks of my joining the rural area there came a letter (in September 1961) from Haldane: "When in Rome and Naples I saw Dr. Siniscalco, who is working on the genetically determined abnormalities which are alleged to give protection from malaria (see box), namely abnormal haemoglobins, thalassemia in heterozygotes, and glucose-6-phosphate dehydrogenase deficiency of the red (blood) corpuscles. This latter condition leads to haemolysis from drugs such as primaquine, and from some species of beans, such as *Vicia faba*. Siniscalco has been working in Sardinia, and finds that the frequencies of thalassaemia and enzyme deficiency are both high in the formerly malarial areas of that island. He wants to work in an area of India where malaria (and particularly *P. falciparum* malaria) is not yet eradicated. He would therefore like to work with you if you go to a malarious area. He (Siniscalco) therefore suggests that you should come to Italy when you can, and learn the techniques, first in the laboratory at Naples, then in the field in Sardinia. This would imply your getting three or four months' leave. I propose to pay for your journeys to and from Italy,

work in their spare time.

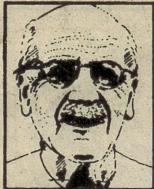
"It is my considered opinion that if Dr. Meera Khan has opportunities of continuing this work, he will be known all over the world (though of course in a restricted circle of specialists) within a few years."

Haldane's letters on such occasions were designed to serve simultaneously several purposes. Invariably copies of such letters were sent to the colleagues concerned. The letters often contained a few important hints about the work, which for some reason or other, could not be communicated more directly. They also included Haldane's impressions on the progress of the work, suggestions over a new line of research, means of providing funds for the work, a set of conditions that might be required to improve or implement a given project, etc. The 1000-worded letter to the Commission, only a part of which is quoted above, did contain all of them.

Every visit to Haldane was a new chapter in my growing book of learning. The study facilities provided by that unconventional but extraordinary teacher included the continuous flow of his ideas, unrestricted access to his sufficiently large personal library of

books and periodicals, his numerous thought-provoking scientific as well as popular articles, uninterrupted stimulating direct as well as indirect correspondence, and most importantly a guaranteed protection from the ravages of bureaucracy of the day. Moreover, Haldane's written comments, suggestions and letters had been extremely effective as methods of teaching science and scientific outlook to his junior colleagues.

HE was fairly critical about the results of his colleagues and sometimes devised new statistical tests to evaluate them. The drafts of papers by colleagues were promptly returned to the concerned almost always with a number of constructive suggestions. Our data on the clinical (genetic) effects of consanguineous marriages in Andhra Pradesh inspired Haldane to comment, "These results are of the very greatest interest, and break entirely new ground. For this very reason they require a highly critical examination." He, then, together with Jayakar developed a test to work out the standard error of an estimated coefficient of inbreeding. In a note accompanying a copy of the manuscript describing the test, Haldane



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and for your expenses there, up to 120,000 lire (about Rs. 1000) per month, and more if needed. I shall, I hope, be able to afford this easily, as I have been awarded a Feltrinelli prize of more than a lakh."

Of course, I took that challenging turn with bouncing enthusiasm. Haldane made, categorically, a few other suggestions to me, "I think the most useful thing you can do is to look for suitably malarious areas in Andhra Pradesh. With regard to other diseases, Indian workers have found that smallpox is more dangerous to blood groups A and AB than to O and B. There is also evidence that anti-syphilitic treatment is more effective on members of group O than the other groups. I do not know if untreated syphilis is less common or less severe in group O. But I know little of human genetics." His modesty was apparent. In this case I was sure that he was mildly directing me to Siniscalco.

"Siniscalco will be able to help you. As however you will come across plenty of untreated cases of smallpox and syphilis you may be able to confirm or refute these statements. I hope to get new institute next month, but I am aware that such things take a long time."

I started preliminaries to go to Italy. I applied for a leave of absence for 4 months starting from 1st January, 1962. In spite of repeated urges there was no response from the bureaucrats at Hyderabad. In those days the Andhra Pradesh bureaucratic machinery was known to be too complex, too slow and rarely efficient. For me it was an extremely difficult and painful exercise to go through. More so, because I was standing in the middle of a long rope held high by two "extremes" in every sense. Bureaucrats at Hyderabad could pass over forever. Haldane could see

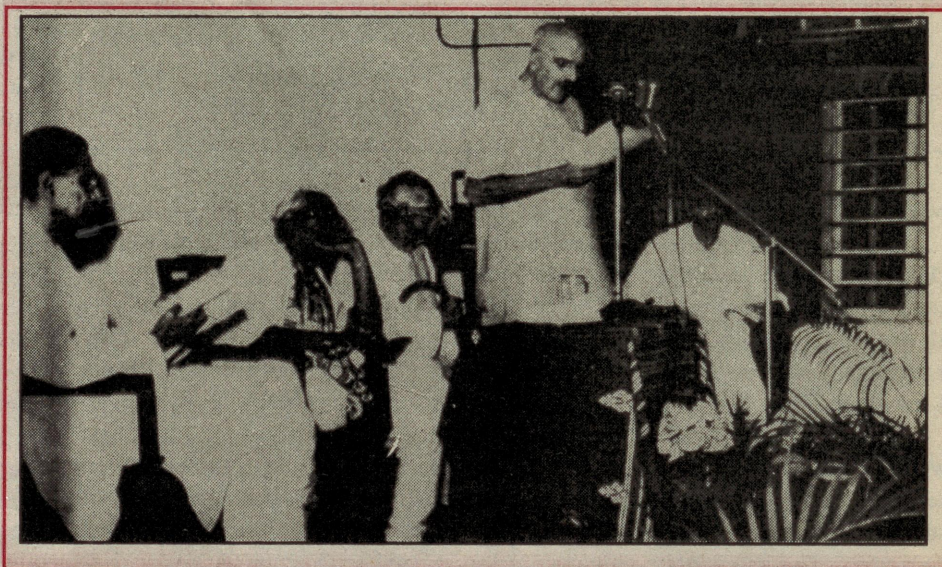
the dangers and quickly came up with salvaging alternatives and wrote me, "I have telegraphed to Thacker and am writing. But if you cannot get leave I want to ask the following questions:

1. If you resigned your post, could you go to Italy as arranged, or do you have to give notice of resignation?

2. If you do so, would you subsequently be able to arrange an expedition with Siniscalco in a malarious district?

3. If the answers to 1 and 2 are in the affirmative, I am prepared to give you...

Sardinian campaign included among other things, the mapping of the human X-chromosome using the then available X-linked markers G6PD, different forms of colour blindness, hemophilias A and B, and the Xg^a blood group, the last marker in collaboration with Drs. Race and Sanger (London). On hearing about that part of our work, Haldane remarked: "It is funny to think that (Julia) Bell and I were in at the start of this human X chromosome work, though in fact I am much more of an ancient monument than that. I heard my first lecture on



Haldane at the Indian Statistical Institute, Calcutta

Given this, will you consider resignation?

"I have a great deal more money than when I saw you last, and no more needs. So do not hesitate to say 'Yes' to 3 if the answers to 1 and 2 are "Yes". This matter is, of course, urgent."

Fortunately or unfortunately, I did not have to answer the above questions. The fetters were unfettered. The leave of my absence was granted. I landed in Rome on January 2, 1962, as a guest to Professor Giuseppe Montalenti, the founder President of the International Biological Programme. I worked in Naples and Sardinia with Professor Marcello Siniscalco. Siniscalco's

genetics at Oxford in 1900, and did not understand much of it."

As I was preparing to return after 6 months of work in Italy, Haldane wrote: "... I hope you will continue to take the Feltrinelli money, particularly as I should like you to go to London, if even for a few days, to see K.R. Dronamraju (and others) before you get back." The Feltrinelli money carried me to London. The others he meant in his letter were Professor Harry Harris then at King's College and Professor L.S. Penrose at Galton Laboratory of University College. Both the visits had left lasting impressions on me.

Thus, my first visit to London though



extremely brief, had greatly influenced my further scientific career. I am grateful to Dronamraju for taking great care in planning and organizing those visits in London to the full satisfaction of Haldane's wish.

I went back to join the Andhra Pradesh Services, this time as a Government Medical Officer at Polavaram which is located on the west bank of the river Godavari, very close to the forest areas where epidemics of *Plasmodium falciparum* were reported, a few months hence.

Siniscalco helped me to take along essential equipment and chemicals to set up a modest facility to perform preliminary investigations on tribals and non-tribals living in and around the malarial belt of the region. This work was meant to serve as a prelude to an ensuing large scale expedition.

Haldane played a major role in realising the total expedition. I was in charge of the expedition at the Indian end and we had Prof. Siniscalco to plan and direct the project. The World Health Organization had paid a substantial part of the expenses. There were Italian, Dutch and American supports as supplements.

Haldane contributed substantially to its implementation. Of course, he initiated the whole program by sending me to work with Siniscalco in Sardinia to learn laboratory techniques and to gain experience in organizing a large scale field research campaign on human population genetics.

During the expedition (December 1963 — March 1964) my services from the A.P. Government were lent to the expedition through the World Health Organization. Prabha Khan, my wife, on a voluntary basis helped us with the administrative work as well as the local arrangements throughout the Polavaram campaign. Part of our residential quarters in Polavaram was converted into a temporary laboratory and was used to accommodate some of the visiting participants. Haldane's financial

Nurturing Scientists

HALDANE advocated the importance of encouraging the young scientists engaged in active research to participate in appropriate conferences. He stressed this point in a reply to the letter of the Registrar General of India in connection with the 11th International Congress of Genetics to be held in The Hague in September 1963. In a note accompanying a copy of that letter, Haldane insisted that "There is of course no need to go if you don't want to. But if a joint paper is read, you should go." I did go. It was a thrilling experience. The Congress was overwhelming. It was one of the best congresses I have ever attended. Haldane's plenary lecture was a special feature and it dealt with "The implications of genetics for human society". He projected his thoughts far into the future and concluded with a plea for research in human genetics throughout the world and a mention of the research program of his human genetics group in India (see the first page of this article). Even today I can read it with refreshing joy.

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support during the active expedition, though modest, was hard earned as he himself stated in the letters accompanying the cheques. "I enclose a cheque for Rs. 5000 as requested in Siniscalco's letter of October 2nd. I gave a talk for the British Broadcasting Corporation on September 15th, and they promised to send you a cheque for 40 pounds, which is a little over Rs. 500. If they have not done so, please take any money which you need from the contingencies covered by the Rs. 5000.

I am just off to U.S.A. where I hope to earn another \$ 1000 or more to pay for the remaining

expenses." Then followed another from Tallahassee, Florida: "I enclose a cheque for \$ 975 (about Rs. 5000). I hope to earn most of the rest which you ask for before I leave here. It is an unpleasant way of earning money, but quick. I don't think I have learned much which is relevant to your work, but some. However Siniscalco will know it."

In the same letter he spoke about a hint of cancer in his large bowel, "I am protesting against American food with dysentery, passing a lot of blood but with no pain. They won't be treating me for amoebiasis, as they found no cysts. Indeed the local doctor hints that I have cancer."

THEN followed a more disturbing note. "While I know that I am fortunate that my carcinoma was located in the rectum, which can be removed with lymphatics, rather than in most other sites, and am also aware that so long as cancer is part of the normal human condition, I had better have it if I live long enough. Nevertheless I venture to hope that you and your wife will escape it and live long enough to get a proper chemotherapeutic or serotherapeutic treatment when you do."

Haldane was disappointed that he could not join us during the Andhra Pradesh expedition. He was never tired of adding a note to remind us of the principles and practice of moral courage, scientific honesty, intellectual integrity, underlining the importance of "discovering new truths and spreading the old ones": "I may not be able to get to Polavaram. So I should be very glad to learn what is happening, and particularly whether your result that some G(6)PD (deficient) bloods reduce the dye after a few hours, and other not till after 24, is being confirmed. If not it would be well to withdraw your paper on the subject, which, I understand from Jayakar, is now in press." My results



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were confirmed and I did not have to retract my paper.

One of the last signed documents from his was to tell, "You should perhaps know that under my will, you and several other colleagues are to receive sums which amount to several years' salary. So don't hesitate to spend anything on your personal and family needs. If it amounts to more than Rs. 1,000 or so I might deduct it from the legacy."

BECAUSE of his being so intimate but formal, elaborate and at the same time subtle, it is difficult to self-ascertain, whether I was a student, a disciple, an associate, a colleague, a collaborator, a protege or a beneficiary of Haldane.

"Unfortunately, I am told that I am dying of cancer. I might not live beyond January 1965, or might hope for a year. ...I should like you here among other things because you might be able to suggest measures to alleviate certain discomforts", wrote Haldane while inviting me to Bhubaneswar. Among other things, was his wish to make arrangements for the disposal of his corpse in a useful manner. Because I was his only medically qualified colleague in India he would like me to take full charge of fulfilling this desire, and to attend the dissection of his body. This did not astonish me. I knew that he wrote in a popular article published in 1927: "When I am dead I propose to be dissected; in fact, a distinguished anatomist has already been promised my head should he survive me. I hope that I have been of some use to my fellow creatures while alive, and see no reason why I should not continue to be so when dead." Haldane narrated some of the medical and surgical histories of his body with dates. His skeleton sustained a number of injuries while subjecting his own body to physiological experiments on several occasions; they were the indelible marks of his career as "the guinea pig". An exhibit of his

skeleton would be both instructive and inspiring to generations of medical students. With this idea, I proposed that the skeleton may be permanently exhibited in the museum of a medical institute.

At the time of surgery in London, it was believed that there was no spread of his bowel cancer to the other organs. But one year later his clinical condition indicated an extensive spread of the malignancy to various internal organs. In India colorectal cancer was not a frequently recorded cause of death. The preserved specimens of various organs and their histological preparations will be of regular use for teaching and research purposes. Because of that reason my second suggestion was to preserve and exhibit them as well. I further indicated that I should identify a team of specialists at an appropriate medical institution which would be prepared to meticulously fulfil his wish. Haldane's condition was fast deteriorating.

The above responsibility of mine was unexpected and there was little time to explore alternatives or to a multiphase approach to carry it out properly. A prior personal knowledge of the incumbent institution, and its facilities and personnel who would be prepared to properly execute Haldane's wish to the last detail, would be a minimum requirement to make an urgent initiation of negotiations.

I could immediately think of Professor R. R. Paladugu, the then head of the Department of Pathology at Rangaraya Medical College at Kakinada, a suitable medical institution nearest to the region of my research campaign in Andhra Pradesh. Haldane favoured my proposals and relegated the relevant responsibilities to me. Mrs. Haldane honoured his decision. The response from the Kakinada Medical College was thoroughly respectable. The Principal held an urgent meeting on November 10, 1964 with the Professor of Pathology, the Professor of E.N.T.

Diseases and me. We discussed the details of arrangements to be made at the receiving institution as well as the preparation, packing and conveyance of the corpse from Bhubaneswar. There was a full agreement on the suggested arrangements. Haldane wrote in his will that his body had been used for both the medical research and teaching purposes during his lifetime, and after his death, whether he continued to exist or not, he should have no further use for it, and desired that it should be used by others. Its refrigeration, if that was possible, should be a first charge on his estate.

ON 1 December 1964 my wife and I returned to Polavaram late at night from our camp in an interior forest village in the tribal tracks. In the early hours of the next morning there was a telephone call from a far away press correspondent to tell me that Haldane's body was on the way to Kakinada and to ask whether I had any statement to make. Haldane's colleagues restrained from making public statements around that time. I simply rushed to Kakinada where I met our friend Sri Pulugurtha, Haldane's personal secretary, who accompanied the body and then I proceeded to attend the dissection.

"True to the wishes of late Professor Haldane, it was thought fit to confine the entire procedure in scientific pursuit without any ceremonial and such other procedures", wrote the Kakinada Medical College Principal in his report. I received a copy of a lengthy autopsy report which carefully documented the condition of individual organs and their histology. The Principal's report added, "The internal organs and the skeleton obtained from the body of Professor Haldane are being preserved in the museum of the Rangaraya Medical College with full scientific data for the benefit of scientific world." As Ronald Clark, his biographer, put it, "In death, Haldane was true to his life."

Dr. Khan is Professor of Somatic Cell Genetics, State University of Leiden, Leiden, The Netherlands

Haldane had a great impact on science in India. His contributions in the field of population genetics are unmatched as P.V. SUKHATME narrates.

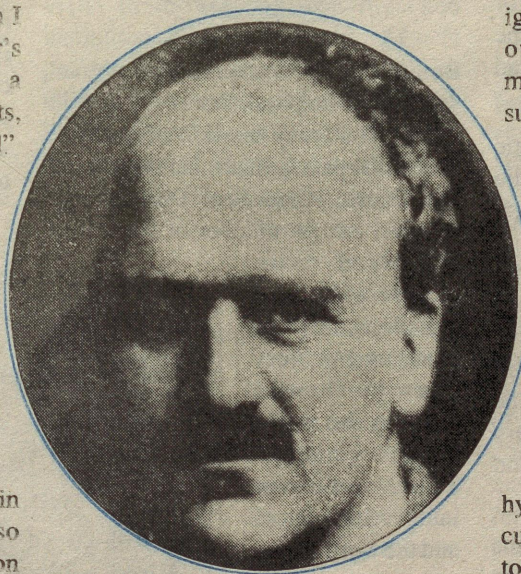


HALDANE AND GENETICS IN INDIA

PROFESSOR Haldane was indeed an extraordinary person, a born scientist. In his own words, "I suppose my scientific career began at the age of about two, when I used to play on the floor of my father's laboratory and watch him playing a complicated game called experiments, the rules of which I did not understand". As a student at school he was "a mere smatterer" and chose diverse subjects but perhaps in obverse combinations. At school he deserted the study of classics and preferred chemistry, physics, biology and history, but later obtained a first class honours in humanities including philosophy and classics. Then he went to Oxford where he took his first class honours in mathematical moderations but also attended simultaneously for relaxation the final honours classes in zoology. His first scientific paper was one with his father read to the Physiological Society barely when he was seventeen. His first contribution to genetics was the discovery of linkage in vertebrates, when he was nineteen. Thus began the scholastic and research career of Haldane who eventually grew into a biologist, biochemist, geneticist and a sage of

science; and, a rebel, a socialist, a Marxist and a philosopher.

Today, the relevance of his personality and his research to our



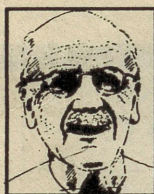
country is perhaps more important

Firstly he is a shining example, like our own Srinivasa Ramanujan, of the irrelevance of scholastic degrees for intellectual and research attainments. He was appointed a Professor of physiology at Oxford without any formal degree in Science. He also believed in

an education that recognises differences in children. He once taunted the American school system where "every child receives the same training - an obvious error reflecting a genetical ignorance of the educators". I feel our own education system should be moderated to give scope for variety in subject and talent. Perhaps the Open University system may offer more scope for such flexibilities; the risks there may be much less.

Secondly, he was a daring experimenter and many a time subjected himself to experimentation. For example he shut himself in a chamber with high levels of carbon dioxide, he swallowed bicarbonate of soda and hydrochloric acid to find a possible cure for convulsions; he allowed himself to be put into diabetic coma; he got operated upon without an anesthetic to allow others to make observations, etc.

Thirdly, his research ideas have a great bearing to his direct and meticulous observations of nature. To cite just one example, the study his students carried out on nest building activity of the solitary wasp *Sceliphron madraspatnam* started almost casually when a wasp



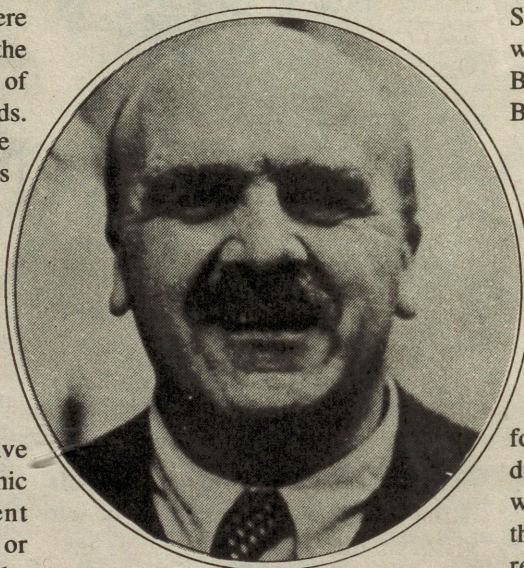
was observed visiting his dining room. Mrs. Haldane and Dronamraju were entrusted with the task of observing its activity. Dronamraju provides a graphic account of the study. They recorded a total of 955 visits of which 772 were concerned with carrying mud from the pond outside and the duration of each of them ranged from 9 to 246 seconds. Eighty visits were spent building the horizontal tubular walls and 277 visits were concerned with daubing the entire nest thus burying it in a solid block of mud. Spiders were brought on 63 visits and flies on three visits. Meticulous detail indeed !

Haldane also advocated inexpensive research in India in view of the economic constraints and also non-violent research, that is without killing or maiming animals, in keeping with the principles of non-violence of the Indian culture.

Also he believed in a pluralistic genetic society and therefore India seemed to have suited his style most. He wrote "I do not believe in uniformity. Can any one think of producing only one species of dog and call it the perfect dog eliminating all others?... If we have any lesson from animal and plant genetics, it is that there is not any one best type in the species. On the contrary we have various environments and various species to fit them."

One must have an idea of the origins of genetic research in India, in order to be able to evaluate the impact of a person of his stature. Leaving aside what one might find in the ancient Hindu literature, the early genetic researches in India perhaps started at a few agricultural and veterinary colleges like those at Pusa, Izatnagar, Karnal, Madras, Coimbatore etc. Apart from conventional breeding studies and

crossing experiments in crop plants or farm animals, one heard of a few experiments on the fruit fly *Drosophila*. Around 1940-45, Khanolkar and Sanghvi started studies on human blood groups and their population variation in



Bombay. A few workers trained abroad, specially in England, came back to India in the '50s. I may mention a few names such as Gopala Iyengar, Janaki Ammal, Pal, Panse, Nirad Sen, Dharmarajan, Sanghvi etc. A number of them were concerned with genetic effects of radiations, or plant genetics but very few in human genetics and population genetics. Thus the men involved, the places and the work turned out were essentially sporadic. It is just about this time that J.B.S. Haldane came to India, to be precise in 1957. By that time, his interests were stronger in theoretical genetics than in experimental genetics. As his sister Lady Naomi Mitchison wrote: "He was no longer

experimenting. He has come to the point where he was bound to try and see science as a whole". Apart from his friendship with Mahalanobis and the socialist atmosphere obtaining in Bengal, this apparently could be the reason why he chose the Indian Statistical Institute as the place of his work in India. That he moved to Bhubaneswar later is a different matter. But if only he had chosen better known places for experimental genetics like the Haffkine Institute, Bhabha Atomic Research Centre or Indian Agricultural Research Institute, the history of genetics in India could perhaps have been different.

I am not competent to sum up his specific contributions to genetics in India. It is however notable that he found that India offered great scope for direct research on plant and animal as well as human populations. He thought that the denseness of tropical flora could result in a symbiotic relationship involving both competition and cooperation between species and more commonly between genotypes of the same species. This aspect still remains to be examined closely.

In the study of human populations, he regarded India as the place where the earliest attempts to apply genetical ideas to human societies are found in ancient Indian writings in the form of the support or otherwise for the caste system. Certain innate characters in different ages and societies, he believed, make it possible for a man to rise into ruling class or into classes with other capabilities. He felt India offered many advantages for human genetic studies not withstanding the

**Haldane's
scientific career
began at the age of
about two, when he
used to play on the
floor of his father's
laboratory.**



disadvantages like lack of laboratory facilities, birth registers etc. Firstly, a number of Mendelian traits, like the short fourth toe they found, could be waiting to be discovered. There is a high prevalence of diseases/defects like malaria, filaria, hemoglobinopathies and other common diseases, whose genetics and associated selection intensity could be studied all over the country under coordinated projects. He considered it a social function of geneticists to popularise human genetics: "It does not matter if many people knew nothing about hybrid maize or progeny test for milk yield. It matters a great deal if they know nothing about human genetics, because it is a topic of interest to all human beings and the gaps in their knowledge will be filled by superstition or intellectually dishonest propaganda".

With this background of Haldane and his research, we may perhaps take a cursory look on the possible impact this may have had on genetic research in India.

Both at Calcutta and Bhubaneswar, Haldane established a strong research tradition in genetics among his students/associates such as S.K. Roy, K.R. Dronamraju, Helen Haldane, S.D. Jayakar, A.K. Ray, etc. Haldane died in 1964 and excepting Helen Haldane and S.K. Roy, all others chose to work abroad sooner or later. His group and Dr. Sanghvi's group in Bombay began studies on the distribution of Mendelian traits in the local populations. Haldane and Dronamraju also initiated studies on consanguinity in Andhra Pradesh to be

followed by others. Haldane and Jaykar carried out important studies in theoretical gen-etics.

Meanwhile in the early '60s more geneticists like M.S. Swaminathan, M.R. Rajashekhar Shetty, S.P. Roychoudhury, O.S. Reddi returned to India after training abroad. Each of them had perhaps some indirect influence of Haldane through Aurbach or Dobzhansky. Each began to establish laboratories devoted to genetic research.

A vigorous atmosphere for genetic research seems to have been created during Haldane's time with his frequent visits to different Universities and institutions within the country. At such an opportune time, Dr. O.S. Reddi took the initiative to start the first University Department of Genetics in the country, the credit for which goes entirely to him. At about the same time, the Mendel

Memorial Symposium was held in Delhi, probably the first seminar devoted wholly to genetics in India. Subsequent growth of genetics in the country is rapid and substantial. More institutions, agricultural universities and conventional universities started departments of genetics or human

genetics. Significant work began to be turned out in plant genetics, *Drosophila* genetics, human genetics and population genetics.

We may also remark in passing that

the Regional Research Laboratory inherited all of Haldane's collection of books and papers and today it has grown to a

centre of excellence in Cellular and Molecular Biology. Dr. Sharat Chandra of the Indian Institute of Science, Bangalore interacted with Jayakar and Mrs. Haldane and today inherited the Journal of Genetics. The set up Haldane left at the Indian Statistical Institute seems to have grown into

multiple divisions of human genetics, anthropology, ecology, palaeontology, plant sciences etc.

Thanks to these developments, today India has developed capabilities in genetic research in frontier areas such as plant tissue culture, recombinant DNA technology and genetic engineering, hybridoma technology. DNA finger printing and human gene mapping. Our geneticists are brimming with confidence even to participate if necessary in the world's most expensive research project namely, the human gene mapping. Haldane unmistakably urged us to be prepared for the future applications of genetic engineering to man — to clone and breed individuals for specialized tasks and abilities such as dark adaptation, radiation resistance, long distance stellar travel, among others.

This article is reprinted from proceedings of the Seminar on Genetic Studies in India : Impact of Haldane, Osmania University, Hyderabad.

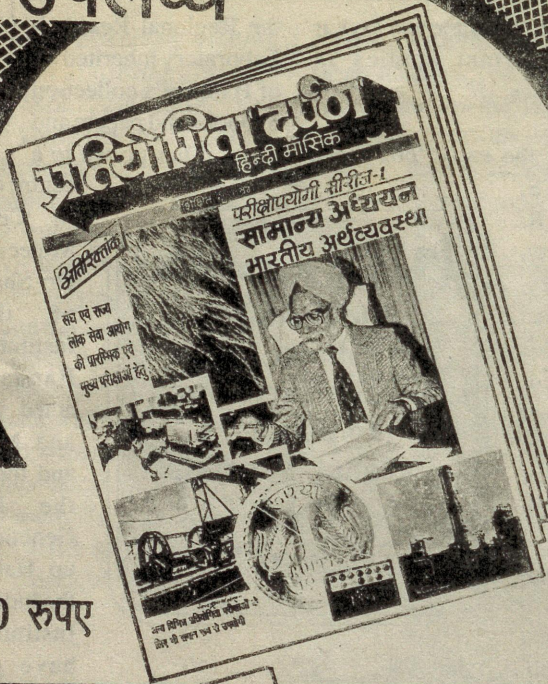
Dr Sukhatme is with the M.A.C.S Research Institute, Pune 411 004

**He was a biologist,
biochemist,
geneticist and a
sage of science;
and a rebel, a
socialist, a marxist
and a
philosopher.**

**Haldane was a
daring experimenter
and many a time
subjected himself to
experimentation.**

अब उपलब्ध

परीक्षोपयोगी सीरीज-1



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30.00 रुपए

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अतिरिक्त

प्रतियोगिता दर्पण
हिन्दी मासिक

सिविल सर्विसेज (प्रारम्भिक एवं मुख्य), भारतीय अर्थ सेवा, उ. प्र., म. प्र., बिहार, व राजस्थान की सिविल सर्विसेज (प्रारम्भिक एवं मुख्य), बैंक प्रोबेशनरी अधिकारी, जीवन बीमा निगम व सामान्य बीमा निगम के अधिकारी एवं अन्य सभी प्रतियोगी परीक्षाओं के सामान्य अध्ययन तथा अर्थशास्त्र (भारतीय अर्थव्यवस्था) के प्रश्न-पत्रों के लिए स्वयं में पूर्ण पत्रिका

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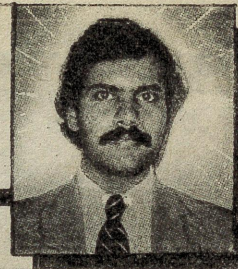
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Author's Bio-Data

- B E, BITS Pilani. M Tech, IIT Kharagpur. NTS scholar. Rank 5 in High School Raj Board.
- World-famous author. Published 3 books in USA including best selling book "Tricks of MS-DOS Masters", 721 pages, \$27.95.
- Increased my reading speed from 72 words to as fast as 1037 words per minute.
- First engineering job paid only Rs 1000 per MONTH. Finally, earned \$50 (Rs 1500) per HOUR in USA as computer expert and writer.
- At the peak of success, I left USA & returned to India to share my mind power study techniques.
- Expert in computers, mind power, and study techniques. Was a member of the Society for Accelerated Learning & Teaching, USA.
- Learnt French, Sanskrit, Karate, Breaking wooden board, many Meditations etc.

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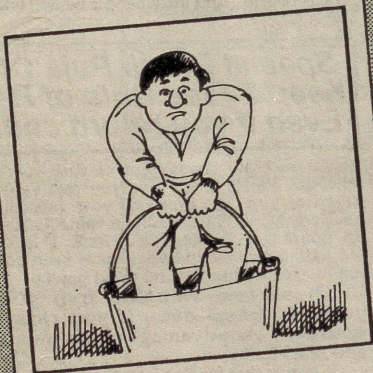
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Why can't we lift a bucket standing in it ?

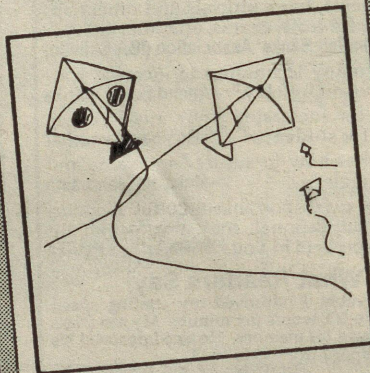
Jitendra Prasad Negi
Kalahandi (Orissa)

First take the case when one is simply lifting a bucket. When one lifts a bucket, an equal and opposite reaction is produced : one pushes against the ground while lifting it. The reaction is neutralised by the ground as the bucket is being lifted up. However, when one tries to lift the bucket while standing inside it, the bucket receives the push. As the lifting force and the push



are equal in magnitude but directed against each other, they neutralise each other and the bucket cannot be lifted.

Dilip M. Salwi



Why is the thread attached to a kite curved at the top end ?

Ranit Mazumdar
Belgharia (W.B.)

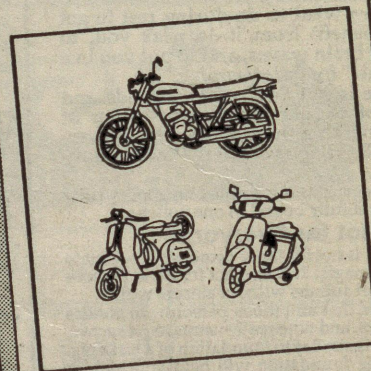
A kite obtains lift to rise up in air when it deflects winds in the downward direction. When it is windy, the thread is held taut by the kite because it is being forced to rise up further in air. But when it is not windy and the kite is standing still in air, the weight of the thread comes into effect. It sags following a curved path.

Dilip M. Salwi

Why is the wheel of a motorcycle spoked while that of a scooter is not ?

Kamaldeep Kaur
Kota (Rajasthan)

There is nothing sacrosanct about one wheel being spoked and another not. Motor cycle wheels have a large diameter and if one has to make these solid, they would become very heavy, leading to a large drag on the engine. Scooter wheels on the other hand have a smaller diameter



and hence the wheel can be solid without too much increase in weight. In addition a spoked wheel is more difficult to maintain for it tends to get deformed rather easily as compared to a solid wheel. So, where compromise for weight is possible a solid wheel is preferred. Now, with use of new materials like carbon fiber composites very light weight large diameter spoke-less wheels are being manufactured especially for racing bikes.

Pallava Bagla

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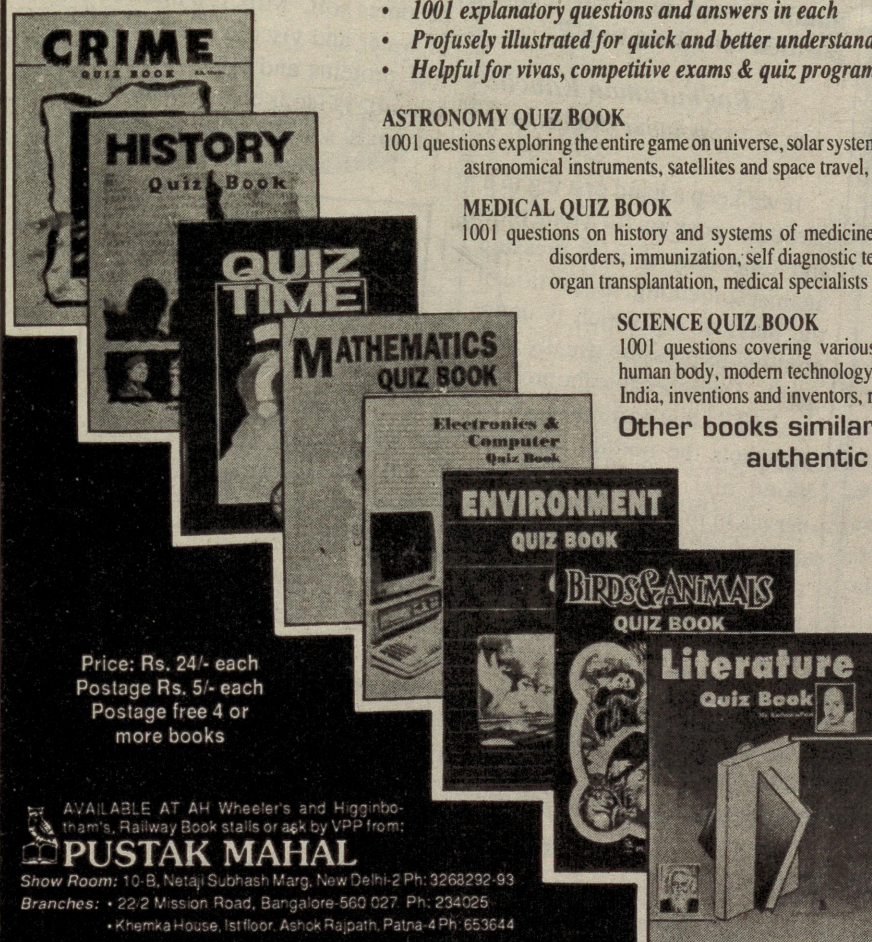
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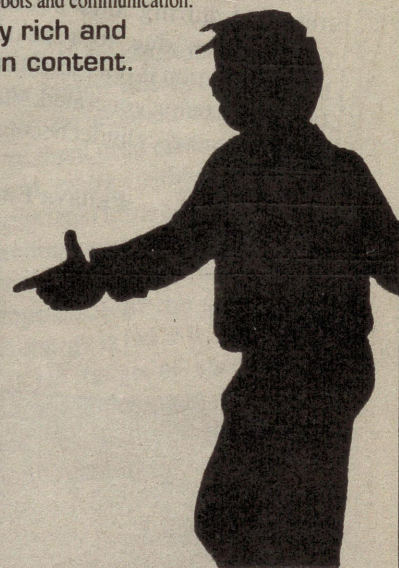
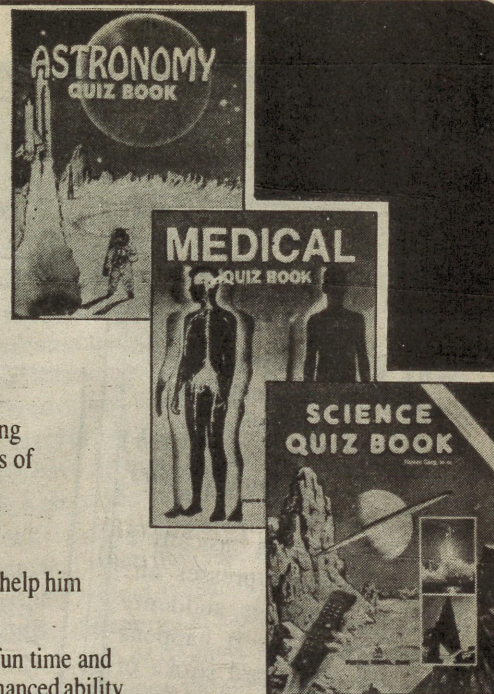
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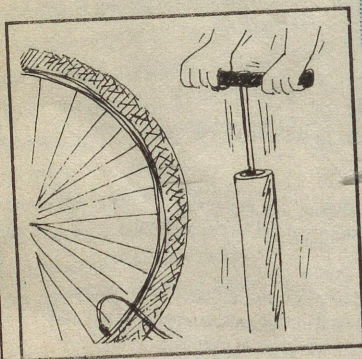
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Why does a cycle pump become hot while pumping ?

Plyush
Patna (Bihar)

A cycle pump is basically a device which compresses air. Whenever a gas is suddenly compressed — as it happens during the downward stroke of



the pump — its temperature increases. Besides, the heat liberated during this sudden compression due to repeated pumping action is not radiated as fast as it is being generated. As a result the metal cylinder becomes hot.

Pallava Bagla



Why does our hand or leg go numb if kept in a particular position for a long time ?

K. Raghuraman Kanchi
Sholapur (Rajasthan)

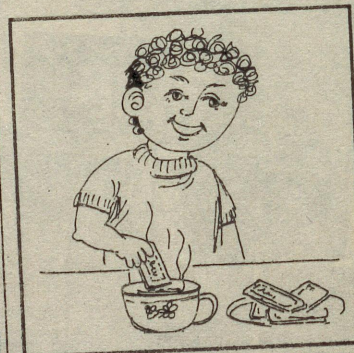
If we keep a hand or a leg in a particular position for a long time and especially if it is pressing against something, the portion of the hand or leg which is under continuous pressure usually goes numb. This is because the pressure exerted on that particular portion interrupts the normal supply of blood and functioning of the nerves in that part of the body as a result of which that part loses the sense of touch and feels senseless. This process is however only temporary. Once the pressure is released or we change the position of hand or leg, normal blood supply is slowly restored and that part starts functioning in a normal way after some time.

Madhu Sahni

Why is it that a biscuit absorbs hot milk readily, but not cold milk ?

Jatin Otajjar
Baroda (Gujarat)

Biscuit particles are held together by weak Van der Waal's bonds, so they crumble easily and are thus soft normally. Biscuits also absorb water easily because of the breaking up of weak Van der Waal's bonds between the particles of biscuit and thus becomes soft. Milk is a mixture of water and viscous substances like proteins and fats. When a biscuit is soaked in milk, it becomes soft because water in



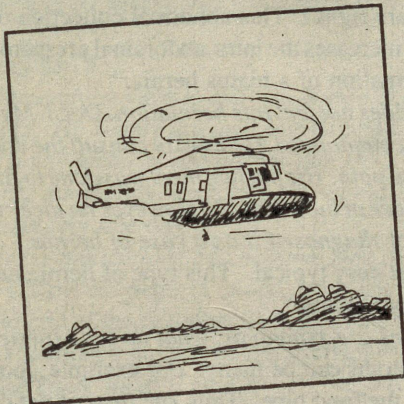
milk disrupts the weak Van der Waal's bonds that hold the biscuit particles together. Hot milk softens a biscuit faster because its viscosity is reduced and it can seep into the biscuit more easily.

Madhu Sahni

How can a helicopter remain stationary in mid-air while an aeroplane cannot ?

*Nipun Gupta
Delhi*

Both helicopter and aeroplane rise up in air because of the lift they obtain due to the shape of their rotor blades or wings respectively. The blades or wings are so shaped that their lower surface is flat or less curved than the upper one. So, air flows at a faster speed over the upper surface of a blade or wing than under the lower surface. Consequently, air pressure becomes less than the normal over the upper surface of the blade or wing (Bernoulli's principle). The normal air pressure prevailing below the lower surface



therefore pushes the blade or wing up. An aeroplane moving on a runway therefore rises into air. A helicopter, on the other hand, obtains lift when its rotor blades start rotating. When the lift is able to overcome the weight of the helicopter, it rises up in air. At a particular speed of the rotor the upward thrust is just balanced by the downward thrust produced by the weight of helicopter. At this point the helicopter becomes stationary in mid-air. Thereafter the helicopter would go up and down when its pilot increases or decreases the speed of rotation of the blades. In the case of an aeroplane which has stationary wings, lift is obtained only when it is in motion. It therefore cannot stay still in air without losing height.

Dilip M. Salwi

Why does a metal turn red when heated ?

*Ranjeet Mahapatra
Sunguda (Orissa)*

To know why a metal turns red when heated, consider the internal structure of an atom. An atom has a central nucleus around which electrons circle in different, fixed orbits. The orbits signify different energy levels of electrons. The electrons closer to the nucleus have less energy than those further away. When electrons gain energy they become excited and shift to the appropriate higher energy orbits and when they lose energy they drop down to their ground states, the lower energy orbits, emitting the energy in the form of radiations. The wavelength or frequency of the emitted radiations depends upon the shift in the energy level of the electrons from one orbit to the lower one.



When a metal is heated, its electrons gain energy and shift to the higher energy orbits. However, they cannot remain in the excited state for long and the next moment drop down to the ground state, the lower energy orbits. The radiations they emit range from infrared to visible light and beyond depending upon their energies. Initially, infrared rays are emitted which are not seen. When the temperature of the metal is further raised or more energy is fed to it, it emits radiations in the visible range of spectrum beginning with red. As the temperature is raised still further, the heated metal emits other visible colours of the spectrum, namely, yellow, blue, etc.

Dilip M. Salwi

Hurting Hernia

SURESH NADKARNI

"Ramesh ! What brings you here ?"

"I came to ask you something, if you have time...."

"Go ahead."

"What is hiatal hernia, Doc ?"

"Where did you hear that word Ramesh ? Who has it?"

"My dad, Doc ! I am extremely worried. I don't know what it means !"

"I will tell you ! You know that our food pipe is in the chest. It enters through a muscular partition called diaphragm in the abdomen. The food pipe ends and digestive tract continues as stomach. The diaphragm works as a partition to keep the contents of the abdomen in the abdomen and contents of the chest in the chest. However, there is a lapse on the part of nature. A snugly fitting hole in the diaphragm gets widened and the stomach, the usual resident in the abdomen, enters the chest. This is called Hiatal herniation, abnormal displacement or protrusion of a normal structure through an opening, that is, herniation through a hiatus which means hole."

"How does one get this hiatus herniation Doc ?"

"Such weakness in the diaphragm is present at birth."

"But after birth also, can one develop such hernia ?"

"Yes, of course ! If the job is a sitting job, or sedentary as usually called, one develops general laxity of muscle tone. Consequently as the tone of diaphragm also gets relaxed, hiatal herniation takes place. What is the age of your father?"

"Fifty, Doc ! Why that ? What has age got to do"

"As the age advances, the laxity of the diaphragm also increases. Hence hiatal hernias are more frequent between the age of forty and seventy. Is he very obese ?"

"Yeah ! He weighs ninety kilos !"

"My God ! That's too bad ! Obesity also can be a cause of hiatal herniation. Pregnancy or a large tumour can increase the pressure in the abdomen and this increased pressure can also precipitate hiatal herniation. Do you know what is ascites ?"

"Ascites means fluid in the abdomen. The abdomen gets bloated, mainly on account of diseases of liver. Alcoholics, I think...."

"You are right ! This abnormal collection of fluid in the abdomen increases the intra-abdominal pressure, culminating in the formation of a hiatus hernia."

"One does not feel this herniation, Doc ! My father didn't have any complaints ! He went to consult the doctor for some abdominal pain. His barium meal was done to find out if there was an ulcer in the stomach. However no ulcer was detected. The doctor diagnosed it as a case of hernia."

"This is very typical. This type of hernia can be entirely without symptoms."

"If there are symptoms, what do we experience Doc ?"

"Symptoms can be many. For example, food in stomach can enter the food pipe. Thus, the flow of the digestive tract is reversed. There is a mild pain in the upper part of the abdomen called epigastrium. This pain comes soon after meals on lying down or on stooping forward."

"How to we get relief ?"

"Very easy ! It is usually relieved by sitting up. Even if one stands erect the pain is relieved. Sometimes this pain travels, goes to the back or the left shoulder and arm."

"Oh ! That's O.K. Nothing serious. Isn't it ?"

"Don't draw conclusions Ramesh. Sometimes the internal lining of the herniated stomach gets lost in the pushing through the hole in the diaphragm resulting in a wound called ulcer. On account of this ulceration, there is oozing of blood. This results in vomiting of blood, called haematemesis in medical language."

"Usually the stomach produces hydrochloric acid for the purposes of digestion, we were taught. Does it also enter the food-pipe."

"Of course. I forgot to tell you. Because this acid enters the food pipe, one experiences heart-burn in the chest."

"Real heart burn. A physical one ! This is different from the heart-burn which I get if my friend wears a newly designed pant !"

"Right ! This acid entering the food pipe causes swelling of the internal lining of the food pipe. This is called oesophagitis."

"A few antacid tablets could relieve this pain, isn't it Doc?"

"Of course, this would relieve pain. But it's not so simple. Sometimes oesophagitis can constrict the passage of the food pipe. This is called a stricture of the oesophagus."

"That's quite serious. How would then food enter the stomach Doc ?"

"Surgical treatment helps such patients."

"Oh ! This is the risk of hiatal hernia. I must tell my Dad."

"Why ? Doesn't he bother ?"

"No Doc. He has been asked to take antacid tablets regularly. But he doesn't take them. He takes them only when he gets the burning sensation, that too when it is of a serious nature !"

"That is very bad !"

"Doctors have advised him to raise the head end of the bed by 20 cm blocks. He simply discards this as a fad. He says that all these funny fashions are not for him !"

"He is doing something wrong ! He would be a sure candidate for surgery one day."

"What other complications can he have Doc ?"

"There is a slow seepage of blood from the ulcerated inflamed lower end of the oesophagus or from the congested mucosa of the herniated portion of the stomach."

"How do we know about it Doc ?"

"He may complain of tiredness. He would feel weak. He may look pale."

"Any tests ?"

"Yes ! The stool examination by a pathologist may reveal the presence of blood in a changed form — called occult blood in medical terms. Oesophagoscopy, a direct viewing of oesophagus with the help of an instrument, resembling a telescope, called gastroscope, can uncover the hidden pathology."

"Hiatal hernia means stomach encroaching in the chest. Isn't it ? When this happens doesn't the patient experience discomfort ?"

"You are right. A large rolling hernia may produce breathlessness. Because of the increased pressure in the chest, the pulse runs faster, the condition being called 'tachycardia'. One might experience the beats of his own heart, called palpitations, more so on lying down. The discomfort can be relieved by sitting. These symptoms resemble sometimes a heart attack."

"How then do we distinguish between them Doc ?"

"Very easy. Electrocardiogram and barium X-ray would

make the picture crystal-clear."

"How do we diagnose this ailment Doc ?"

"The complaint by the patient that upper abdominal discomfort occurs on lying down or stooping forward and gets relieved by sitting up or standing is very much indicative of hiatal hernia. Barium meal, X-ray examination, and gastroscopy can also confirm the diagnosis."

"A stricture resulting on account of hiatal hernia, would not allow the food to enter the stomach, as you said. That means it may be thrown out or the patient may feel that it is 'stuck' in the chest. Isn't it Doc ?"

"Yes, of course."

"My granny had cancer of the oesophagus. She also complained like-wise."

"That's a very good observation Ramesh. We always think of this possibility and exclude it with the help of barium swallow and oesophagoscopy."

"O.K. ! Now you tell me in short, what other precautions should be observed by my dad ?"

"He should not sleep for at least two hours after food. He must have been advised tablets like domeperidone or metoclopramide."

"Yes ! But he hates to take these tablets daily. He feels...."

"It is not important what he feels. He should abide by the doctor's instructions."

"He has been advised some tablet called Ranitidine."

"Cimetidine or Ranitidine are a must for such an ailment."

"When would you advise an operation ?"

"Only if he gets a stricture...."

"Luckily he doesn't have symptoms of stricture, which you have told me. Hence we have to see that he follows all these instructions !"

"That's a better decision."

"Thank you Doc ! I would follow those instructions and avoid the surgery atleast. Any other instructions ?"

"He should eat small quantities of food at a time. Walk or stand for about half an hour after each meal. Sleep propped up on pillows. Eating a diet of greasy, fried, highly seasoned food should be avoided. He should take milk and reduce his weight if he is over-weight !"

"Yes, that's a major problem ! I will have to be after him to reduce his weight. And Doc, when do we think of surgery?"

"When there is severe and repeated bleeding from stomach or food pipe, there is obstruction to the passage of food, pain becomes unbearable, a portion of the stomach gets 'choked' in the hernia, then surgery is indicated."

"I get the point. Thank you Doc. I will be on the lookout for these symptoms !"

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SKY CORNER

DECEMBER

Latitudes 0° to 40° N



MAGNITUDES

- MINUS ONE
- ZERO
- FIRST
- SECOND
- THIRD
- FOURTH

♀ Venus
♄ Saturn

December

The Planets

THE diagram shows the evening sky as seen from latitudes 0 to 40 degrees North. The inner circle represents the horizon as seen from latitude 22.5 degrees North. The chart has been extended on the northern and southern sides for use all over India.

Beginners wanting to use the chart should hold it overhead and turn it in such a way that the North, South, East and West marked on the chart point to the correct directions. With some experience it would be possible to use it in a more convenient position. With the help of a few known star groups in the sky the remaining stars will be seen at about 2130 hrs, 2030 hrs and 1930 hrs of local mean time on 1st, 16th, and 30th of the month.

The star chart meant for a particular day for a given hour can be used for the next day 4 minutes earlier and for the previous day 4 minutes later. For example, if a chart is meant for 8.30 p.m. for 16th it can be used on 17th at 8.26 p.m. and on 15th at 8.34 p.m. In the same way it can be used for other months; for 16th November it will hold good at 10.30 p.m. and for 16th January at 6.30 p.m. and so on.

The stars move from east to west in the sky in their daily motion (due to rotation of the Earth) at a rate of 15 degrees per hour. The chart can also be used at other hours in the evenings after taking into account the above shift in position of the stars.

Planetary Positions for December 1992

Date	1st		10th		20th	
	R.A.	Decln.	R.A.	Decln.	R.A.	Decln.
Mercury	15h 22m	15.8S	15h 43m	17.4S	16h 34m	20.9S
Venus	19h 32m	24.1S	20h 17m	22.1S	21h 05m	18.9S
Mars	8h 01m	23.1N	7h 58m	23.7N	7h 49m	24.6N
Jupiter	12h 38m	2.8S	12h 42m	3.2S	12h 47m	3.7S
Saturn	21h 05m	17.7S	21h 08m	17.5S	21h 12m	17.3S

(Adopted from figures supplied by Positional Astronomy Centre)

The Moon

THE full moon occurs on 10th at 05.11 a.m. and the new moon occurs on 24th at 06.13 a.m. I.S.T. The moon passes about six and a half degrees south of Mars in the morning of 13th, six and a half degrees south of Jupiter on 18th, about one and a half degrees south of Mercury on 22nd, five and a half degrees north of Saturn on 27th and about seven degrees north of Venus on 28th.

The moon is at apogee or farthest from the Earth on 2nd and again on 29th and is at perigee or nearest to it on 14th.

The lunar crescent becomes first visible after the new moon day in the evening of 25th.

A total lunar eclipse occurs on 10th. It is visible in India. The moon enters umbra at 03.29 a.m. and leaves it at 6.59 a.m. I.S.T.

The Earth is in winter solstice on 21st.

Mercury (Budha), visible in the morning sky rises about one hour before sunrise during the month. It becomes direct on 1st and is in greatest western elongation of about 21 degrees from the Sun on 9th. It passes about 6 degrees north of the star Antares (*Jyestha*) on the 19th. It moves from Libra (*Tula*) to Sagittarius (*Dhanus*) through Scorpius (*Vrischika*). Its visual magnitude varies from 0.0 to -0.5.

Venus (Sukra), visible in the evening sky sets about three hours after sunset during the month. It moves from Sagittarius (*Dhanus*) to Aquarius (*Kumbha*) through Capricornus (*Makara*). Its visual magnitude is about -4.2.

Mars (Mangala), visible in the morning sky rises about three hours after sunset during the first half of the month and about one and a half hours after it during the second half. It passes about 3 degrees south of the star Pollux (*Punarvashu*) on the 23rd. It moves from Cancer (*Karkata*) to Gemini (*Mithuna*) through retrograde motion. Its visual magnitude varies from -0.7 to -1.3.

Jupiter (Brihaspati), visible in the morning sky rises about one and a half hours after local midnight during the first half of the month and about half an hour after it during the second half. It is in Virgo (*Kanya*). Its visual magnitude is about -1.9.

Saturn (Sani), visible in the evening sky sets about four hours after sunset during the first half of the month and about three hours after it during the second half. It is in Capricornus (*Makara*). Its visual magnitude is about +0.7.

(Source : Positional Astronomy Centre, India Meteorological Department, New Alipore, Calcutta : 700 053)



with storms at sea supports the conclusion that the constellation system was designed primarily as a navigational aid for seamen.

Thus if the system of the ancient constellations as given by Aratus was a deliberate attempt to provide a navigational aid for sailors, an orientation of the system with respect to the equator, and therefore the north celestial pole, would be preferable. And that is what we find, though the pole is the north celestial pole of 2300 BC.

THIS remark leads us to some further considerations. The navigator people and the constellation-makers could have been the same people or two different peoples. The navigator people could have lived at a later era than the constellation-makers, even if they were of the same race. Thus the constellation-makers may, over many centuries, have observed the heavens,

THE CONSTELLATION MAKERS

In this second and concluding part of his investigation
ARCHIE E. ROY finally unravels the identity of the
constellation makers.

WHY was Eudoxus' Globe out of date by more than one and a half millenia? Didn't the constellation-makers notice in that time that precession was ruining the veracity of astronomical statements on it? Why didn't they update it? Why did they map out the sky in the first place?

There are at least three possible answers to the last question. They are that the motives were calendrical, religious or navigational.

When we examine Aratus' poem we find that there are only a few allusions

to agricultural pursuits in contrast to his fellow Greek Hesiod's famous poem in 1914, *Work and Days*, which concentrates on linking astronomical phenomena to the agricultural calendar. It could, in fact be looked upon as a poetic manual for seamen.

Written in the third century BC, some passages in Aratus' poem show a sophisticated degree of astronomical knowledge in its easy acceptance of the Earth poised in space, the heavens revolving about it, with two poles, one of which is not visible. The important point is that the poem's preoccupation

projecting on the random patterns of the stars the figures of their people's legendary heroes and heroines, monsters and more familiar animals as a useful method of memorising the heavenly panorama. The stars of the zodiac would probably have been the earliest sections to be arranged in this way for they were constantly being traversed by Sun, Moon and planets, which were under the jurisdiction of the gods. Finally the whole sphere of the heavens, apart from the zone of avoidance about the south celestial pole, was organised, deliberately and at a specific era.

The navigators adopted this system for their own purposes, taking it over holus-bolus, adding all the associated weather lore to provide their people with a body of useful navigational instructions that would enable them to voyage safely out of sight of land. This body of astronomical and meteorological knowledge would be taught to their navigators. But to continue our detective story, who were these people — the suspects ?

WE have four suspects. They are the Phoenicians, the Egyptians, the Babylonians and the Minoans.

In some ways the Phoenicians are obvious candidates for the role of the navigator people who used the constellation system described in Aratus. Their cities, among them Arwad, Tyre, Sidon, Beirut and Byblos, occupied the area we now know as Lebanon.

The Phoenicians were Semite in origin. Their most prosperous period lay in the years between 1500 BC and 500 BC. Great traders and wanderers, their culture was borrowed from many sources, including Babylonian, Egyptian, Minoan and Mycenaean. Phoenician culture produced beautiful and sophisticated work in glass, bronze, ivory and many other materials. From the shell-fish *Murex trunculus* they obtained scarlet and purple dyes; in the holds of their far-ranging ships they transported a wide variety of cargoes — raw materials, ores, strange animals, wines, precious stones, in fact anything that could turn a profit.

According to Aratus, the Sidonians (that is the Phoenicians) navigated by the constellation of the Little Bear, or Cynosura. They therefore to that extent and almost certainly to a great extent used the sky at night for navigational purposes.

And yet, as the creators of the constellation-system described in the *Phaenomena* of Aratus, they are non-starters. The mythology in Aratus does not fit them. And anyway, although

their latitude fits, they lived too recently to meet the requirement of date. In police parlance, they had motive and opportunity but history is their temporal alibi !

IN the case of the Egyptians the time factor is no problem. The Egyptian civilisation is one of the oldest on record. The sophisticated splendours of the Old Kingdom were already being created when the constellation-makers did their work.

As early as 2800 BC, Egypt was producing brilliant achievements in art, astronomy, civil engineering, mathematics, medicine and other skills. Early on, the priest-astronomers discovered a harmonic and satisfying significant relationship between earthly and celestial cycles. They had divided the year into three distant sections, the inundation, the sowing and growing, and the harvesting. They noticed that when Sirius rose just before the Sun, then the life-giving Nile began to rise at Memphis.

The Egyptians did map out the sky to the extent of using the stars to tell time at night. This was done as early as the 24th century BC.

Perhaps the best known of the monuments displaying constellation figures is that found in the temple of Denderah. It is an astronomical ceiling on which rather more care has been taken to depict the constellation figures correctly. The circular zodiac is usually dated to around 36 BC while the straight sections, on the ceiling of the outer hypostyle hall, date to the reign of Tiberius Caesar (14 AD - 37 AD). It is therefore not surprising that the twelve zodiacal constellations are essentially those of Aratus and Ptolemy. The other constellations, however, are markedly different. The Great Bear is a crocodile; there is a hippotamus in the centre of the planisphere and an ape under the scorpion.

It was in Egypt, also that Eudoxus sought the astronomical wisdom of the ancients and obtained his star-globe.

the Egyptians were also great traders throughout most of their long history. Even so, one cannot but feel that since so much of the Egyptian way of life has survived, much clearer indications would have been found if they had originated the detailed body of stellar knowledge embodied in the poem of Aratus. And in addition, Egypt lies entirely south of latitude 32°N, too far south for the locality of the constellation-makers or the navigator peoples.

LIKE the Egyptian civilisation, the Babylonians lived in a naturally-irrigated region. Throughout the last two millennia BC the culture and influence of the great kingdom of Babylon was dominant. The Babylonian form of the Akkadian language became and remained the *lingua franca* of the Near East and beyond.

Part of the reason was that the priesthood promulgated very effectively the doctrine that their god Marduk should be the chief god of Mesopotamia and that it was heaven's will that Babylon should be the capital city. In the epic poem, *Enuma Elish* the Creation of the World is described. Marduk the chief god established Order out of Chaos, creating places in the heavens for the other gods, setting up their likenesses in the constellations. He also defined the calendar, the sequence of celestial events signifying the changing seasons. To this end he set up the Zodiac.

We owe our knowledge of these remote times to a number of widely different factors. The Sumerians invented the cuneiform script, using a metal or wooden stick or wedge to make impressions on soft clay tablets, rather like the marks made by crows' feet in mud. The tablets were then baked in the sun or in any oven. Thousands of these tablets have been found in the ruins of their cities.

Among data obtained from the sherds covered with cuneiform writing are star lists. Dating from the fifth century BC, these lists give details of constellations and their positions relative to each other.

Many of the names of these constellations are the ones we are familiar with today. For example, the Bull, the Twins, the Scorpion, the Archer, the Fish-Goat (Capricornus), the Lion and so on. But some are different. Instead of the Swan, the Lyre and Auriga, they had the Panther, the Goat and the Bowl.

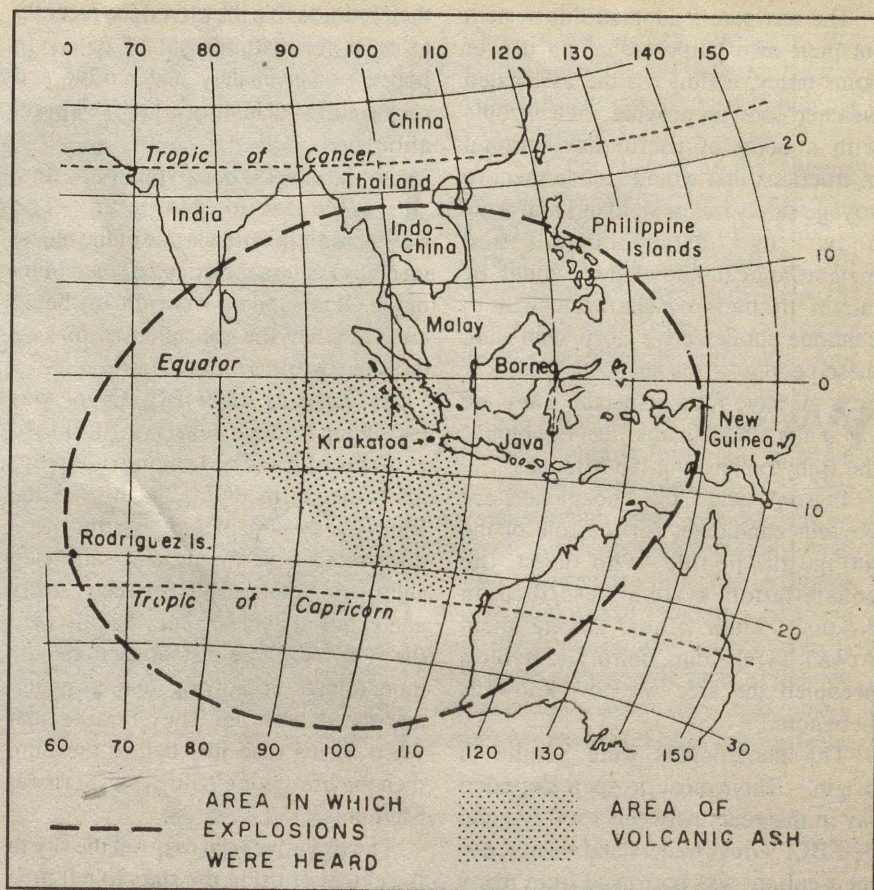
Among the many tablets in the British Museum are three which happen to be surviving fragments of the Sumero-Akkadian Euphratean Planisphere. The planisphere fragments contain familiar constellations showing that the Euphratean celestial sphere was mainly our own. The names of the months, the names of certain stars and numbers of degrees also appear.

Additional evidence that the majority of the constellations we are familiar with were known to the ancient Mesopotamian civilisation comes from boundary stones, contract tables and cylinder seals. Boundary stones with inscriptions were set up to mark the boundaries of fields, perhaps, given by the king to one of his officials for services rendered. Many of them also carry constellation figures, as well as Sun and Moon.

The conclusion is inescapable. Through-out the millennia in which the Mesopotamian civilisations flourished, the constellation figures and legends finally embodied in Aratus existed on all levels, religious and secular.

HAVE we reached the end of our search for the constellation-makers? It is clear that the Sumero-Akkadian people of the Euphrates region were using a system of constellations essentially similar to that given in Aratus as far back as 2100 BC and probably for many centuries before that date. The basic myth-systems were also similar, an indication of the widespread cultural and commercial influence of the earlier civilisations of Mesopotamia among the eastern Mediterranean region up to and through the Homeric period.

Other evidence also seems to point to



Krakatoa : the area of the ash deposit

the Sumero-Akkadian priests as the constellation-makers. Unlike the Egyptians' home land, the Sumero-Akkadian region does not flatly disagree with the required latitude. We also know that ships sailed into Agade in the 24th century BC from India and South Arabia with Bahrain (ancient Dilmun) as the clearing centre for the traffic so that a navigational system of some sort for seafarers would be required.

Nevertheless this sea traffic itself lay in latitudes far nearer the equator than the latitude derived from the *Phaenomena*. And so a certain reservation should perhaps be attached to the Sumero-Akkadian solution and we should consider who else were around during the third and second millennia BC. And perhaps we should assess their fitness, not to be the constellation-makers in the sense that the Sumero-Akkadians were, but to be the people

who took over and modified the Euphratean system for their own navigational use. There was such a people in the Mediterranean region, about 1500 km west of Babylon. They were the Minoans.

Before 1900 AD the Minoans were known only in mythology. One of the most fascinating legends concerning the kingdom of Minos in Crete is that of Theseus and the Minotaur. The Minotaur was half-man, half-bull, the monstrous offspring of the union of Minos' wife Pasiphae with a bull. Under the palace of Knossos, this dreadful creature roamed the labyrinth designed and built by the great architect, inventor and engineer Daedalus. To most scholars prior to 1900 such legends were merely a witness to those ever-present powers in men of wishful thinking, imagination and romantic hankering back to a golden age that

never really existed.

But archaeologist Sir Arthur Evans after spending a quarter of a century digging, sifting, deducing, reconstructing, and using up his personal fortune came out with some startling findings which he published in his definitive book *The Palace of Minos*. In many cases it becomes clear that Evans, on seemingly doubtful or flimsy evidence, was led to conclusions that more recent finds have merely substantiated, a faculty which is always tiresome to more pedestrian researchers.

The island of Crete was ideal for human habitation. Forests of cypress, cedar, oak and fir clothed the hillsides; the land was fertile, giving sustenance to vines, olive trees and corn, providing pasture for cattle, sheep, goats and swine. Fruit was grown. In the seas around, fish were plentiful—mullet, bass, grouper, octopi, a favourite subject of the Cretan artist, were caught. The valleys and marshes abounded in game such as pigeon, partridge and waterfowl. Bees were kept for their honey. And yet to obtain the benefits of all this bounty provided by the mother Earth, hard work was required, producing an industrious, fit, non-indolent race.

By 2000 BC, Minoan ships were regularly carrying to faraway places throughout the Mediterranean cargoes of oil and wine in huge pithoi jars, handsome pottery, packages of silver cups, gold jewellery, engraved gems and semi-precious stones, inlay and filigree work in all of which the Minoan

craftsmen excelled. In return they imported gold from Egypt, ivory from Syria, where elephants were not exterminated until the ninth century BC, copper and tin and amber from Europe which they probably collected at ports at the north of the Adriatic Sea or even voyaged as far west as Spain to obtain.

As Evans' work and that of other archaeologists progressed, it became clear that Minoan civilisation flourished universally in Crete until 1700 BC when some terrible natural disaster, probably

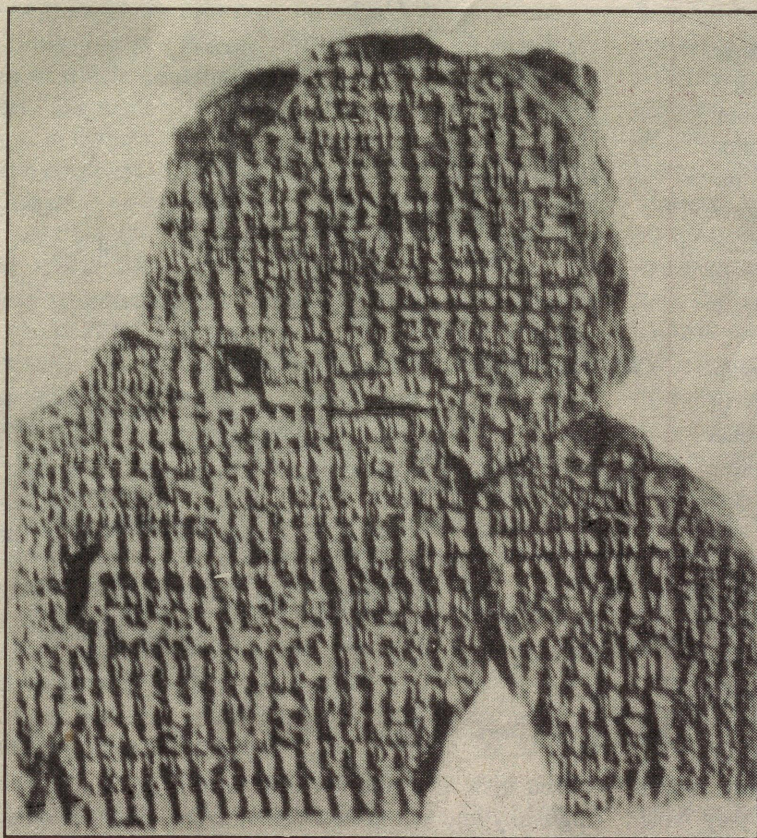
together to produce a beautifully harmonious, cultured and happy way of life.

And then, at the summit of the Minoan achievements, another almost universal disaster occurred. Whatever the nature of this disaster, it must have come upon the Minoans so suddenly and so completely that they were unable to recover. It happened sometime about 1450 BC. Archaeological evidence paints a though-provoking picture of palaces and settlements, hundreds of them, destroyed by fire and possibly by severe earth tremors and great floods.

Apart from Knossos which may not have been utterly devastated and so was worth patching up, the ruins of other palaces and settlements were abandoned. But now foreign rulers, almost certainly Mycenaean, occupied the last palace, Knossos, having conquered the remnants of the once splendid and now stricken Minoans.

THERE is a strange and pleasant harmony about the ruins of the palaces of Crete. It is not only the overall architectural similarities that impress but also the inspired locations of the sites. They seem to have been chosen to allow their people to enjoy the most pleasing

prospects of the bright and richly-coloured Cretan landscape. Walk away from the immediate vicinity of the ruins, away from the visitors scattered amongst them. Find a soft and shadowed carpet of pine needles amid the trees and listen to the busy whirr of the crickets and the sound of the breeze sighing through the branches of the pines above. It is a wind



The cuneiform script invented by the Sumerians

a violent earthquake, destroyed the places. With admirable fortitude and resilience the Minoans recovered quickly from the cataclysm and rebuilt their civilisation, carrying it to even greater heights of prosperity and artistry. In the new palaces of this second palatial period whole communities of artisans, artists, architects and servants worked

that has wafted up the neighbouring valley, carrying with it the scent of flowers and herbs. Is it sheer imagination that one feels a sense of peace and contentment and happiness, a legacy of the long-gone Minoans' attitude to life?

Whether it be imagination or not, there is no doubt that they were a most remarkable people, the first highly-civilised nation of Europe, a people of artists, seafarers and traders. Is it possible that they were also the constellation-users? Did their navigators use a sky system borrowed from the Sumero-Akkadians?

It must be said that we have no direct evidence that convicts them beyond reasonable doubt. No frescoes have been found showing the night sky with the familiar constellation figure painted over the star patterns. No literature analogous to Aratus has been recovered from the ruins of the palaces.

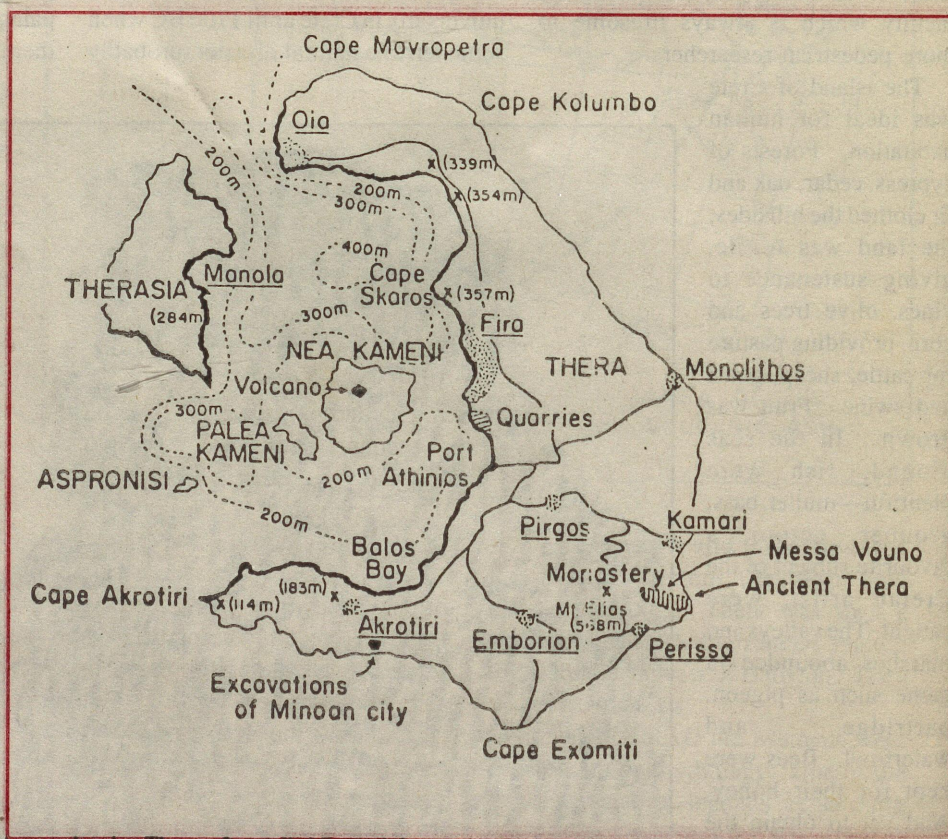
Nevertheless, the Minoans neatly fit the requirements of the navigator people. The date is right. The Minoan overseas trading empire was fast expanding between 3000 and 2000 BC. The latitude is right. Crete lies between the parallels of latitude 35° and 36° N. And the Minoans were the supreme sailors of the age. Like their successors, the Phoenicians, they would have required navigational aids in their long voyages and like the Phoenicians, they would have used the stars.

One of their strongest and most clearly established characteristics was a quickness to seize on anything useful they found overseas whether this be new forms of pottery, or metalwork, or engraving or any of the myriad commercial and artistic activities they encountered. And having learned all they could, they easily surpassed their

teachers.

The second fact is that they were in contact with the Babylonians through Syria from an early stage of their history. The Minoans must have been familiar with the old Babylonian celestial sphere and the pantheon and mythology developed by that people. As their overseas trading developed, involving longer and longer sea voyages, their quick pragmatic minds would have

sphere, producing new generations of star-globes? Didn't they notice the celestial changes? Astronomers as highly skilled as they were must surely have done so and provided their navigators with navigational aids that were not obsolete. Possibly something happened between 2300 BC and the date of Eudoxus' visit to Egypt, something that put the navigators out of business.



A map showing Thera, often called Santorini

seized upon this idea of dividing the night sky into star groups named after mythological heroes as an excellent way of teaching navigation to their sailors. If so, they would refurbish the system, perfecting it as they did all other arts they embraced, superimposing their own pantheon and mythology over the old.

NOW coming back to Eudoxus' star globe, why did the makers of that globe not update their celestial

Is it sheer coincidence that nearly all archaeologists who have studied the remains of Minoan civilisation on Crete and elsewhere have accepted that a sudden and universal disaster occurred that completely shattered the Minoan palaces, settlements and colonies or caused their abandonment? A disaster that occurred somewhere around 1450 BC? Was it the reason why Eudoxus' star-globe was so badly out of date? Was it a cultural relic from the wreck of

the Minoan ship of state that had survived in Egypt ?

It is only in recent years that the nature of the great disaster has been appreciated. About 120 km North North-East of Mount Ida in Crete lies the island of Thera, where the Minoans had a thriving community. Some time about the middle of the second millennium BC, the island suffered a paroxysmal volcanic eruption of quite exceptional ferocity. Many authorities believe that the volcanic explosion at Thera was probably the greatest catastrophe in the history of man.

Thera, often called Santorini, is the only active volcano in the Aegean. This island, like Krakatoa in Indonesia is really a group of isles, one of which is much larger than the others. The main island is referred to as Thera. In the past forty years oceanographers, vulcanologists, geologists and archaeologists have put together the history of Thera. It would appear that the Thera and Krakatoan scenarios shared the same dramatic plot to a quite astonishing degree of similarity.

The relative magnitudes of the Thera and Krakatoa disasters can be evaluated. In the latter case some 10^{24} ergs of energy were produced by the collapse of 23 square kilometres of island, 300 metres thick, through a distance of 600 metres. In the Thera case we are dealing with the collapse of 83 square kilometres of island. Now, the Krakatoa caldera was 300 metres deep after the explosion and the fallen island had an average height of 300 metres before collapse. In the Thera case the great cliff is 400 metres high. The contours of the land, to the east of the cliff, show that the missing part of the island was almost certainly higher still. The present depth of the caldera below sea level is between 200 and 400 metres so that we may reasonably assume an average depth now of 300 metres. The collapse of an area 83 square kilometres and at least 400 metres thick through a distance of the order of 700 metres is therefore

indicated. Energy amounting to 7×10^{24} ergs, or seven Krakatoas, must have been released.

When we consider the widespread and awesome damage caused by the Krakatoa explosion and collapse, it is reasonable to suppose that the late Bronze Age cataclysm at Thera had *at the very least* similar effects over a comparable area of the Mediterranean.

FOR Crete and the other islands of the Cyclades it must have been the end of the world. In varying degrees of severity they would be exposed to noise, deadly tsunamis, earth tremors, atmospheric shock waves, darkness that may have lasted up to 72 hours, pumice fall-out. The toll of ships, towns, villages seaports and lives in the eastern Mediterranean must have been colossal. If the tsunamis struck during the panic produced by the claustrophobic pall of darkness, the doomed Minoans would never really have known what hit them.

While the present author was researching and preparing the material for this account he discussed the Thera eruption and its effects with Professor Angelos Galanopoulos, a vulcanologist who has made a special study of the Thera eruption and its consequences. Professor Galanopoulos reaffirmed his belief that the staggering list of disasters did take place on the almost unbelievable scale already described.

And certainly the catastrophe was remembered. It is certain that apart from the accounts of the great disaster given to the Egyptians by Minoan refugees fleeing from the wreckage of their island, there would also have been left further relics. If the Minoan navigators did use star globes and if one of them ended up in the priestly archive along with accounts of the lost land in the Great Green Ocean, it would have carried its out-dated astronomical information down through the centuries to its rendezvous with Eudoxus when he came seeking knowledge from the priests. If we trace the description of the constellations as given in Aratus back

to the ancient Minoan people, the supreme navigators of their age then according to the arguments of Marinatos and those other researchers who look upon lost Atlantis as a memory of the wonder and the destruction of Minoan civilisation, we are also attributing that outdated body of astronomical knowledge to the people of Atlantis.

It is therefore conceivably possible that the constellations described by Aratus have part of the legacy left to us by the Minoans who themselves borrowed the system from the constellation-makers, the Summero-Akkadians. The Minoans were blown from the stage of life, the glory of their genius and culture obliterated by earthshock, fire, ash fall, flood and invasion, but their golden age was not completely forgotten. Daedalus and Icarus, Theseus and Ariadne, the Minotaur in the Labyrinth, Minos and his great sea empire, fabulous Atlantis and its dreadful end were remembered. And, not the least, the brilliant astro-navigational system carried on star-globes and finally enshrined in the *Phaenomena* of Aratus.

So short-lived are the empires of man measured against the durations of constellations that the groups of stars by which the Minoan sailors navigated are still with us — the mighty hunter Orion, the Great Bear circling the Pole, Taurus the Bull, the sinuous Serpent and all those other lamps of Atlantis described in the *Phaenomena*.

And there the case rests.

Perhaps fresh evidence, literary or archaeological, will come to light in the future, either in support of, or against it. Is it too much to hope that in one of the houses of the Minoan seaport on Thera a star-globe still lies buried in the pumice awaiting discovery by the archaeologists ?

Time will tell.

(Concluded)

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Haldane: Life Of A Prodigious Mind

(Continued from page 14)

mate for him. She too like JBS, was an 'Indophile'. In the latter half of 1950's several conditions and considerations prompted the Haldanes to migrate to India. There was the Police Dog affair. Helen Spurway with a visiting American returning home on the 5th November (1956?) had a brush with the police. She apparently had inadvertently stepped on the tail of a police dog who was sitting with its tail on the sidewalk, although the matter may not have been so simple. She may have flaunted the police. She was hauled in for drunkenness, disorderly conduct and assaulting a police officer. In the Court, she could have been released by paying a small fine but this was unthinkable for the Haldanes. There was the technicality that if she went to prison, the Provost had warned her that she would have to resign her University College post. She was put in Holloway from where she got released by one Mr. Waller.

This matter and JBS's extreme outrage over the British invasion of Suez precipitated their resignation from University College. JBS officially announced that he was emigrating to India because he considered Britain to be a 'Police State'. Elsewhere (in his article 'A passage to India'), JBS has written that the main reason for migrating to India was the kind of research opportunities he was interested in were better in India than in Britain. Moreover, he was to retire in 1960 and his support would probably have dropped to zero. When somebody mentioned to him that he was going to a superstitious country, he defended his decision by drawing attention to Christian mythology and drew comparison between Narasimha and St. Michael, both being chimaeras.

COVER STORY

Lysenko Affair: Darkness at noon over Genetics

LYSENKOISM has already entered in the lexicon of genetics defined as a pseudoscience which flourished in the Soviet Union and its satellite countries from 1932-1965. Essentially it rejected Mendel's particulate theory of heredity and T.H. Morgan's chromosomal basis of the genes. It preached instead that acquired characters can be inheritable implying that improvements effected through adaptations to environmental conditions would be inheritable from then on. Champion of these ideas was Trofim Lysenko who building upon an earlier Soviet plant breeder Michurin's observations on grafting tied this dogma to the communist politics and using State's patronage, ruthlessly purged Mendelian geneticists.

In 1943, Lysenko published a booklet under the title, *Heredity and Its Variability* in which he made some fantastic claims some of which have been cited elsewhere in this article. Lysenko had quoted also from Haldane's book *New Paths in Genetics* and sent a copy of his work to JBS. Haldane may have been cited in support because he responded by saying that his book was already somewhat obsolete and if he wrote another one he probably would

have revised his views. But then JBS went on to ask for experimental data for the claims made. In spite of the lack of answers and what already was there in the booklet, Haldane continued to give Lysenko the benefit of doubt.

In 1947, Haldane published a book entitled *Science Advances* wherein JBS had written essays on very wide-ranging topics. This book was reviewed by R. Brightman for *Nature* who was quite critical of JBS. To quote Brightman, "His first concern is not to advance science but communism." The reviewer went on to add, "But it is time that protest was made against the view that subjective exposition can advance the cause of science and Prof. Haldane's carelessness in this respect may well alienate the support of those whose help is badly needed. Nor does it help the advance of science to attach radical or political labels to it." There may have been an uneasy tolerance of Mendelian Genetics thus far but in 1948, at sessions of the Lenin Academy of Agriculture Sciences of the U.S.S.R., that lasted more than a week, genetics of Mendel, Weismann and Morgan got a full dressing down. Verbatim report of these sessions runs into more than 600 pages. Lysenko summed up, "The Michurinists say that inheritance of acquired characters is

For good measure he added that the incarnations of Vishnu at least provide an outline of vertebrate evolution: a fish, a tortoise, a boar, a man-lion (*Narasimha*), a dwarf and then four men. He further defended India and his decision by another shining example, this time from Mahabharata.

Yudhishtira who upon reaching *Svarga* (heaven) with his dog is informed by *Indra* that dogs are not admitted in

heaven. Yudhishtira refuses to enter heaven without his dog because a nobleman must not abandon any creature who has put faith in him. The dog turned out to be *Dharma*, the god of justice and both were allowed in. Haldane draws the moral that man must not do an action which he regards as dishonourable even if ordered to by the chief of the gods (*Indra*) in person. Thus, in a way with lot of sentiments



possible and necessary. Morganists,, cannot comprehend this principle so long as they have not fully discarded their Weismanist notions."

There had been a few dissidents and in fact Zhukovsky pointed out that Michurin did not speak of Mendel the way it was claimed in the sessions. Michurin had said that Mendel's rules do not apply to perennials, particularly to fruit-bearing plants. But after the sessions were over Zhukovsky desired to make a statement and he went through what would amount to a recantation! Alikhanian followed Zhukovsky and in addition said that like Zhukovsky this 'change of heart' had preceded Yuri Zhdanov's letter in Pravda that morning.

At this stage a motion was received to send a letter to J.V. Stalin. The letter after making some ingratiating remarks commended the great work of Lysenko. It ended on a note, "Glory to the great Stalin, the leader of the people and coryphaeus of progressive science!"

Finally a resolution was adopted which called *Michurin* biology as progressive and materialist and the other trend as reactionary, idealistic that of Weismann (Mendel-Morgan). The rout of Mendelian genetics was complete and a purge followed. Mendelian geneticists were to be removed from the scientific councils. The cytogenetical laboratory of N.P. Dubinin was abolished as unscientific and useless.

Julian Huxley wrote two long articles

in *Nature* delineating the 'real' issue in Soviet Genetics. According to him, "There is now a party line in genetics..... A great scientific nation has repudiated certain basic elements of scientific method, and in so doing has repudiated the universal and supranational character of science." Prof. N.I. Nuzhdin a U.S.S.R. geneticist and protege of Lysenko replied to Huxley's criticism in *Nature* and accused, "The opponents of Michurinian science reject a scientific discussion because they have nothing to offer in its place".

Sir Henry Dale (1949) President of The Royal Society in his letter of resignation from the U.S.S.R. Academy of Sciences said, "The whole great fabric of exact knowledge, still growing at the hands of those who have followed Mendel, Bateson and Morgan is to be repudiated and denounced." Haldane did not resign from the Academy but apparently broke off with the party over Lysenko affair. Prof. H.J. Muller also resigned his corresponding membership.

After Stalin's death, Vladimir Engelhardt and other biologists with the help of Andrei Sakharov fought back in 1955 and Lysenko was removed from his post. Lysenko was reinstated in 1961 as Head of the Lenin All Union Academy of Agricultural Sciences by Nikita Khrushchev. In 1961, the International Congress of Biochemistry was held in Moscow and although by now Lysenko was back in the saddle and perhaps doubted even the existence

of DNA, the Congress barring some minor difficulties seemed to have gone off well.

Before the second fall of Lysenko, he suffered one more ignominy at the hands of Andrei Sakharov. Sakharov has recounted this episode in his memoirs. In June 1964, biologists had voted to elevate Nikolai Nuzhdin to become a full member of the Academy. Nuzhdin was hand in glove with Lysenko in persecution of genuine scientists and this outraged Sakharov. When Nuzhdin's nomination came, Sakharov spoke up. "The academy's charter sets very high standards for its members with respect to both scientific merit and civic responsibility. Nuzhdin does not satisfy the criteria. He and Lysenko bear the responsibility for the shameful backwardness of Soviet biology and of genetics in particular, for the dissemination of pseudoscientific views, for the degradation of learning and for the defamation, firing, arrest, even death of many genuine scientists. I urge you to vote against Nuzhdin." Lysenko was furious, "People like Sakharov should be locked up and put on trial." Nuzhdin was not elevated to full membership. Only Sakharov's being the father of the soviet H-Bomb seems to have saved his skin. With the fall of Khrushchev, Lysenko also fell. N. Dubinin was made Director of Institute of Genetics in 1966. Lysenko died in 1976.

N.K.N.

and convictions, the Haldanes arrived in India in July 1957.

The Haldanes were invited by Professor P.C. Mahalanobis, an eminent statistician and a Fellow of the Royal Society, who headed not only the Indian Statistical Institute but also was helping with India's 5-year plans. Haldane launched several Indians in their career. Some of the prominent ones were S.K. Roy, K.R. Dronamaraju, T.A. Davis

and S.D. Jayakar. By 1961, however, Haldane appeared to be having strained relations with the Indian Statistical Institute. As usual, Haldane was peeved first at the sacking of a junior staff member for smoking in the presence of a senior one. He said, "It appears that some persons in the Indian Statistical Institute wish to model it on the court of a British Viceroy rather than on a scientific laboratory. If they succeed

they will certainly make original work there impossible and this may well be their aim." The final break came when Mr. Kosygin, Head of U.S.S.R. was to visit the Institute and Professor Mahalanobis changed the arrangements that Haldane had made. Both JBS and Helen Spurway resigned.

About a month earlier, Vice-President Radhakrishnan had offered the Haldanes to work in the proposed

National Laboratory for Biological Science likely to be ready that year. Dr. Thacker, D.G. CSIR followed this up and Haldane agreed to start a Genetics and Biometry Research Unit in Calcutta. The Haldanes had to travel to Europe for about 4 months and this time they travelled on an Indian passport.

The association with CSIR was short-lived. Haldane found this barred him from speaking in support of a Congress candidate in the elections. Added to this was the usual requirement to agree to be transferred anywhere. Then in June, CSIR employees were asked not to approach foreign agencies for funds for travelling abroad before getting prior official approval. Haldane said if he has to forfeit this, he would rather resign. Things were getting muddled and Haldane resigned. He wrote to Florey that he still liked India.

BY the end of June 1962, he had another job. This time in

Bhubaneswar, Orissa, through the good offices of Ritchie Calder who had gotten Biju Patnaik's 1960 Kalinga Prize. Although, feeling his age, Haldane seemed happy in Orissa. But in 1963 while visiting the United States, where he consulted doctors for his rectal bleeding which he thought might be due to dysentery, he was advised extensive check-ups. In England, admitted to University College Hospital, diagnosis of rectal cancer was made. Although he underwent an operation, it was the beginning of the end. In the hospital he wrote a poem "Cancer's a Funny Thing" that seemed to laugh at Cancer. On return to India, in August it was discovered that the cancer had recurred in his abdomen and liver. He died in Bhubaneswar on 1st December 1964. He had bequeathed his corpse for medical research.

How does one measure J.B.S.

Haldane? Intellectually and physically — a man larger than life. The reach of his imagination was astounding. Always in sympathy with the underdog, he was guided by his personal credo. He was fearless and could confront the most formidable. His only failing may have been his not recognizing the Lysenkoist threat to intellectualism which in U.S.S.R. was only partly warded off by Andrei Sakharov in the Soviet Academy. Towards the end, JBS travelled on an Indian passport. Can we not claim him as a great (adopted) son of India? And why not? After all even Nobel Prize winners H. Khorana and S. Chandrashekar are claimed as India-born U.S. scientists.

(This article is dedicated to the memory of Late Dr A.R.Gopal Ayengar my mentor and friend. The author would also like to acknowledge the help of Mrs. Rosemary Harvey, Archivist, John Innes Institute, United Kingdom.)

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Social Application...

(Continued from page 19)

8. *'We shall never understand human heredity. The problem is too complex for human minds. Perhaps no mind can understand its own genetical determination'*. I do not believe this statement. Because Benjamin Franklin could not use it to light a house this does not mean that his work on electricity was futile. The adequate utilization of human genetics may well require an effort greater than that so far expended on all the sciences. It will certainly require massive work on individual and social psychology. Our descendants may never undertake it. If they do not our species may exterminate itself, or evolve without conscious guidance, and stagnate or die out, as most species have done in the past.

I believe that it is entirely possible to

improve our species until most of its members possess the capacities of its best few thousand members in the past and present, while its exceptional members are beyond the scope of our imagination. It would probably be easier to destroy it by breeding for the characters most admired in existing societies. A vast improvement in social structure is needed before we can think, with any hope of success, of what innate human capacities are needed in its components. This does not mean that we should postpone serious research in human genetics until our society reaches perfection. On the contrary, research on human genetics will probably give us essential data for the improvement of society, as research in crystallography led to the prevention of infectious diseases, and research on lightning to the whole modern system of engineering.

In this small space I have been unable to deal with most aspects of human

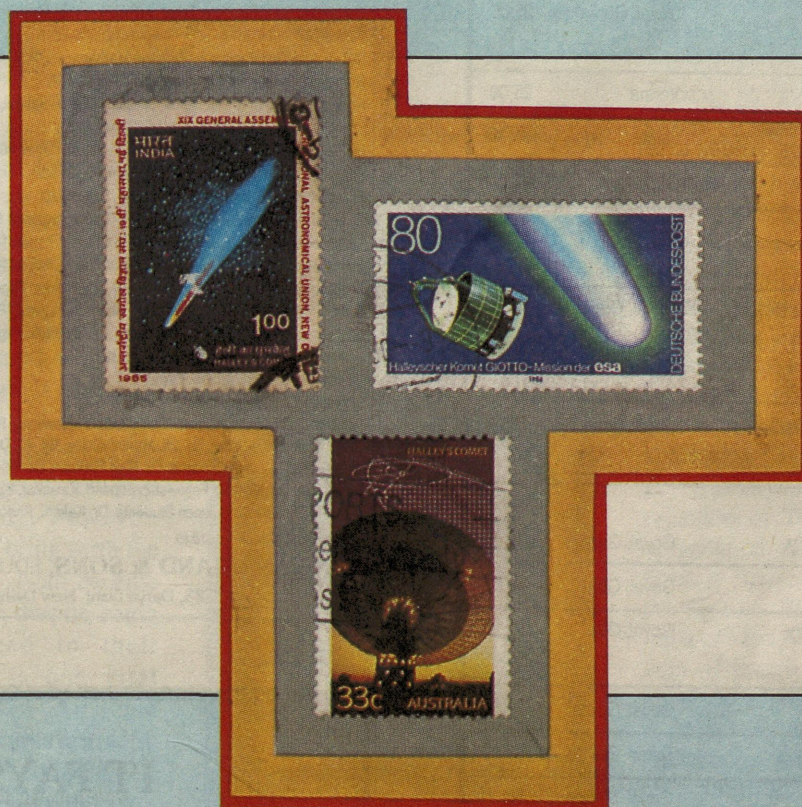
genetics, and have doubtless been both superficial and dogmatic. The plain fact is that human genetics is a very difficult branch of science, and has only been developing on scientific lines for about sixty years. So far it has only saved a few thousand lives and prevented the birth of a few thousand defectives. The evils done in its name by the National Socialist Party probably outweigh its benefits. But if one believes in evolution by any means other than divine intervention a knowledge of it is essential for the human race. Evolution is, however, a very slow process compared with history, and we need not be dissatisfied because sixty years of work by a few hundred people have not yet given us a full understanding of the processes of human evolution, much less the power to control it. □

(Reprinted from Science Reporter, November 1965)

SCIENCE ON STAMPS

KABITA ROY

HALLEY'S COMET



THE year 1986 being the Halley's Comet Year was celebrated by many countries through the issue of postage stamps. In the 17th century, Johannes Kepler and Sir Isaac Newton described and explained the motions of planets and satellites but not of comets. The comets were seen as atmospheric phenomena which occurred at random. The link between comets and the solar system was discovered by Edmond Halley, an English astronomer, who started studying the comets when he saw the comet in Paris, in 1682. During 23 years of studies and calculations, Halley found that the comets of 1456, 1531, 1607 and the one he had seen in Paris in 1682, which followed the same motion of the solar system, appeared at equal intervals of approximately 76 years. Halley predicted that the comet of 1682 would come back in 1758 but he died before the return of the comet. The comet was named after him as a tribute to a man who replaced superstition

by a brilliant scientific discovery. In 1986, too, according to Halley's prediction the comet was visible in the sky during March and April.

Edmond Halley (1656-1742) achieved distinction in many areas of science during his life and in 1720 he became Astronomer Royal at the Royal Observatory at Greenwich in England. Many countries marked the occasion with stamps. Great Britain issued four stamps depicting the comet's different forms in the sky. Ciskei, a South African country released 12 stamps, the designs of which constitute a single picture separated by perforation only. The picture shows the southern skies with the comet and several meteors in the foreground and the earth, moon, sun and main constellations in the background.

Besides Australia, Brazil, Jersey, Poland and a host of other countries, India also featured Halley's comet on a 100 paise stamp issued on the occasion of XIXth General Assembly International Astronomical Union.

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The Threat and the Glory : Reflections on Science and Scientists

by Peter Medawar, edited by David Pyke (Oxford University Press, Oxford) 1991, Pp 291, £ 6.99 (pbk)

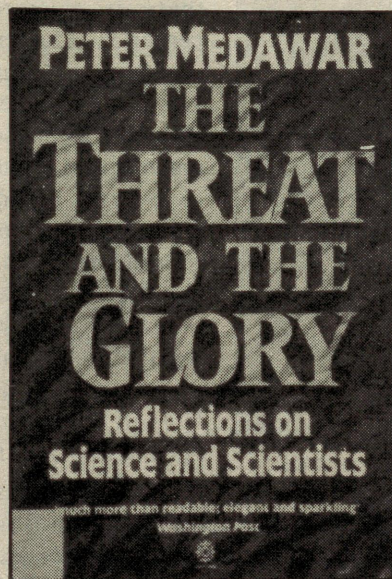
“SIR Peter Medawar was three great men. He was a great scientist, a man of great courage — and a great writer.” Thus introduces David Pyke, a friend of Medawar, this collection of essays, some of them appearing in print for the first time.

There is a similarity between Sir Peter Brian Medawar, one of twentieth century's greatest biologists, and Stephen Hawking, the mathematician, cosmologist and prestigious Lucasian professor of physics at Cambridge, England. Both were disabled in their productive years. For great men like Medawar and Hawking, however, physical handicaps only bring forth the best in human pursuits. Both became prolific writers of repute despite being crippled and confined to their wheelchairs. There is one vital difference, though. An ace experimentalist, Sir Peter was distinctly unlucky but was more fortunate in having Jean Medawar for his wife, a life scientist in her own right. Not so Hawking. The Lucasian professor is a theoretician to whom modern computers and speech synthesizers have made up for his physical infirmities. Another point of difference. The cosmologist has now become something of a cult figure in transcending the world of physics into theology and mysticism. The urbane Medawar did not mix science with religion, nor religion with science.

A pioneer in immunology, Sir Peter shared with Sir Macfarlane Burnet the 1960 Nobel Prize in physiology/medicine. How many doctors or surgeons, who now routinely transplant organs, know that Medawar's work on tissue rejection is the cornerstone for modern transplant surgery? Never mind, there will be a lasting memorial

to Medawar and his team from all those human beings who surmount the trauma of an organ transplantation and go on to live their full lives.

Be that as it may, what interests the common man who has even passing interest in science is Medawar the writer, a writer *par excellence*. Whether peers or students or laymen he addressed, Medawar had few equals among scientists. Book reviews were his soft-chosen mode of communication. Sir Peter never reviewed anything without producing a polished essay, which transcended in quality and permanence the original work he reviewed.



What is the threat and what is the glory Medawar speaks of in this posthumous collection of his essays? It is the great glory and it is also the great threat of science, Sir Peter would say, that everything which is in principle possible can be done if the intention to do it is sufficiently resolute. Be it philosophy of science (Karl Popper was his guru) or ethics of using experimental animals, Medawar had clear-cut views. Scientists may exult in glory but, cautions the sage of biology, the reaction of the common man is more to cower at the threat. *The Threat and the Glory* brings under one cover 23 essays which span a

wide range of fascinating subjects: genetics, evolution, creativity in science and philosophy. To balance such heavy-duty stuff, Pyke includes some light-hearted, yet pretty serious, essays in which the Nobel Laureate airs his views on scientific fraud, on how to survive a stroke, and the like. Pyke the editor has chosen the title from Medawar's 1977 review of June Goodfield's *Playing God : Genetic Engineering and the Manipulation of Life* (and other books) in *New York Review of Books*.

As Lewis Thomas, himself a medical scientist and renowned writer, says in his foreword, Medawar will be a steady source of Ph.D. theses in biology and immunology a fifty or a hundred years from now. "I can already imagine" the doctoral dissertations: the tolerance of mice, the tolerance of twin cows, something less than the tolerance of psychoanalysis, outright immunologic rejection of Teilhard de Chardin, the acceptance and revascularization of Francis Bacon." There will be other scholars in English literature on the track of Medawar the twentieth-century man of letters. And finally, Thomas attests to Medawar's unflinching faith in science saying that the future philosophy scholars will discover by reading Medawar's books that the century made whatever sense it turned out to make because of science.

It's a pity that Sir Peter, who won the Kalinga Prize and the Michael Faraday Medal for popularization of science (the later a few days before his death) could not visit India, owing to ill health, as is customary for Kalinga Prize winners. There is no need to despair though. Up and coming scientists and budding science communicators can read his books — *The Art of the Soluble* and *Advice to a Young Scientist* in particular. Young or old, scientist or not, you will find them as insightful as they are entertaining. If you are only interested in scholarly writing in science, then read his provocative essay 'Is the scientific paper a fraud?'. Reading and re-reading Medawar periodically will keep dullness at bay.

P. S. Shankar

BOOKSHELF

TOY JOY by Arvind Gupta and Ramesh Kothari, Pg. 28, Price not mentioned; **PUMPS FROM THE DUMP** by Suresh Vaidyaranjan and Arvind Gupta, Pg. 27, Rs. 10.00; **LEAF ZOO** by Arvind Gupta, Rs. 10.00 (Published by National Council for Science and Technology Communication, Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi-110016); **MATCHSTICK MECANNO AND OTHER SCIENCE EXPERIMENTS** by Arvind Gupta (Published by Arvind Gupta C7/167, S.D.A., New Delhi-110016), Pg. 48, Rs. 10.00; **LITTLE SCIENCE** by Arvind Gupta (Published by Eklavya, E1/

208, Arera Colony, Bhopal-462 016), Price not mentioned; **THE TOY BAG** by Arvind Gupta (Published by Eklavya, E1/208, Arera Colony, Bhopal-462016), Rs 10.00

EFFORTS at popularising science in India seem to have taken a firm foothold. There have been isolated attempts in the past at taking science to the masses by organisations working on their own in the remotest corners of the country. But now there is a more concerted effort at inculcating the scientific temper that has been so much talked about in the past. More recently the task of propagating the scientific spirit has become much more innovative. The success of the *Jan Vigyan Jathas* speaks for itself.

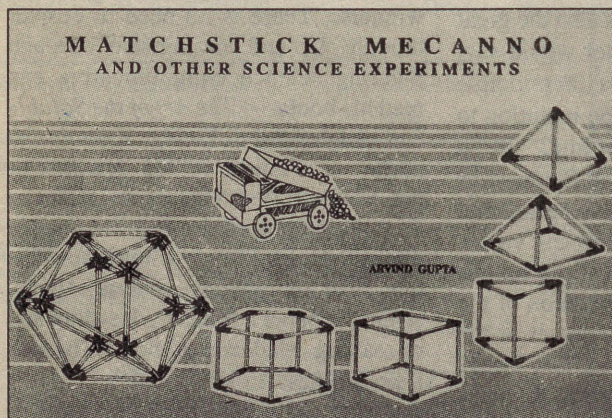
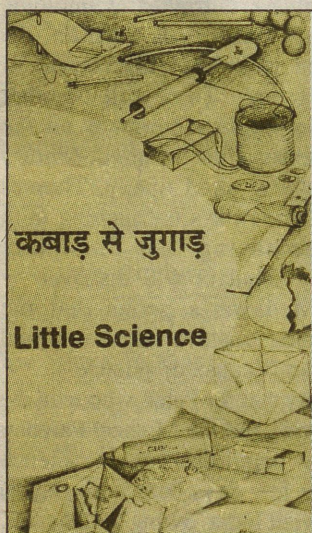


And of late, the spate of popular science books, especially meant for children, is an indication of the need for scientific awareness among the masses.

Most of us still believe that science is a difficult subject and ought to be taught at higher levels of education.

But this is far from true as the books under review make it amply clear. Almost all basic concepts of science could be easily understood by children by merely performing simple experiments or making toys with virtually zero-cost materials. Targeting science popularisation at children could be the most beneficial. For it is they who as grown ups are most likely to spread the scientific spirit of enquiry and reason. The books under review attempt to do just that.

Capitalising on the natural curiosity of children and their tendency to play with anything they come across these



books manage to carry across scientific concepts while the children are just playing. And what's more, the playthings require nothing more than pieces of waste paper, pins, rubber bands, tubes, bulbs, discarded ice cream sticks, used refills, bottles, match sticks and boxes — in effect, materials that entail virtually no expense. The sophisticated and so-called hi-tech toys of today may excite the children but leave little scope for learning. and it is here that the toys mentioned in these books score over the hi-tech ones.

Leaf Zoo is perhaps meant for very small children. It shows them how to make all sorts of animals using just leaves. This not only makes them familiar with various animals but also leaves of many different kinds. And then, in *Pumps From The Dump* you make a whole lot of pumps from materials virtually retrieved from dumps or ready for dumping, some of them even lying around the house. The model pumps actually work and have been in use for over centuries.

The other four books help you perform several science experiments and make interesting toys. Using just matchsticks one is told about various geometrical figures and the way they

are used in nature. Concepts like chromatography, motion films, mixing of colours, area, volume and weight and what makes an aeroplane fly are explained away by simple experiments. And then, you make a whole lot of toys like a mini camera, flick knife, matchbox racehorse, water wheel, battery engine, paper flute, motor and many others.

These cheaply priced books are very well illustrated. Although some experiments have been repeated this does not detract from the merits of these books. A valuable possession for all those who want their children to use their head and hands.

Hasan Jawaid Khan

THE GANYMEDE TAKEOVER

by Philip K. Dick and Ray Nelson, Arrow Books Limited (Distributed by Rupa & Co, 7/16 Makhan Lal Street, Ansari Road, Daryaganj, N. Delhi-110002) Pp. 192, £ 3.99

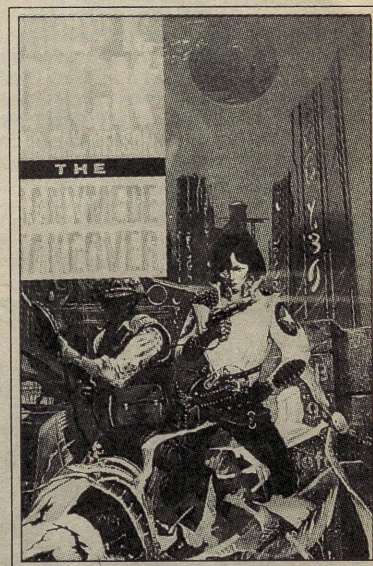
THOSE books that retain their charm over the years are considered to be classics. But most of the books that are written do not fall under this category as is the case with the book under review. Just one word is sufficient to sum up the book under review, "dated". The language, the theme and the protagonists belong undoubtedly to the sixties and this is clear without glancing at the year when the book was first written.

The attractive cover, catchy blurb notwithstanding, the story-line reflects those initial days of science fiction writing when the fear of an extraterrestrial take-over of earth was paramount. This was one of the first phases of science fiction literature which has since scaled the heights of sophistication and specialization.

In the book under review, earth has been invaded and taken over by a species of advanced worm-like life forms from Ganymede. Most humans, especially individuals in a position of power and

with the ability to lead, have been selectively exterminated by specialized weapons targeted at them. But earth is still populated by pockets of humans of two types. The first are those who have submitted to their alien captors and are in effect their lieutenants now. The second, led by Percy X, a trained telepath, are, in the time honoured tradition of tales, the freedom fighters or members of the resistance.

Added to the cast is a confused girl torn between her Ganymedian allegiance coupled with personal ambition and her admiration for Percy X. There is the



Freud-like Head of Psychedelic Research whose works fascinate a Ganymedian leader and whose devices ultimately lead to a triumph of the earthlings.

The concept of the illusion machines which can conjure up a complete army of illusions that surprisingly refuse to disappear even when the machine is switched off is the only high point and redeeming factor of the book. It is also the pivot on which hinges the human victory over the Ganymedians.

All in all, a disappointing book but this is only to be expected, considering that in the last fifteen years science fiction literature has advanced so much that a special reprint of a 1967 book cannot hope to enthrall.

Sukanya Datta

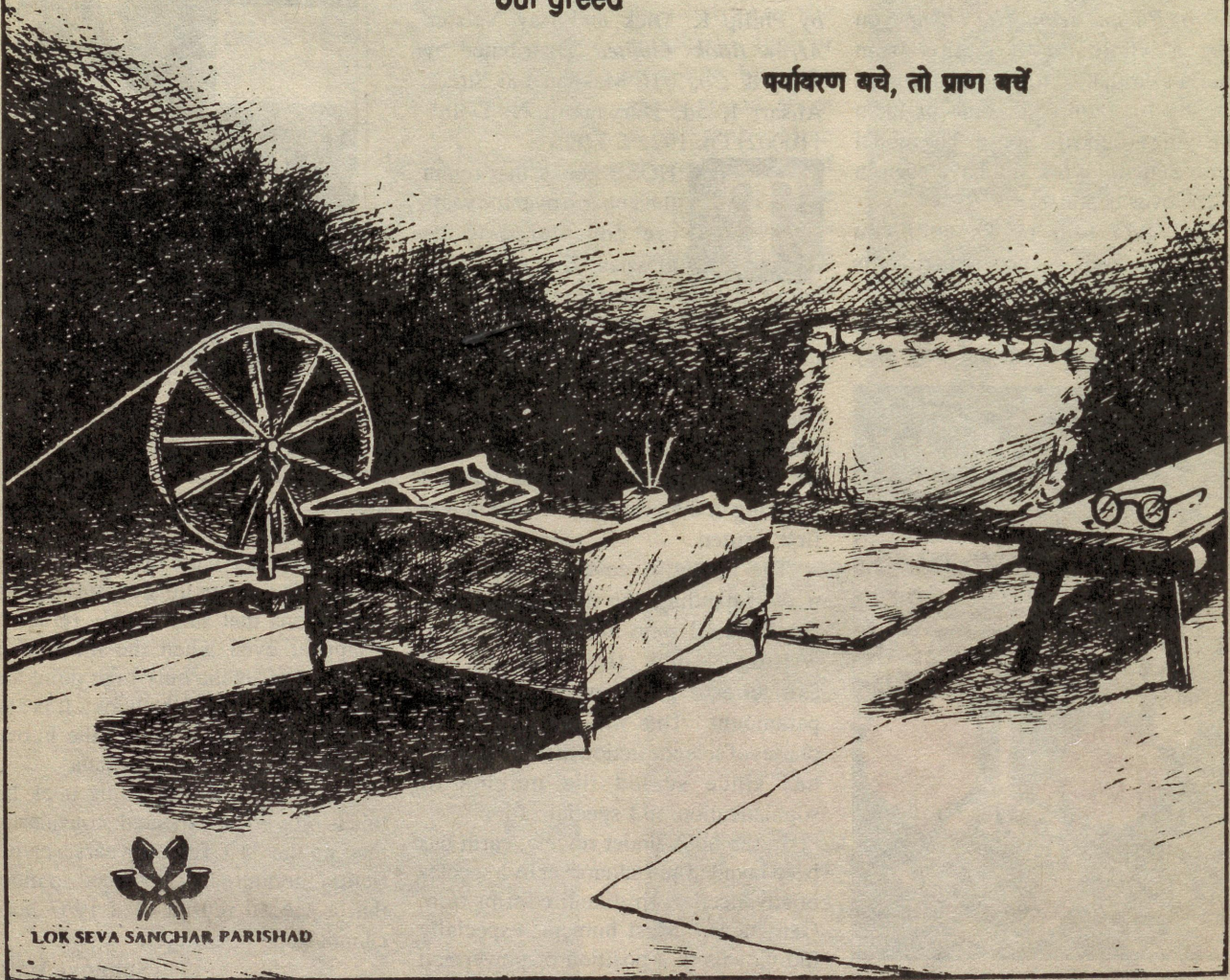


*"The earth provides enough to
satisfy every man's needs, but
not for anybody's greed."*

Gandhiji

Let us, today, remember these words of the
Mahatma and resolve to simplify our needs.
The environment should serve our need, not
our greed

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PLUGGING IN TO

WAVE POWER

SHORELINE wave devices such as this should produce electricity as cheaply as hydro-electric stations. That is the view of engineers who have built Britain's first wave power station on the Isle of Islay off the west coast of Scotland. Such stations are economical to build and, unlike offshore wave power machines, are easily accessible for maintenance in all but the worst weathers.

The project, developed at Queen's University, Belfast, Northern Ireland, uses a Wells air-driven turbine to turn energy from waves entering a narrow rock gully into electricity. Broadly, there is a concrete rear wall built from the sea bed upwards, a roof, and angled front wall which is constructed to remain several metres below the water surface under any tidal condition.

As the water enters the gully, it is pushed under the projecting front wall and upwards into a chamber. This forces the air above to be inhaled and exhaled through a turbine mounted just below the roof to the rear of the structure.

Dr Trevor Whittaker, the project manager, believes there are many sites in Scotland where such stations could be built to produce anything from a few kilowatts to several megawatts per kilowatt hour of electricity. Tests with the Islay wave machine in sea conditions ranging from calm to storms are expected to produce an average output of 36 kW per kilowatt hour which is sufficient to meet the electricity needs of a small village in the area.

London Pictures Service

SKID MARKS

ANIL AGRAWAL

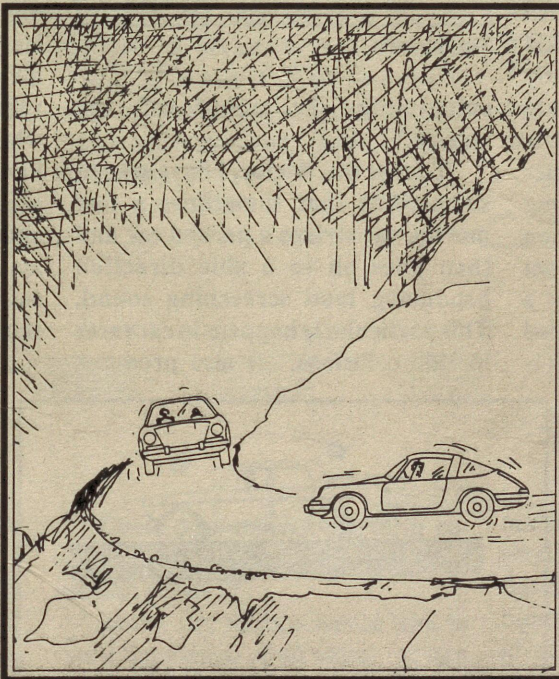
“Good morning, doctor. Oh, good God! What are you doing today on this mountainous highway?”

“Good morning, Tarun. Today morning a ghastly accident occurred at this Mussourie-Dehradun highway. One Mr. Varma was going to Mussourie from Dehradun in his car with his girl friend. Apparently, he was driving at a very high speed. Somewhere in midway there was a sharp U-turn and Mr. Varma couldn't negotiate the turn well. From the other side, another car was coming down from Mussourie and going to Dehradun. The police tells me that it was driven by one Mr. Pillai who was coming back to Delhi after finishing his holidays. He was accompanied by his wife and two young kids. In an attempt to save a collision Mr. Pillai steered his car away towards the valley. Unfortunately, his car fell in the valley and, what's most unfortunate, Mr. Pillai's young daughter died in the accident. Mr. and Mrs Pillai along with their elder son survived but all suffered multiple fractures and are in hospital now. Mr. Varma also tried to prevent the accident by driving away from Mr. Pillai's car. He steered the car towards the mountainous side and ultimately his car collided with the mountainous wall. He and his girl friend also suffered minor injuries but they are out of danger.”

“Oh, I see, but what exactly are you doing here?”

“Tarun, as you know, the legal speed limit on this highway is 30 km per hour.

We enquired Mr. Varma and he insists that he was driving well below this speed limit. When the police visited Mr. Pillai in his hospital, he was just fit enough to give a statement. He said that Mr. Varma was coming up at a very high speed and he himself was driving at about 25 km per hour. So, in effect



each insists that the other was driving at a higher speed than prescribed by law. As you know, on mountainous highways there are often no pedestrians, so we have no eye witnesses either. Now the police has asked me to determine the speed of each vehicle, because only then can the responsibility of this accident and of the unfortunate death of the child be assessed properly.”

“But that is most preposterous. How can you assess the speed of the

vehicles now when both have collided? One is even deep down in the valley. There are no eyewitnesses either. I agree you are clever, but it beats me how you are going to determine the speed of each vehicle.”

“Tarun, all is not lost. Can you see the skid marks here? These skid marks are telling us a big story, only if we know how to decipher it.”

“How are you going to do that?”

“Tarun, it is important for you to know how skid marks are produced in the first place. When the brakes are applied, the tyres begin to rotate more slowly. Thus what happens is that the vehicle is moving at one speed and the wheels are rotating at a progressively slower rate. Actually, a stage comes when the vehicle is still moving, but the tyres are completely locked, i.e. they are not rotating at all. When this happens a rubber residue actually gets burnt at the surface of the tread. In fact, microquantities of rubber start boiling, and this residue of boiling rubber builds in front of the skidding tyres. It is this residue of boiling rubber which sticks to the road surface and gives rise to the skid marks.”

“Oh, I see.”

“Tarun, these skid marks are called the locked-wheel skid marks or deceleration skid marks because they are produced during deceleration of the vehicle. It might surprise you to know that even an accelerating vehicle leaves skid marks. They are known as

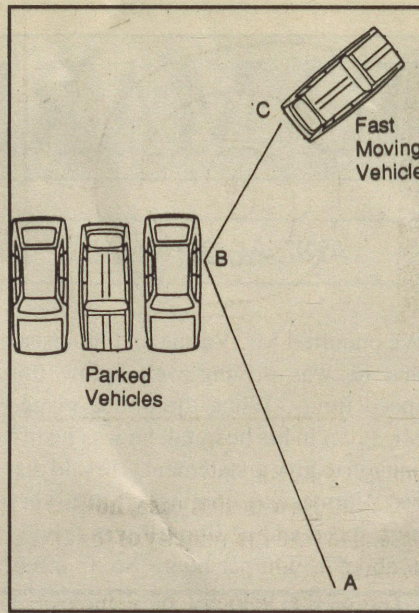
acceleration skid marks. These marks are left when the vehicle drive wheels rotate faster than the movement of the vehicle. When a sudden acceleration causes the drive wheels to spin, it burns rubber from the tyres as the vehicle lurches forward accelerating to the speed of the spinning wheels. the acceleration skid marks are made till the vehicle does not move at the same rate as the tyres."

"So, when you see some skid marks on the road, how do you determine whether the driver was applying the brakes or accelerating the vehicle?"

"Tarun, the appearance of both acceleration and deceleration marks are different and an experienced investigator can at once distinguish between the two. The acceleration skid mark is quite dark with a particularly dark line down each side of the skid mark. As the acceleration skid mark is made, it becomes progressively lighter and narrower as it fades, becoming unobservable eventually. A deceleration or locked-wheel skid mark does not show these characteristics. There is a third type of skid mark too; it is called the centrifugal skid mark. This mark is left when a vehicle tries to negotiate a sharp turn while travelling at a high speed. You must have heard the screech of tyres when a fast moving vehicle tries to negotiate a very sharp turn, skid marks produced during such a manoeuvre are called centrifugal skid marks."

"So, we have three types of skid marks; the acceleration, deceleration and the centrifugal skid marks. Are there some more too?"

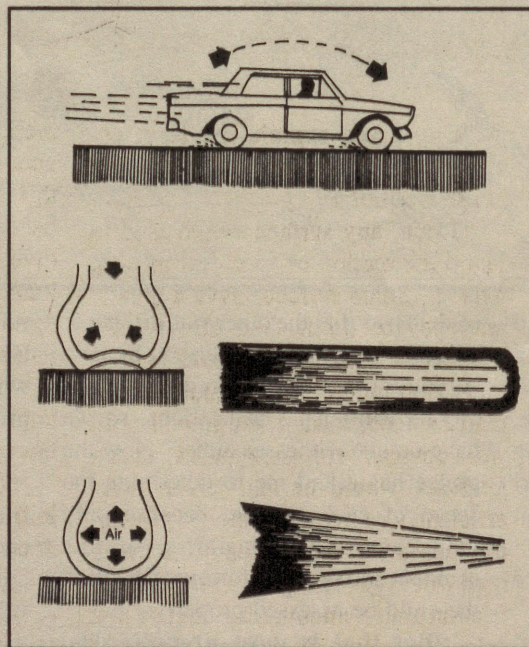
"No, these three are the main types of skid marks. I must tell you that each type of mark gives us tremendous information about the behaviour of the vehicle at the moment these skid marks were produced. What we are having here are the deceleration skid marks. They are very valuable to us in



The side-skid

calculating the speed of the vehicle."

"Excuse me, doctor, I have seen in some films that sometimes a fast moving car strikes a parked car and then goes on in a side direction producing loud screeching sound. This particularly happens in car races in side collisions. It also produces



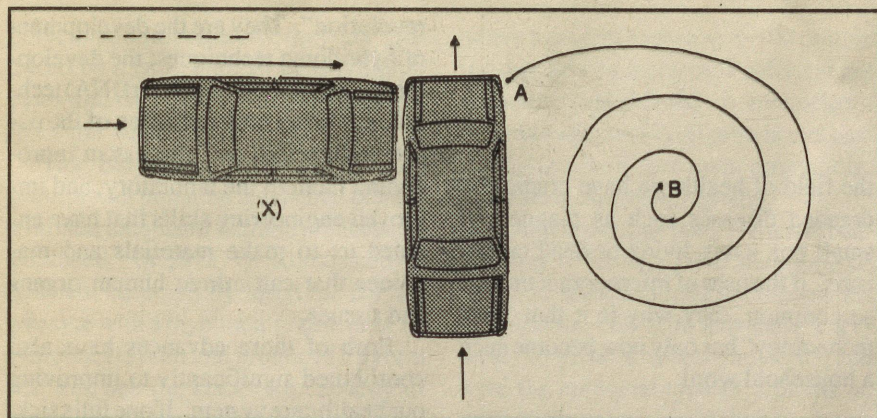
Mechanism of locked-wheel skid mark

skid marks. What type of skid marks are they?"

"Good question, Tarun. This is actually a variant of deceleration skid mark and is called the side-skid mark. You must realize that there are only three things we can do with a vehicle. We can make it go, we can make it stop, or we can turn it, and each of these manoeuvres depend on the interaction of the rubber with the road. It is these and only these three manoeuvres which can produce a skid mark. When a fast moving vehicle is pushed sideways by a parked vehicle or by a pole, the moving vehicle is actually decelerating and thus side-skid is basically a decelerating skid mark. To calculate the speed of a fast moving vehicle, we must measure the length of the whole skid mark as I shall tell you a little later. Now in a case a vehicle sideswips another vehicle, the whole skid mark, before and after the impact, must be measured. On rare occasions, a vehicle may be sent into a circular spinning path. The skid marks are again very much in evidence. In such cases, the whole spiral path of the skid marks must be measured. To be sure, there are two more subtypes of deceleration skid marks : the gap skid and the skip skid...."

"Just a minute, doctor. Let me see. There are three main types of skid marks. Of these three, the deceleration skid marks have further three subtypes—the side-skid, the gap skid and the skip skid. Is it correct?"

"That's right. The gap skid is created by a driver who is pumping the brakes of his vehicle. With each application of the brakes the wheels lock and leave an observable locked-wheel skid mark. Then there will be a blank space of approximately 6 to 10 metres or more and another locked-wheel skid mark. This type of skid mark is most often evident when a driver's brakes had failed. He applies the brakes and skids; then the brakes



A fast moving vehicle can be thrown in a spiral path

fade or fail. He then pumps the brakes by releasing pressure on the pedal and hits the pedal again, and again, and so on. To measure the speed of such a vehicle we measure only those segments of skid marks which are on the road. Thus when we see the gap skid, not only can we calculate the speed of the vehicle, but also say that the brakes of the vehicle had failed."

never left the road.

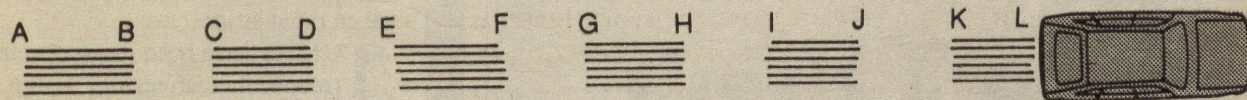
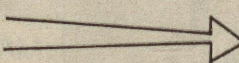
"Good. Now in this case, how are we going to find the velocity of the two automobiles?"

"Tarun, the velocity of a moving vehicle is given by the formula $V = \sqrt{255Sf}$ where V is the velocity in terms of kilometres per hour, S the skid distance in metres and f the co-efficient of friction...."

"How are we going to do that?"
 "Tarun, from the same formula that I gave you earlier, we find that $f = V^2 / 255S$. Now what I am going to do is to drive a test vehicle on this road at exactly 25 km per hour. 25 is just an arbitrary figure. I could as well drive it at 26 or 27 km per hour. But when we have $V=25$, it becomes easy to calculate. When the vehicle attains the exact speed of 25 km per hour, I will apply brakes forcefully till the vehicle screeches to a halt. Look, we have done just that now. Let us now measure the skid marks. Oh! They have a length of exactly 3.5 metres! Let us substitute this figure in our formula. It now becomes $f = (25)^2 / 255 \times 3.5$. This gives $f = 0.7$ or 70%. So, the co-efficient of friction of this road is 0.7."

"So far, so good. Now how do we calculate the velocity of the cars?"

"Look here. The length of skid



The gap skid

"That's fantastic. And what is the skip skid?"

"This is the third type of locked-wheel skid mark. It is caused by the bouncing of the vehicle for example, the mark by an empty tank when it bounces over a railroad track while trying to stop. Another example is a vehicle which bounces over a rough or pot-holed road. The wheel in this case remains locked and touches the road in approximately 1.5 to 3.5 inches. In this locked position the wheel lands on the same portion of the tyre that left the road and upon the same plane of burning rubber. A skip skid, unlike the gapskid, is measured in its entirety, from the beginning to the end as though it had

"Could you explain the term co-efficient of friction in somewhat greater detail?"

"Tarun, any surface would tend to retard the motion of an object moving over it. Some surfaces have a greater tendency to do it than others. For instance, a rough road would tend to retard the motion of an automobile more than a smooth road. If the smooth road were covered with snow or ice, such a tendency would be still lesser. Co-efficient, also known as the drag factor, is a measure of this tendency. A rough road would have a higher co-efficient of friction than a smooth road. Let us first calculate the co-efficient of friction of this road."

marks produced by Mr. Varma's car is about 15.5 metres. Let us now substitute this figure in our formula for velocity. It becomes $V = \sqrt{255 \times 15.5 \times 0.7}$. This gives us the value of V equal to 52.59 km/hour. Wow! That figure is certainly more than the prescribed limit. It was indeed Mr. Varma who was driving his car so fast which gave rise to this unfortunate accident. Let us tell this to the police."

"Thank you, doctor, for letting me know such interesting things about drag marks."

Dr. Aggrawal is Associate Professor of Forensic Medicine at the Maulana Azad Medical College, New Delhi-110 002

IDLI, Dosa, Khaman, Uttapa, Yoghurt (curds) are being made by housewives all over the country. In making these products of everyday use, housewives, without knowing anything about biology, use biological

the field of health we have eradicated dreaded diseases such as plague and small pox using living or dead organisms. If the uses of microorganisms are so common, they why is it that "biotechnology" has only now become such a household word.

**BIOTECH
IN
HEALTH
CARE**

MANOJ MOJAMDAR

organisms known as fermentors. These living fermentors are also used for industrial scale production of alcohol and in many countries yoghurt and cheese are produced as a cottage industry. In

There are many reasons for this. However, four main developments can be attributed for giving this new vigour to an age-old technology, which some even consider as the new "Industrial

revolution". They are the development of hybridoma techniques; the development of recombinant DNA (rDNA) technology; better understanding of the tissue architecture and success in reproducing them in the laboratory, and improved engineering skills that have enabled us to make materials and machines that can mimic human organs and tissues.

Each of these advances have also contributed significantly to improving our health care system. If one falls sick, one goes to a doctor, but in some cases the doctor may consult a biotechnologist. However it is very difficult to define 'biotechnology' and to say who exactly is a biotechnologist. Like in any technology, many people from diverse fields are involved in its development. There are biologists, chemists, biochemical and chemical engineers, electronic and computer specialists and so on.

With so many specialists involved, no wonder, the pace of biotechnology industry is progressing very rapidly, affecting every facet of our lives. In health care alone, the technology has taken rapid strides.

THERE have been many developments that affect our health directly, such as improvement in food qualities, food-yields or the development of bio-pesticides. There have also been many that affect our health care system directly. One of them is the hybridoma technology which has helped in producing pure antibodies for use in vaccines and for other purposes. Conventionally, antibodies to antigens have been produced by injecting the antigen, usually a protein into the animal. Recognising the antigen as a foreign or non self, the body produces antibodies to destroy the injected substance. In normal circumstances this is the mechanism by which the body fights the invasion by virus, bacteria or other foreign body. These antibodies are produced by a particular type of cell known as the B-lymphocyte. Conventionally produced antibodies are known as

polyclonal antibodies as they are produced by a large number of B-lymphocytes and each one of them is different from the other.

The B-lymphocytes have limited multiplying potential and hence there is a limited amount of antibody that can be produced. In 1975, G. Kohler and C. Milstein successfully fused the B-lymphocyte with a myeloma (a cancer of B-lymphocyte) cell and produced a hybrid cell that had the combined capacity of producing a single type of antibody (monoclonal) and unlimited growth and multiplying potential. Thus large quantities of a single type of antibody could be produced that could be characterised and used for clinical as well as other purposes. Now these monoclonal antibodies could be labelled with fluorescent compounds, enzymes, radionucleotides or toxins and employed for different uses. In clinical medicine three main uses have been found for labelled monoclonal antibodies.

The monoclonal antibodies especially have been found to be very useful in the diagnosis of practically all diseases including infectious diseases such as tuberculosis, malaria and filaria. By far, they have been the most useful aids in the differential diagnosis of cancers. Since the course of the disease and treatment modalities of a cancer depend on proper diagnosis, it is very important that a proper diagnosis be made. Most cancers involve undifferentiated cells that cannot be identified by routine histological methods. To give one example, it is very difficult to differentiate between an amelanotic melanoma tumour and a hemangioma, on the basis of routine clinical and histological findings. While hemangioma is a relatively benign tumour, melanoma is a very aggressive cancer that spreads very rapidly. An improper diagnosis here may result in a real tragedy in one case and in the other a benign disease being treated aggressively with dangerous radiations and chemotherapeutic agents. Fortu-

nately a protein known as S-100 protein is expressed on melanoma cells and not on hemangioma cells. A monoclonal antibody against S-100 protein can easily distinguish between amelanotic melanoma and hemangioma.

Another tumour that is often misdiagnosed is the lymphoid neoplasm as carcinoma. Carcinomas are the cancers of epithelial cell type and have a tendency to grow in sheets and cords, and have the epithelial type of proteins on them. Some of the lymphoid neoplasms also have a tendency to grow as sheets and cords, but do not express the epithelial proteins. The absence of any reaction with monoclonal antibody raised against the epithelial proteins is a clear indication that the tumour could be of a lymphoid origin.

ONE of the major method of treatment of cancer is to operate and remove the tumour. However, cancer cells have a tendency to persist in the blood and lymphatic system and start a tumour at any place in the body. At this stage it is difficult for the surgeon to cut open the body at many places so he gives up and relies on radiation and toxic drugs to cure cancer. Even here it is important to localize or pin-point a tumour and estimate the total tumour burden so that appropriate doses of drugs or radiation can be calculated. Here again monoclonal antibodies labelled with radio-active chemicals especially ^{125}I have proven to be very useful. The cancer patient can be injected with ^{125}I labelled monoclonal antibody and after a certain period either a gamma-scan or a CAT Scan can be done. Dark spots appear wherever the tumour nodules have been formed. The therapist can now decide either to go for surgery or calculate appropriate doses of drugs or radiation. In a number of cancers the imaging technique has confirmed the presence of tumour foci long before any other currently available method can detect them.

Monoclonal antibodies, however, have a limited potential as therapy

against cancer cells. As pointed out earlier, the monoclonal antibodies are raised against very specific proteins. In spite of this, however, they have not had wide spread use for treatment purposes especially in cancer treatment. This is because many of these proteins or antigens found in cancer cells are also present on other cells in the body. Destruction of these normal cells will definitely have repercussions on the normal physiological functions of the body. So far, only melanomas and neuroblastomas have been treated with partial success by monoclonal antibodies.

Nevertheless, monoclonal antibodies have a tremendous potential in the treatment of infections and parasitic diseases. The proteins or antigens present on these infectious and parasitic organisms are not likely to be found on human cells. One such example is 'filariasis' where at least one monoclonal antibody formed against cuticular antigens has been found to kill the organism.

One of the most successfully employed method of monoclonal antibody treatment is coupling it with toxins such as ricin. This is called the "magic bullets" treatment as the immune part of the immuno-toxin homes on to the specific cell and the toxin part does the killing. Such type of killing also called targeted drug delivery has been found very useful in purging the bone marrow of leukemic cells.

The rapid advances made in molecular biology, the discovery of restriction endonucleases that cleave DNA at specific sites, the DNA ligases that can join the cut DNA portion with another DNA piece have made it possible to obtain in large quantities any protein that is needed. The basic method consists of using restriction endonucleases that are naturally present in many bacteria as a weapon against invading virus, to cut portions of DNA and select the wanted portion of DNA. This portion of the DNA is then ligated with the DNA of a plasmid cloning vector. Such plasmid

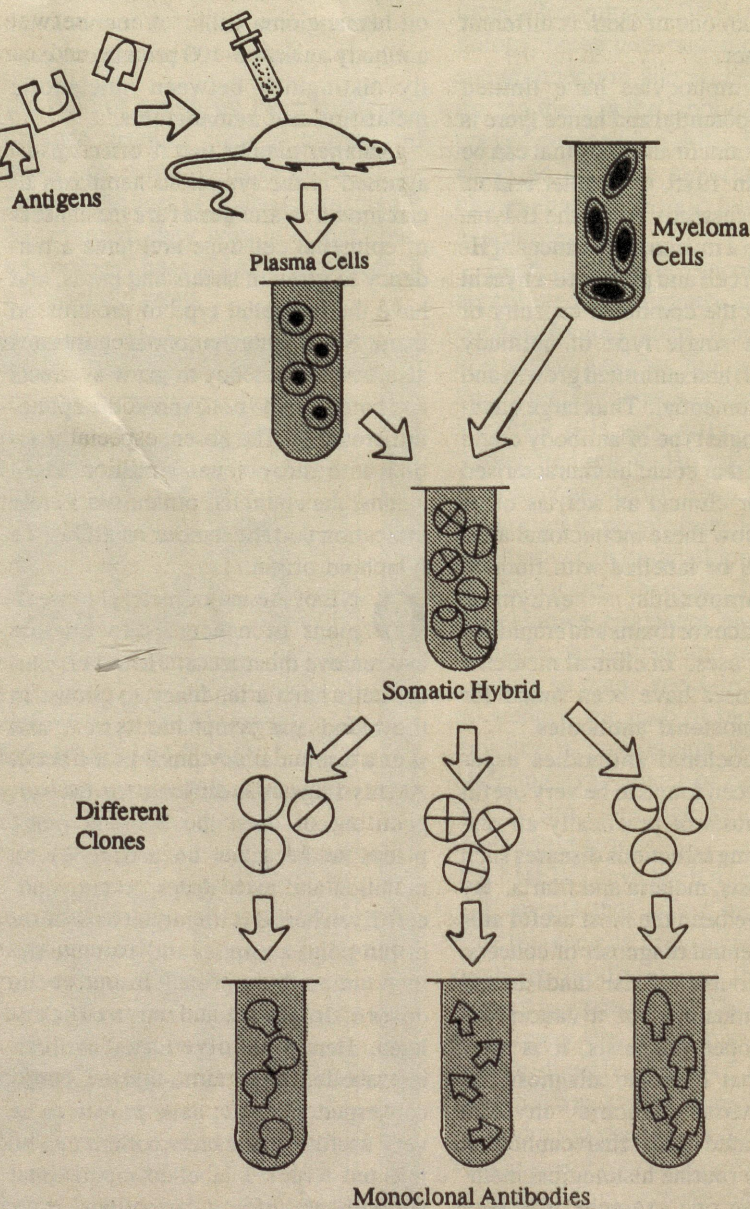
cloning vectors also are naturally present in many bacteria and have circular DNA with sites recognised by enzymes as "DNA replication origin sites". Since plasmid DNA contains many genes that may be superfluous and not wanted, the restriction endonucleases can be used to remove them. Plasmids have been constructed from naturally occurring forms, preserving only those features that will aid in cloning. One such most widely used plasmid is PBR³²².

IN mammalian and other eukaryotic DNA, linear sequences coding for mRNA are not present. They are interrupted by intervening sequences called introns. Hence, it is sometimes better to use mRNA itself to make linear DNA by the help of reverse transcriptase and ligase this DNA to the plasmid DNA.

The plasmid is then used to infect the bacteria, and the infected bacteria is then selected. Since bacteria have the capacity to grow fast a large amount of the needed protein can now be obtained.

Functioning of many proteins, depends not only on their amino acid sequence but also on modifications such as glycosylation, or folding which occurs after their formation. Such post-translation modification occurring in bacteria are not similar to those occurring in eukaryotic and mammalian cells. Hence, for some proteins, it is necessary to clone the DNA into a yeast, or mammalian cell.

Products formed by recombinant DNA technology and used in health care system are numerous. These in-



Monoclonal antibodies are secreted by specially selected somatic hybrid cells which are produced by fusing a cancer cell with an antibody producing cell

clude a large number of antibiotics such as penicillin, chlortetracycline, cephalosposin and biological response modifiers such as interferons, lymphokines, enkephalins, hormones, growth factors, and so on. Enzymes such as renin, tissue type plasminogen activator alkaline and acid proteases, amylases, pectinases, cellulases, lactases

are also produced using recombinant DNA technology.

The antibiotics are of course used for the treatment of many infectious disorders and some of them are used for cancer therapy. Interferons are used for the treatment of viral infections and also for certain types of cancers. Lymphokines are used to activate lympho-

cytes for their immune defence work. In fact a new kind of treatment called lymphokine activated killer cell therapy is being successfully used for the treatment of cancers. The therapy consists of isolating the lymphocytes from the operated tumours, activating them with lymphocytes from the operated tumours, activating them with lymphokines and injecting them into the patients. Hormones such as insulin used for diabetics, somatomedin for dwarfism, calcitonin and parathyroid hormones for preventing senile osteoporosis are now-a-days obtained by modern biotechnological procedures. Growth factors are being used for speeding up the healing of skin and tissue wounds and for enhancing growth rates of normal cells *in vitro*. Enzymes such as renin are used for the treatment of hypertension; tissue plasminogen activator for removing blood clots responsible for heart attacks. Other enzymes are used in leather technology or detergents while rennets are used for making curds on a large scale.

The recombinant DNA technology has led to identification of a large number of genes, whose expression occurred only rarely during the cell cycle phases. Many such genes are continuously expressed in cancer cells and therefore they have been clumped together and are called oncogenes. The oncogenes code for a variety of cell growth and differentiation regulatory proteins such as growth factors, their receptors, protein kinases etc. The identification and localization of these genes has helped us in differentially diagnosing hyperproliferative disorders and cancers. We know for example that keratinocytes in psoriasis patients are hyperproliferative but are not cancerous because in these cells only two oncogenes the *cfos* and *cmyc* genes are activated. This results in the induction of proliferation and delaying differentiation but does not result in cancer. For these keratinocytes to become malignant another oncogene *csrc* needs to be

activated. By analysing mRNA/proteins coded by these oncogenes one can identify the differences between hyperproliferative disorders and cancers.

In addition to diagnosis, isolated genes can also be used for curing many genetic disorders. One example is albinism where the gene for tyrosinase can be inserted in the developing embryo and albinism cured.

THEN there are biopesticides and transgene plants which indirectly influence our health care system by either killing pests and/or improving the nutrition. Pests, especially crop pests destroy several million tons of food plants throughout the world. With organic pesticides such as DDT, BHC being banned in many countries, because they destroy ecological systems, there has been a resurgence of crop pests and other transmitters of diseases such as malaria, filaria, yellow fever etc. Every organism has its own natural enemies and Biotechnologists have now turned towards using them for selective killing of these pests. Two of the biopesticides that have been successfully field tested have been a kind of fungus that specifically grows on mosquito larvae and a microfungus that grows on crop pests. In our country, several institutes and university departments are involved in developing biopesticides against disease carrying mosquitoes and crop pests like crickets.

In addition to improving crop yields another idea that is being tried is to bring two different nutritional aspects of two different plants together in one plant. In many households throughout the world potato and tomato are eaten either at the same meal or alternate meals. They may not know that nutritionally this combination gives the essential amino acids like lysine from potato and minerals and vitamins from tomato. But instinctively they do eat potatoes and tomatoes. Biotechnologists have now succeeded in bringing the two qualities together in one plant and have

made the pomato !

Several such transgene plants, pest resistant cash crop plants and biopesticides are now being used throughout the world to meet the needs of hungry masses.

NATURE invented biopolymers that have the same combination of tensile strength, flexibility and easy maneuverability that wheels have. Biotechnologists are now interested in the structure and chemicals of these polymers so that they can now engineer these for biological and clinical use.

A wide range of materials such as plastics, metal alloys, ceramics, graphite, glass, carbon etc. are made into fibers that have applications in the making of artificial heart, contact lenses, hip joints etc.

Another interesting development in this field is the 'Biochip'. The microchip is used in calculators. In the 'Biochip' the specificity of the antigen-antibody reaction is used to make contacts necessary for completing the circuit in the microchip. The biological uses of such a 'biochip' consist in the development of 'Biosensors' that respond to outside stimulus.

Heart transplants and the associated problems of rejection and the necessity of keeping such patients on immune suppressors are well-known. Looking into the mechanics of how the heart functions, Dr. Jarvik made an artificial metallic-plastic heart called Jarvik's heart. For many kind of operations like open heart surgery, valve replacement, and removal of cardiac aneurisms heart lung machines have been developed that take over the functions of heart and lung at least during the time the operation is in progress.

The human body suffers from a number of valve defects and vessel aneurysms. These can now be replaced by artificial valves and vessels made up of plastics etc. One such example, which is commercially available is the 'DeBakey Dacron' vessel.

Steel rods and angles have been used

over the years for broken bones and hips. Now we can have bioacceptable and biodegradable polymers for bones and joints. Among the bioacceptable materials used for bones and joints are the tough but malleable silicon elastomers. Biodegradable materials are usually chemically treated natural polymers. Although as yet, the ideal biomaterial for different uses is not available, many biotechnologists are currently doing active research in the field.

Burns patients have a tremendous problem to face. They not only have to combat the infections on their exposed flesh, but also have to prevent tremendous water loss. Several kinds of artificial skins are now available that minimize water loss while the body grows the skin over the burnt flesh. Such artificial skin includes collagen sheets, processed pig skin, processed potato peels etc.

THE science and art of growing cells in artificial conditions is relatively new. The basic requirement for the cells to grow is (a) substratum (b) media, very similar to those of blood chemicals, (c) oxygen and other gas conditions similar to those found inside the body and (d) same temperature as that found inside the body. In spite of all this, the cells tend to grow as monolayers and do not form tissues and organs as they do in the body. There are many reasons for this, such as our media may contain factors that selectively allow the growth of only few kinds of cells and the absence of extracellular matrix for the different type of cells to organize themselves into tissues. So far tissue culture has been useful in biotechnology in the production of vaccines and some cellular products. The advance of biotechnology is now enabling us to understand tissue architecture, the components and functions of extracellular matrix, the stringent media, growth factor, hormone and vitamin and mineral requirements for growth of special cells. Tissue culture is now able to influence

biotechnology and its role in health care is slowly becoming apparent and useful.

The idea of 3 - D cultures is to grow cells in such a way that the architecture and functionality of the organ is maintained. The 3-D cultures have made a beginning in clinical application with 3-D growth of epidermis. The keratinocytes can now be grown and epithelia formation induced by media Ca modulation. Such *in vitro* cultured epithelia have been clinically used for the treatment of burns cases. So far an estimated 2000 burns cases have been treated by cultured epithelia grafts. The advantage of this technique lies in the fact that the epithelial cells in culture grow at a faster rate than in the body. If autologous skin is not available even heterologous transplantation can be done, as there is no immune rejection involved and the transplanted keratinocytes stimulate the growth of patient's own skin cells.

Epithelia is itself only 6-20 cells thick and it is quite difficult to do the grafts. To improve grafting now a days composite dermis-epidermis cultures are being made. They consist of dermal fibroblasts being grown above the gels. Such composite dermis-epidermis cultures have been found to be easier for grafting.

The skin is relatively simple in terms of tissue architecture and hence it is the first organ to be grown in 3-D culture. Another tissue that has a relatively simple architecture is the cornea, which will be taken up for 3-D cultures soon.

There are other cells such as melanocytes, nerve cells and Cardiac myoblasts that refuse to grow in culture. The requirement of these cells for growth is very stringent and may need artificial growth factors such as phorbols esters etc. Among these, melanocytes have been successfully grown in our laboratories both from normal individuals and from normal areas of leucoderma patients. These cells are now being grown and multiplied into large numbers for

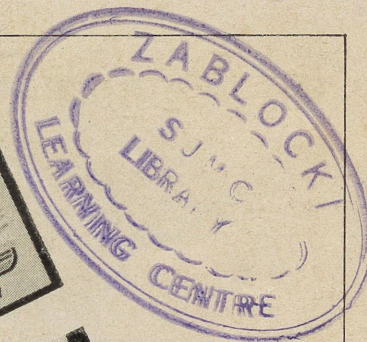
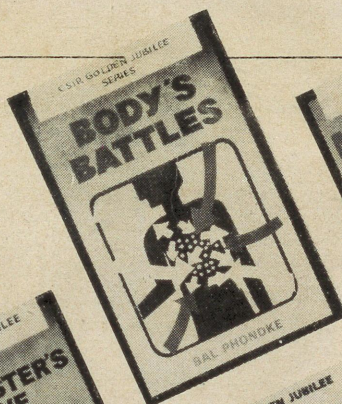
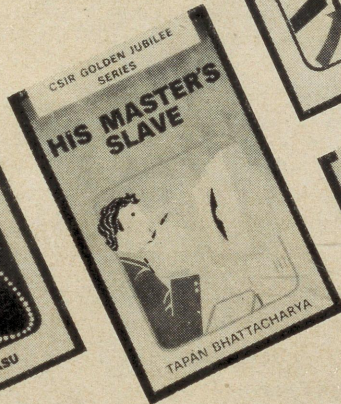
transplantation into depigmented patches of leucoderma patients. Cultures of other recalcitrant cells for medical purpose is being taken up by our laboratories.

It is not possible to have a donor and recipient together side by side in the same hospital. So the donor tissue has to be stored in physiologically viable and functional conditions. There are several ways of doing it. One is to try to maintain the tissue in artificial media. This method can be applied for short duration only. With the development of cryopreservants and technology and machinery for desired cooling rates, tissue banks like the blood banks, are now capable of stocking a large number and variety of tissue for transplantation purposes. Such organs currently being banked include cornea, heart valve, skin, kidney etc.

PREDICTING the future, especially in the field of science is a dangerous venture. How biotechnology is going to affect further health care is very difficult to answer. Progress in all fronts mentioned here will continue, with new monoclonal antibodies, gene products, biopolymers and cell cultures being developed and used for diagnostic and therapy purposes. Our understanding of the mechanisms involved in the formation of cancers would improve. Aging may be understood better. Improvement in crop yield, better and sturdy animals, better eggs and quality milk for improved nutrition should be around the corner. Developments in the field of biopesticides, better processing and storing of food etc. should lead to a proper balance of nature in this ecology conscious decade. Health and proper maintenance of our ecosystems for ourselves and our future generations should soon become a reality with the progress being made in biotechnology.

Dr. Mojamdar is at the National Facility for Animal Tissue and Cell Culture, Jopasana, 85/1 Paud Road, Kothrud, Pune-411 029

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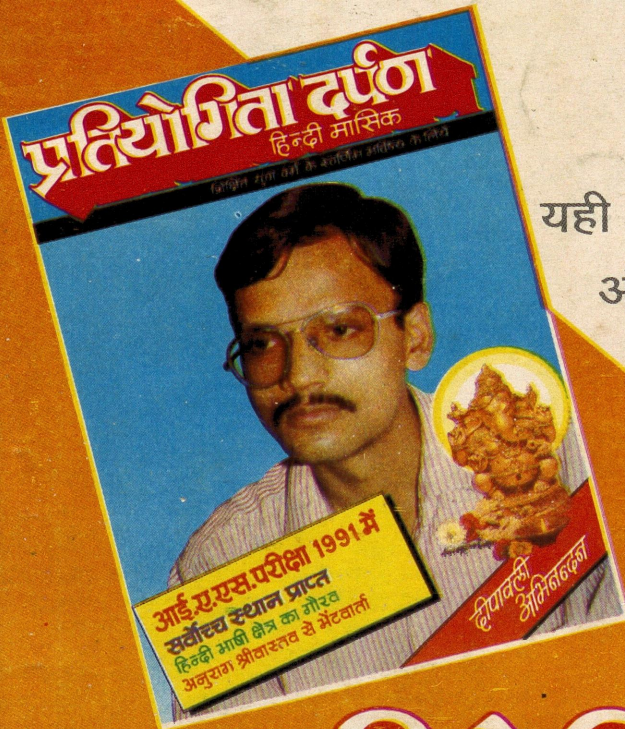
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