BOOK REVIEWS

Scientists in Search of their Conscience. Edited by Anthony R. Michaelis and Hugh Harvey. Springer Verlag, 1973. Pp xiii+230. $16.30.

A symposium on the effect of Science on Society organised by the Weizmann Institute of Science was held at Brussels in 1971, and its edited proceedings dedicated to the memory of one of the participants of the Symposium, Prof. A. K. Katchalsky, who died in tragic circumstances in 1972, has been published by Springer Verlag in 1973 under the title "Scientists in Search of Their Conscience". The participants were mainly from Europe and U.S.A., drawn from the various disciplines of Science, and the key question they discussed was the dilemma facing Scientists today, viz. the loss of freedom that is inevitable if they have to face the responsibility of their work. Since there were no participants from outside Europe and USA, one missed the opinions and views of the other great block of developed countries and also of the developing countries so urgently seeking an identity of their own.

The duration of the Symposium was for two days. The opening session was chaired by Prof. A. B. Sabin and the speakers were the then Minister of Politics and Scientific Programme of Belgium. His excellency T. Lafèvre and Mons. A. Spinelli. The first day covered three sessions. The morning session had Prof. F. Cramer and Prof A K Katchalsky as speakers under the chairmanship of Prof J. C. Kandrew At the afternoon session Prof L. Van Hove and Prof. C. L. Pekeris spoke and Prof. H. B. G. Casimir was in the chair. The first day closed with the dinner session under the chairmanship of Sir Siegmund G. Warbourg with Prof. R. Aron as the speaker. The second day covered two sessions, of which the morning session was chaired by Prof. W. Gentner and the speakers were Prof. O. Maalϕe and Prof. D. Samuel. The afternoon session had Prof. M. J. Higatsberger in chair and Prof. J. J. Solomon and Prof. M. Feldman were the speakers. The speakers of the concluding session were Prof. V. F. Weisskopf and Prof. A. B. Sabin. The titles of the addresses of the speakers were as follows :

F. Cramer : Can our Society meet the Challenge of a Technological Future ?

A. K. Katchalsky : A Scientist's Approach to Human Values

L. Van Hove : Physical Science in Relation to Human Thought and Action

C. L. Pekeris : The Impact of Physical Sciences on Society

O. Maalϕe : Can Ideas from Molecular Biology be applied to Economic and Social Systems ?

D. Samuel : Science and the Control of Man's Mind

J. J. Salomon : Science and Scientists' Responsibilities in Today's Society

M. Feldman : Science and the Crisis of Democracy.

Among the speakers the first two, Cramer and Katchalsky are chemists, Van Hove is a physicist, Pekeris a mathematician, Maalϕe, Samuel and Feldman are biologists, and Salomon has been interested in international scientific collaboration. No doubt the physical and biological sciences were well represented, but the inclusion of the points of views of behavioural scientists, psychologists, economists and technologists would have made the Symposium more interesting. It would be difficult to give in any detail the various points that emerged from the very lively discussions that followed the main speeches, for which one may refer to the book itself. The speeches of the principal speakers will be reviewed here and for this purpose their actual words will be fully used.

In the opening session Prof. A. B. Sabin, President of the Weizmann Institute and a medical scientist, posed two questions (1) What are the scientists going to do with all the knowledge they have discovered ? (2) What are the scientists doing to help Society to solve the serious problems facing mankind ? For answering these questions Sabin said that Society must define precisely the areas where Science can come to its help. His Excellency E. T. Lefèvre, noted the profound effects on Society of scientific discoveries which drive men to endless introspection. The changes brought about by Science are irreversible. Man accepts new myths and can not reject what the evolving technology gives him, and yet when he ponders deeply he can not accept the consequences of technology. There have been enormous damages caused by the march of Science. The benefits of Science generate new problems. Lefèvre suggests that to surmount these new problems, intensification of scientific activity is necessary which can be based on economic growth only, and so one needs to know what kind of Society we should want. Mons. A. Spinelli, the founder of the movement for Federal Europe, made the following points. As against the traditional cultural aspect of Science, the latter today has also economic, social, political and moral values. Science is so expensive and complex that it is no longer the affair of individuals, but is a political matter concerning all governments. The necessity of planning scientific research at all levels, from within a research institute up to the world level, has become of paramount interest. This means the establishment of priorities of scientific research as against other needs of Society, which leads to a continuous struggle to evaluate the interests of Science and convince Society that these are useful to it. A demand is emerging that research should improve the quality of Life and the quality of Society rather than just satisfy a quantity of needs. Prof. J. C. Kendrew said that prior to 1960 the attitude of the scientists and the governments was somewhat uncritical in assuming that: the more Science the better. Now the question is being raised—why and for what is the money given to Science ? Is the work of scientists relevant to the problems of people paying for it ? This puts the scientists at a disadvantage for they are not used to justify their work, and assume rather that benefits are automatic. It is not clear how to study the links between pure Science and large scale Technology—certainly cost-benefit analysis has not upto now provided justification

for the large amounts spent. One is faced also with the problem : How to distribute funds between scientific activity and other areas of similar cultural activities ?

Prof. F. Cramer was mainly concerned with the teleonomy of biological history. Man was the only animal that emerged from Evolution with a critical awareness. At the beginning he was concerned only with symbolic checks of his environment with religious and eschatological orientations. Gradually rose the need to construct a secular historical ontology. M. Eigen developed a physicomathematica theory, in which is life characterised by two concepts : (1) Reproductive autonomy, which means the capacity for autonomous self-preservation in an environment, and of reproduction, (2) Evolutionary teleonomy, i.e. the ultimate aim and the inner laws by which the biosphere is changed in a ordered manner to the end. In (2) the question that is to be answered is : What is the meaning of biological history ? The principles available to answer this question are just the same as those used for searching the meaning of universal history. The answer to this question falls in two groups. The first group is vitalistic in nature and so not acceptable to many. One metaphysical solution in this group, due to T. de Chardin, is based on the assumption that reproductivity and directedness are inherent life qualities and man has achieved maximal evolutionary rank and maximal transcendentreason. In the second group the view is that teleonomy is the superstructure of reproductivity. The scientific basis stems from the argument that though evolutionary processes are irreversible, thermodynamics of irreversible processes does not rule out that at different points of time highly complex structures emerge and organise themselves autonomously on increasingly higher levels, creating their own history. The conclusion in this type of argument is that reproductivity of Bios generates its own teleonomy. It is quite possible that there are diverging paths of evolution, possibly at other places of the Universe, so that there may be many differing kinds of evolutionary ends. Cramer rules out one autonomous evolution with a general valid ultimate aim or teleonomy issuing from it. Thus there may be evolutions leading to insect nations with collective abilities instead of a system based on individual ability. If there is no general valid natural history, we can atleast examine our particular evolution. viz. that of the homo sapiens. Man left evolution in the Darwinian sense when he changed from the life of a nomadic hunter to that of a sedentary farmer. From that point he was no longer subject to law of survival of the fittest. In his ability to control nature to suit his requirement, not only did he bring his own evolution to a close but also that of a great deal of his natural environment. In the latter half of 20th century he has taken the step of renewing his deteriorating organs, and as a final step he may even dispense with all organs except the brain, which may be made to live on indefinitely with its personality and faculties of thought, associations, and memories in an environment conditioned carefully to preserve it. Cramer reviewed the achievements of biological research in the 19th and 20th century, which has directly generated population explosion, a crisis of modern times. Furthermore such advances in scientific knowledge leave man

in conditions produced by his efforts, but which he can not fully understand, and in fact some of which he cannot welcome. This leads to a positive feedback from scientific research to Society, giving rise to new questions and new obligations. Cramer examined the question whether scientific progress can continue at the present rate of acceleration resulting from such a positive feedback. He thought that a limit must exist to such progress as a result of a definite material presuppositions. An exponential rate of growth makes the approach to the limit increasingly fast. Thus accelerating kinetics of progress demand that progress cannot be an eternal attribute of human history; consequently progress in scientific endeavour must also slacken. Another point that Cramer makes is that the Psyche of modern man is in the process of a metamorphosis. H. Marcuse observed that the performance principle itself, which yielded progress is now under question. If this is abolished progress will stop, whereas progress is the competitive principle of the Faustian man. If everybody attains a certain standard of life, then it is conceivable that nations will agree to a progress freeze to avoid a global proliferation in every sphere of activity. The struggle for survival will start again if any nation breaks the agreement. Planning is needed, for as Picht remarks, man is faced with production of not only nonanimate objects but also of his world. Planning today has to do with the realisation of surplus of potentialities. Scarcity has shifted and has reconstructed elsewhere, but not diminished. As progress overcomes scarcity, will civilisation come to an end ? Marcuse thinks not. With the liberation of Eros man will examine with his fully developed knowledge, the question what is good and what is bad. Cramer summarised by saying that scarcity is the biological norm, the motivating force of living, and is essential for progress. Elimination of scarcity is a great hazard if not associated with a new type of asceticism and voluntary renunciation. Today planning must be based on the awareness of this need for asceticism. Science can only supply man the material for planning a technological future but by itself it can not decide his destiny.

Cramer's speculation of a possible shape of things for homo sapiens is based on the hypothesis that scientific activity will be allowed to go on at the present pace by Society. It is by no means a very desirable prospect. The question of scarcity and necessity of planning is becoming more and more important as can be seen from the recent dramatic demonstration that the magnificient western civilisation is based so precariously on Oil, which is mostly in other hands. The progress of the western civilisation was based on easy accessibility to the necessary raw materials; once this becomes difficult the whole system is in danger of collapse. The problem for them is heightened by the fact that it is no longer possible to use force for securing raw materials without invoking far reaching consequences for the aggressor. On the other hand the emerging nations may command the raw materials but lacks the high level of technical excellence necessary to be able to exploit their natural wealth and make the big jump to the desired level of prosperity. Whether planning on a world wide basis with a view to make the diminishing resources available to all

nations in an equitable manner, would ever be possible, is an open question. In a world in which a great portion of the population lives at the starvation level, one may not talk meaningfully of voluntary renunciation or asceticism to bring about an end to competition.

Prof. A. K. Katchalsky examined in his address the moral consequences of scientific endeavour. He remarked that it has not been possible to develope Science into an universal language so that it could be incorporated into different cultures without destructive side effects. It has been said also that Science is neutral only in its approach, but not in its consequences. Scientists therefore suffer from a kind of guilt complex because of the possible consequences of their works. Modern research raises heavy moral and ethical questions. To take an example, it is suspected that a male having a chromosome structure XYY may be a potential criminal; but should Society restrain such a person if he has not committed any actual crime. Katchalsky maintained that as a result of Science and Technology, the world is no longer an open system, in which the infinite reservoir of the environment could absorb in itself the consequences of human activities. Today Technology has reduced the world to a closed system. Whatever is done at one place affects the surroundings and is felt at other places also. Thus the problem of pollution is to be viewed with this attitude towards a closed system. Man is compelled to think of a new morality transcending national levels, as required by the finiteness of his global system. The pschycological development of man is needed in which he will be aware of a hierarchy of belongings, giving him obligations of a global citizen without generating any moral conflict to his national belonging, as much as the latter does not conflict with his belonging to a village or a town or to a family. Only then man can cope with global problems and international relations. Katchalsky points out the criticisms that the younger generations are making today to the failures of meeting the challenges of the impact of Science on Society—that scientific activity is antihuman, making man a stranger to himself and causing him to lose interest in life itself; that man should get rid of all curiosity, for this in a scientist only satisfies himself, for which he sacrifices the world; and that antiintellectualism is the right road to the salvation of the world. Katchalsky emphasised that such criticisms are self destructive, for there can be no moral or ethical philosophy without cognitive foundation. Indeed curiosity has deep biological roots, and it is this curiosity and not some material factor which led to the development of Science. Thus antiintellectualism is antimoral. The problem is how to foster an intellectual approach that has a moral weight. Science teaches how to evaluate correctly honest informations about the real world leading to personal maturation which as Freud pointed out, amounts to acquisition of a Realität Prinzip, distinguishing subject from the object. Thus negation of Science is a retreat from maturity with all the moral consequences. Science is intrinsically antiauthoritarian and relies on an external judgement of nature. Biologists claim that their discipline may generally teach man the motivation of his behaviour; even the 10 commandments

may have biological origins. From antiheroism of ants with no individuality based on genetic dictum, evolution goes to man with an incomplete determination, who, faced with choice, must be concerned with moral and ethics. This is a transition from a biologically determined behaviour to a culturally determined one. In man a conflict appears between personal tendencies to survive and the interests of Society. Thus scientists can not remain isolated in ivory towers unconcerned with human affairs ; they must bear the responsibilities of their deeds. Katchalsky tentatively spoke of what may be done. On the educational level scientists must collaborate with those directly concerned with human behaviour—the anthropologists, the pschycologists, the sociologists etc. J. Piaget discovered that during the cognitive development of man,at about the age of 14-15 years,a formal structure appears in the mind of children ; concepts acquire meaning, and moral dicta find justification. Without the development of this structure a person remains immature. A jump is necessary to a higher internally directed cognitive structures as the present day structures are inadequate. Using concepts of statistical mechanics. Katchalsky stated that cognitive structures are dissipative structures of the human mind. It should be possible to derive these structures from the interactions of information flow in the human mind. Maslow has shown every man can reach higher degree of maturity with an appropriate education, and develop the inner formal structure of a responsible personality ; high cognitive levels in man lead to high artistic interest and high morality. Such a maturation of personality to higher levels would equip man better to cope with the problems of the present. But the problems are urgent and can not wait for the maturation of man ; scientific progress is very rapid and technological consequences are urgent. Science still has the classical hierarchical and meriotocratic pattern, something like that prevails in the Catholic Church, making it the privilege of an international elite. Ivory tower attitude has helped scientific research, but scientific education is not a matter for the elite but is a major social enterprise. Scientists must adapt themselves to these contemporary needs of mankind. Emergence of a pioneering group of scientists, attempting to humanise Science and synthesise human needs and scientific development, is necessary for Science to survive ; only then Katchalsky thinks man will reach the promised land of Tagore, where man can live without fear.

What Katchalsky says about our living in a closed system is very important and is realised by every thinking person ; Unfortunately the urgency of the problems resulting from such a situation is realised by nations only after some traumatic experiences on a global scale. They agreed to international cooperation on a global scale twice in human history—each time after the end of a world war, and set up international organisations with this aim. But these organisations soon lost their direction and purpose when confronted with national interests. About a new type of education to bring out a higher cognitive structure in the mind of man to measure upto the emerging needs of the coming Society, the experiences in India has been very discouraging ; the education system is on the verge of collapse. The

reasons for this are well known ; the rising level of unemployment is a major factor. The main question here is how to save the system from a total extinction, and not how to change it to produce men with higher level of maturity. In countries like India, Science and Technology themselves are already on the retreat before they could even make a fair start, being over-whelmed by the crippling economic and political problems. So it is futile to think of the emergence here of a pioneering group of scientists who would humanise Science, because the problem now is the very preservation of Science from the intense pressure to which it is subjected.

Prof. L. Van Hove surveyed the rise of physical theories whose aim was to describe a large class of natural phenomena on the basis of a minimum of mathematical laws and equations. He briefly passed over the great steps in history of Physics starting from the Newtonian epoch upto the present time. He mentioned that many of the discoveries, though not particularly fundamental by themselves, changed and revolutionised a good part of Technology. Most scientific findings have no direct impact on human affairs. There is no way of telling in advance whether a piece of scientific research can have technological application, and if it does whether it will be good, bad or both. Since the social, political and moral consequence of Science have become a concern of all, research is now a matter of national and international politics. Next Van Hove described the emergence of Big Science, necessiated by colossal scope and cost, requiring planning of very large laboratories on either national or international level. Van Hove observed that in such large laboratories scientists with exceptional talents are not always used where they can be most useful, i.e. to advise on the scientific policies of these large research projects. Summarising he said that the development of Physics has shown that a mathematical description of natural phenomena is possible, and this application of mathematical technique to physics can serve as a model to its application to other sciences. It illustrates both the power and limitation of such techniques. A lot of thinking, scientific knowledge and philosophy is needed as well as action, prediction, planning and technology. Secondly Physics has discovered and studied the properties of natural forces and of material systems providing occasionally ways of controlling and utilising some of them. This has nonscientific consequences of tremendous importance in human affairs making Science a matter of Politics, national and international. Thirdly emergence of Big Science requires formulation of a global Science policy by which world's most advance research tools can be planned, requiring the participation of the best brains, whose numbers being small, their integrated wisdom should not be too large to organise.

It is by no means so certain that the model of Physics with its power and precision can serve to be adequate to study the laws governing Society and can make any prediction of its future evolution. So far Big Science is concerned, it is starting in India also, on consideration of prestige, at a time when other priorities for the country are pressing hard for recognition. We have to study how Big Science in

India develops and indeed whether it could survive at all, the technological foundation being what it is and other national needs claiming higher priorities.

Prof. Pekeris examined closely the role of scientists and advisers in panels planning big projects designed to benefit Society. He remarked that it has been demonstrated that new technologies could be developed from an initial state where these technologies did not exist, and that it has been shown during the wars that coherent teams could be formed which work with extraordinary enthusiasm and efficiency. Why then should it not be our effort to initiate peacetime projects beneficial directly to Society ? Pekeris discussed the question of leadership of such projects. J. Von Neumann, as head of a team studying numerical weather prediction with help of computers, felt that the short range prediction problem was more or less solved. Pekeris felt that with the death of Von Neumann, the leadership which was necessary for a breakthrough in this problem was lost. Pekeris said that scientists could contribute to the welfare of Society by taking the initiative and responsibility themselves for some projects which are of direct benefit to Society. The alternative to this is to spend much of the time in the passive role of the advisers in committees and panels as unprejudiced but in many cases also uninformed experts. As illustration of his theme Pekeris referred to the controversies round the question of supersonic transport (SST) in USA. The SST Environmental Advisory Committee was formed in 1971. Precise informations about the stratosphere necessary to answer the various questions that were asked in this connection, were already available in the thirties. However the way the scientists advised in the committee was somewhat casual and influenced by nonscientific considerations. Pekeris drew the following conclusions from this : (1) The scientists sitting on Government panels must be ready to devote more time to the task or should refuse to participate (2) The community of scientists must assume collective responsibility for the operation of these panels and should certainly seek to be informed about them and (3) All this clearly requires expenditure of more time on public problems by scientists than what they are accustomed to in the past. Difficulties rise because the scientists are also subject to human frailities.

In India we have in large abundance the phenomenon to which Pekeris refers—scientists working in variety of committees, governmental and semi-governmental. It is very doubtful whether they are able to achieve anything worthwhile. The whole philosophy seems to be to regard these committees as rubber stamps to some policy, that is convenient to authorities, or to taper off some other policy ; also these activities are useful to the scientists in their lobbying with the authorities for funds and privileges. There have been scientists pioneers here who initiated important projects beneficial to Indian Society and they have worked with great dedication. But their experiences have not always been happy, for the question that is invariably asked is whether one is with the authorities or is in the opposition.

The dinner session speaker Prof. R. A. Aron described the dilema of conscience facing those scientists who are engaged in works for the State, whose consequences

they know to be evil. Aron maintained that it is of little importance whether the scientists maintain the distinction between the truth aimed and attained in itself and for itself and the uses of knowledge, or whether, on the contrary the scientist admits that by its very nature the knowledge derived from modern Science incorporates its own application. It is perhaps true that destructive use of technology cost less than its constructive use ; it is cheaper to destroy a city than it does to rebuild one. Some scholars follow the Aristotle Dixit that search for truth is good in itself and prefer to consider it quite moral to persue in their laboratories the solitary undefined goal. Others realised their responsibilities and took to politics as they consider these matters too serious to be left to the politicians. However their special knowledge do not entitle them to be at the helm of affairs of the State, as they do not possess the special diplomatic ability to play with the menance they wish to avoid. Similarly the politicians do not possess either the knowledge of his objective needing scientific description nor yet the technique of its manipulation founded on proven learning. Doubts are growing already in the mind of the scientists engaged in national defence about the judgement of the means and judgement of the end, when indeed no link is necessary between them. A paradoxical situation rises—certain scientists can work best when working for the defence organisations, yet they perhaps feel they must condemn the policies of their State. Their refusal to participate gives them only moral peace, for the State is powerful enough to continue its work without their participation. Scientists certainly have the right to criticise the conduct of the State which draws benefit from his work ; if he finds himself in radical opposition to the policies of the State, it is right and perhaps even his duty to fight and oppose. In a democratic society scientific community like any other community will seldom speak with one voice and refuse to work for the State. Some of them will hesitate to press forward their refusal to serve, for fear of the dangers to which the State may be exposed as a result of their refusal. Thus the scientific community is impotent—only some of its members act legitimately like other citizens. The scientist's special knowledge does not measure to the influence that he exerts on decision making of the State. Many pressures work to make him conform. Funds for research are always limited, and in absence of other patrons, the State holds most of the power to allocate. Scientists have to convince the State to receive their share of funds. The difficulties of comparison between the intrinsic value of their programmes and the plethora of radically heterogeneous considerations make the relationships between the scientists and the State ambiguous. Because of importance to Defence, modern science has become an affair of the State. Aron expressed the hope that the thirst for reason and the thirst for power would never be confused ; but he said also that perhaps the word reason does not have the same sense according to whether it is question of agreement among researchers or a compromise between opponents. The meeting of scientists discussing scientific problem is an act of faith in the universal vocation of Science, the affirmation of a com-

munity divided by frontiers but united in spirit. Science carries with it the springs of power, and the State, which has remained Sovereign, have conncealed and delayed the spread of knowledge, some times with good reasons, whereas the peaceful community of scientists refuses on principle to keep secret the knowledge once discovered. It is the duty of scientists to set aside political conflicts, whether great or small, and freely exchange ideas. Scientists must safeguard as far as they can, the transnational city whose freemen they are. This city knows the quarrels of different schools of thought, even of vanity, but refuses the conflicts of nations as defined by their frontiers.

Prof. Aron's comments are very relevant for India, where at the beginning the Government had organised Science to meet its specific needs. Later Science flourished on donations of funds from nongovernmental organisations and private charities. Today, after independence, the State is again supreme so far Science is concerned. There is hardly any scientific organisation today in India, which does not depend on the State for its very existence. Many institutes have socalled autonomy; but such controls operate making the autonomy ineffective. Also research equipments are difficult to obtain necessitating a rigid control by the State of their distribution; scientists therefore have to spend most of their time away from their true vocation, lobbying with the authorities for favours and pittance, trying to prevent their projects from being lost in the bureaucratic jungle. This is a demoralising way of life and the scientists very soon slide back in their own special profession and usually become mere dilettante in their respective fields.

Prof. O. Maalϕe examined the evolution of the delicately balanced controlled systems operating in biological systems like cells which are responsible for making these systems work at a maximum efficiency. The purpose of the control loops is to ensure that the cell at all times produces just enough of any particular enzymes. Each control mechanism requires that in course of evolution a new protein is introduced in the assembly of cells whose function is to turn on or off a particular enzyme in the cell. Each of these control proteins must itself have evolved, and through mutation and selection, acquired that particular sensitivity of control element, enabling the cell to optimise the production of the enzyme it controls. Thus in course of evolution one specific control mechanism after another was introduced in the whole system, and Maalϕe felt that some particular feature of the system as a whole has been governing the selection processes through which the little control loops in the big net work have approached the sensitivity needed for the whole system for maximum efficiency. It is difficult to say what this specific feature might be. Effect of drugs and antibiotics on the cell affecting some particular function of the cell may be used to make guesses. One must look for some feature of paramount importance in the system round which everything is organised, and if such a feature can be identified then perhaps eventually one can understand and even modify the system. Then Maalϕe took a big jump and attempted to project this conclusion from cell organisations to the complex social structures of higher forms of life

including man. He considered the transmission of knowledge from one generation to another and the process of learning and communication, within the structure of which there is a large number of controls on the behaviour pattern of Society. Legislation or adoption of rules of conduct introduce one form of control after another, which together define the actions and reactions of Society. Patterns of controls evolve very slowly ; to dramatically and quickly modify these is perhaps the greatest challenge to man. This is particularly so, as the result of a slow evolution the controls are deeply embedded in literature and history and indeed in the very language used to transfer these controls from one person to another. Language has become loaded with meanings and associations from which it is hard to escape. One particular control that has been seen to operate in the last three or four centuries of western civilisation is that implied broadly in the word conquest—conquest of ideas, of territories, of power. During a crisis, the solution used to lie in expansions—for people to go elsewhere and start again. But as Katchalsky pointed out, open systems become closed in course of time, and very soon such solutions are not easy. Conquest has to be deemphasised since it can no longer work with freedom or recklessness. Finally Maalϕe commented on teaching. The heavy expenditure that USA or Europe are prepared to make to bring up a person to a certain level of knowledge, indicates that there is advantage in doing so. It would be good if other countries also could do this. But actually what happens is that the developed countries purchase persons from outside and swallow them into their *status quo* system, which is evidently undesirable for the Third World.

Maalϕe has described some of the controls operative on Society ; but he does not explain what is to be done for preserving the atmosphere of freedom that scientific work needs from the controls which the Society and the State wish to impose on these activities for a variety of reasons by a variety of means at their disposal. Such controls tend to increase rather than diminish, at least in the emerging countries. In order to work collectively in harmony some kind of self control is certainly necessary by way of discipline for the scientists in countries like India, where resources are so inadequate. But scarcity has only resulted, so it would seem, to a mad cannibalistic struggle, which is threatening the very existence of Science in this country.

Prof. D. Samuel discussed the emerging field of Brain Research, a potentially dangerous field. The field is also called Psychobiology ; it has large contents of Physics and Chemistry and is of obvious significance among the public because of a growing fear that the results of such research would ultimately control the individual will. Such attitude, Samuel felt, was antiscience and even antiintellectual in the sense described by Katchalsky. Part of reason for the reaction is the growing disappointment in Science and the rise of Drug Culture, particularly in the western world. Certain chemicals have dramatic effects on the mind, opening "doors of perception" of and closing "doors of reality". The perils of uncontrolled use of drugs, specially that of the addictive drugs are well known. But drugs also alleviate pain, reduce anxiety, and insomnia, control violence and partially compensate

for the loss of concentration in the ageing. The marriage of Pharmacological Chemistry and Behaviournal Sciences produced the science of Psychopharmacology. which has remarkable prospects, in the sedatives and the stimulants, together with drugs capable of suppressing aggression, reducing fear, and perhaps capable also of enhancing specific functions of the brain such as ability to learn and remember. But this is a far cry from changing the complex function of the brain. Drugs alone would not change the mind of persons and make them work against their convictions. Brain washing involves the interaction of two persons, the interrogator and the victim. There is far sharper reaction against ESB—electrical stimulation of the brain, though it is known that only the chemistry of a well defined area of the brain is changed. These reactions arise out of the inherent feeling in the individual of vulnerability and the basic need for protecting one's innermost thoughts and feelings. The public is seriosly concerned with the ability of ESB to change the behaviour pattern of an animal, e.g. to stimulate animals to eat without being hungry. to generate fear and aggresion and even to change social dominance in animals]. Delgado has remarked that ESB is nonspecific and the possibility is remote that the investigator can compel the subject to perform any complex task. Delgado has also stated that whereas one can control things like flexion of a limb, control of a tremor, remembrance or desire to excel, one cannot change by ESB, language, culture, personal identity and free will. Then Samuel turned to the question of brain transplantation and remarked that whereas this has been done in amphibia and parthenogenic fish, the problem is quite different for mammals, where the complexities are enormous, and immunological protections are difficult to overcome, and evidence or nerve regeneration rather small. Another area of public anxiety is Skinner's Operant-Conditioning where, by an ingeneous technical control system, the behaviour of an animal can be gradually altered by a system of predetermined schedule of reward and punishment. It has been possible to get volunteers to study changes in heart rates, alpha rhythms of the brain or even the pattern of paradoxical sleep. all of which are basic functions and which were considered beyond human control. But these also require complex conditioning techniques and a measure of cooperation with the human subject. Then Samuel discussed the question of control of the individual by mass media, where by transmission of selected information people manipulate each other ; education, prayer, rhetoric propaganda, demagoguey, romantic seduction and advertising are typical efforts—all the forerunners of control by information. Samuel did not discuss this any further as he felt that this subject is not yet a Science. On the gain side of brain research is the beginning of a rational approach to alleviation or cure of mental retardation, of many brain diseases and the possible conquest of pain. Many of these diseases are due to genetic faults, missing enzymes and blocked metabolic pathways ; with the acquired understanding, effective controls are being evolved. The possibility is being visualised of direct linking of specific nerve cells to exter-

nal senses, which may herald vision in the blind, for example. The ultimate aim of Psychobiology is of course to understand the brain itself—in adult less than a kilo and a half in weight but using a quarter of the oxygen that is supplied by the lung and the heart. Its energy output is less than 25 watt, but it is the control centre of all functions of the body, instinctive or learned. Unlike many other organs the neural cells operate independently, firing, recovering, spontaneously sorting, storing and retrieving informations constantly. The number of synaptic connections are more than a million times 200 million, the last figure being the estimated number of telephone throughout the world. In order to understand the brain, subtle chemical and electrochemical sensors must be used. These sensors, connected to a fast online computer may ultimately correlate the electrical and chemical changes in the central nervous system with mental activity, and lead to an understanding of the functions of groups of neurons and to a valid model of the action of the brain. Directly affected from such understanding will be many fields including education, evolving new method of absorbing rapidly large quantities of informations and, for example, determining the specific age when children are most receptive to learning. There will be opened many possibilities of expansion of the mind, of memory, of decision making and possibly even of heightened imagination. Samuel believes such research should continue—he is not a believe in moratorium in Science. He feels that it is the duty of scientists not only to determine for themselves what is possible and what is not, but also to pass on this knowledge to the public. Samuel stressed the need of a code like the Hippocratic oath among brain researchers dealing with the ethics of the use of human volunteers for experiments which can be damaging to the brains.

Throughout his address Samuel tried to set at rest the present fears and repugnance regarding brain research ; but since this Science is still at its infancy his optimism may not be entirely justified. The fear will persist, as the urge to dominate is one of the basic traits in man ; the brain research may evolve terrible instruments for this purpose. The ultimate goal of all this work is for man to know himself. For the purpose of achieving a maximum efficiency in a living system Nature seems to have partitioned knowledge among its various constituent parts. Thus the cognitive structure in the mind, which we are accustomed to place at the highest level in the hierarchy of cognitive and action mechanisms of the different organs, has very little knowledge of them and, indeed, of itself, and has to plan expensive research to obtain these informations. With the break down of these isolating barriers, is it correct to assume that the whole system will operate more efficiently? There will be great temptation, perhaps very foolishly, for man to accelerate the pace of modification in himself. Such changes may be irreversibly destructive. Knowledge is not wisdom ; surplus of knowledge has not been entirely beneficial to man and his world.

Prof. J. J. Salomon covers some of the ground examined by Aron and examines the causes of decay in the edifice of science and the growing criticism against

it as to, not what it can do, but to what it is. He recalled that A. H. Duprée had compared the mighty edifice of Government Science of the mid 20th century with the magnificient Gothic cathedrals that used to dominate the 13th century landscape. Here assembled the biggest throngs of the faithfull and it acquired the most effective power of persuasion. Ten years after a period of unprecedented growth, the Cathedral of Science is showing cracks everywhere. The Right attacks it as a costly pastime of the mandarins, who care nothing for economy of return or industrial development. The Left attacks it as an instrument of war and industrial domination, which does not meet the real needs of Society, satisfying only imaginary needs. Our civilisation is based on the assumption that progress of knowledge is good, because it liberates, and by its very essence, it benefits mankind. But the triumph of rationality has led to reason becoming the support of the irrational. There is a growing fear today of the consequence of scientific discoveries. Conquest of atom leads to terror ; escalation of military power, far from saving society threatens to destroy it ; discoveries of Molecular Biology threatens the manipulation of heredity. There is confused talk of a moratorium on discoveries and a return to the idyllic state of Rousseau's man. Salomon also felt that moratorium is absurd ; Science has history and history can not be stopped. Research has become, whether the scientists desire it or not, a political affair. The ideology of Science forbids thinking of it in the unequivocal terms of politics, for discourse of Science is neutral guaranteed by the objectivity of its method, which requires rigour, attention to facts and respect for proof. The fight against authority, religious economic or political, is no less a part of Science than its theories and discoveries. Bacon's axiom "Knowledge is Power' does not mention the difficulties such associations might involve. Effectively Science is neutral only in the ethical plane, apt for good and evil like Aesop's tongue. Bacon foresaw some of the problems that would rise ; in New Altantis he said that scientists will reserve the right to decide which discoveries can be revealed to the State. But he did not mention what would happen if the State decides that some of the discoveries are too important to be made public and that Science is too important to be left in the hands of scientists. A political character of intellectual approach does not rule out the patronage and subsidy that scientific societies demand from the State, on the basis of independence from it. The resulting tension has become serious and dramatic only in our century, because sciences today have become social institutions, not necessarily governed by pure reason. Governments feel Science is a national asset, a decisive factor in the balance of power, and an indispensable tool in the exercise of the government itself, and infact, Science has become indispensable if Governments have to meet their needs. Science operates in the political domain, because it cannot do without the State, for no private foundations can bear today the cost of capital investment that are needed for it. This growing dependence of Science on the State, has led to the policy for Science being inseparable from policy through Science. Scientific research has to pay a similar price for the links it maintains with the Industrial system.

As the source of innovations, rapidly exploitable, it forms an integral part of the production system. This aspect of utility, which Science has preferred, may be considered to be a kind of prostitution of its ideals and a betrayal of the ends and interests to the extent that it should be concerned with pursuit of truth. Salomon uses the word Technonature to denote this area of interaction of Science with Authorities, recalling Galbraith's use of the word Technostructure. Nature of modern Science and the structure of the industrial systems make the scientists inevitable partners to politicians; there is no need to think of a conspiracy between them. All fields of scientific research fall under Technonature. The institutional dependence of Science does not mean that Authorities can easily or effectively alter the content of Science. Scientific institutions are sufficiently strong and well organised to prevent this with help of the international recognition that is given to them. What the authorities can do is to restrain Science from appearing in public discussions, by screening part of its results and or distorting their meaning. But even though political authorities cannot tell scientists how they should search or, a fortiori, what they should find, everywhere they aspire to tell them what they should look for. The characteristic of this new partnership between Science and Politics is that their possible conflict lies no longer on the plane of truth but also on that of performance, though the later plane is unsuited for demanding from pure research an account of itself. It is not possible to isolate the type of scientific research which is immune from all pressures from Society. A strict frontier between pure and applied research can not be drawn. All contemporary research is a constant coming and going between the concept and the application, and today the distinction is a matter of psychosociology. The ideology of Science proclaims the autonomy of research, just as the consumer is declared the sovereign in market economy. In actual practice market economy does not function freely ; so also the scientist has to take sides when he agrees to work on a programme depending on support from the State. The natural discourse of Science declines all responsibility for the use of the results of Science ; but it is these very results which make Science legitimate to Society. The end of the laissez—faire in the relations between Science and Politics means the emergence of scientist as an ambiguous species in the genus of political animals—the ambiguity rising from the denial of belongings to the genus. The dilemma rises because the scientist proclaims himself outside politics,but is caught in the trap of responsibility, leading to a personal choice between the impossible mission of acomplishment without support of Authorities, and the compromising of that mission by the support it receives. The scientist, who questions himself the consequences of his work, cannot evade his responsibility. It is not enough to search, the real problems begin only after. It is too convenient for scientists to shut themselves in their laboratories, and not face the fact they are both producers of consumers of social change ; consumer because they depend on the wealth given to them from the community ; producer because they transform the wealth into discoveries which are factors of

change. This however gives the scientist no competence in the political field, for his competence in his own field gives him no greater authority in any other field. In fact in political fields, scientists often have a certain naiveté in thinking that value judgements and ideological options can be reduced in clear and precise terms. The sole foundations of his social responsibility is that he is better armed to throw light on the problems connected with the role of Science. Today knowledge cannot be distinguished from its consequences, and so there cannot be Science without Conscience. Since Technology is wholly dependent on Science, it is the function of the scientist to be the conscience of Technology, to inform, to educate and to warn against misuse. It is only thus the priests officiating in the Cathedral of Science will cease to be confused with the merchants, magicians and time servers. End of laissezfaire of relations between Science and Politics does not mean there will be unlimited freedom to innovate. It is a matter for the scientists themselves to contribute to the control of technical innovation, i.e. to bear on the political institutions to ensure that the criteria for support and exploitation of Science are not based solely on output, profit and short term prospects.

In India the Cathedral of Science is showing crackers even before the structure has been completed. It is not that Society and the State have ceased to have faith in the scientists and their skill; on the other hand there seems to be too much of uncritical belief in their skill. The habit in the country is to heap praise and prizes on success; usually the reaction soon sets in going to the opposite extreme of despair if in course of time the initial optimism seems unjustified. The life of scientists is not easy or their working conditions favourable. The hidden restrictions imposed by the funding authorities and the scarcity of equipment prevent the scientists from making worthwhile contributions leading to a pervading sense of frustration among them. The desperate economic malaise pervading over the country generate a constant feeling of insecurity. The desire is there to make a giant jump to bring the country in level with the West; success of such a transition does seem somewhat doubtful because of the uncertainties of the necessary support, lack of efficient management and the absence of unity of purpose. So far Technonature is concerned, Indian scientists have been rather timid. Scientific societies, because of the dependence of their existence on State funding, have not been able to advise the State with boldness and vision, or to organise the management of scientific endeavour in the country with any degree of success. Industries have been reluctant to use the processes developed by the Indian scientists and technologists because the market is one of scarcity, which does not encourage competition, and also because they are satisfied with rather short time gains brought about by doubtful foreign collaborations and imports. The search for our natural resources has yet to be carried out with the thoroughness it deserves; traders have been allowed to export resources that are so badly needed for internal consumption, in order to earn the foreign exchange to pay for the imported technologies, some of which perhaps we can do without. All this shows that the problems of the developed

countries in the West are completely different from those of countries like India. The end of laissez faire relations in Technonature is no where in sight in India.

Prof. M. Feldman's aim was to outline certain aspects of the impact of modern Science on the political structure of the western society with respect to the present, and even more to the future crisis of democracy. History of the western world has not followed the predictions of great scholars of the nineteenth century. Marx claimed that the capitalistic society would be faced with rhythmic crisis of increasing frequency and strength and would collapse even without the direct intervention of socialistic movements. This has not happened as a direct result of the dramatic development of Science and Technology with the consequent outburst of production increasing the purchasing power of the workers, and consequently decreasing the appetite in them for social and economic revolutions. The ideological difference between various parties in different countries has vanished; since political ideology is no longer related to actual decision making, the elector cannot predict the decisions of his elected delegates. He can publicly protest, but he cannot influence the decision making apparatus. This loss of predictability has important sociopsychological implications. In midst of profound changes in the last fifty years in all spheres of human activity, the democratic decision-making apparatus has remained invariant ; the basic dogma in this apparatus is not that the majority can be relied on to make the right decision but rather that by definition, the majority decision is the right decision. Today the choice is no longer between the political doctrines but between alternative methods and techniques for achieving the same goal ; these are matters for Science and Technology. Does the dictum that majority decision is the right decision still hold, or does Democracy need to change its operational tools ? Recent history of Western Europe shows three distinct eras : (1) Era of struggle for equal civil rights, (2) Era of struggle for equal distribution of capital and (3) Era of struggle for equality of know-how which is just starting. Know-how rather than rights and capital will determine the successful leadership in a technological world. So far know-how has not been a factor for choosing political leaders for whom a broad education was considered enough. Since now know-how is emerging as an important factor, the problem is now how to educate the leaders in the sophisticated and complicated know-how, and also how to make possible the participation of the individual in the decision-making. Feldman then turned to the role of ethics in decision making. Ethics has no objective criteria whereas Science is based on two principles which has ethical values : (1) Science develops in a non-authoritative way, (2) Science thrives on free information exchange and communication, i.e. the progress emerges not out of a choice of moral principles but on the methodology of Science. What will then ensure a humanistic or ethical considerations in decision-making with regard to all other components of our life in an era when these are no longer the basis of political operations. Man's behaviour both at individual and social level is genetically determined. Feldman felt that ethical

choice in a scientific world is an open and pressing problem; for this choice we may have to act against some of our genetic preconditioning.

In India there exists one of the largest democracies in the world. Today after 27 years of independence, signs of growing disappointment in Democracy is becoming more and more felt. There is a realisation that the election precedure no longer depends on the intrinsic quality of the persons offering themselves for election, but on the other factors like the political status of the parties that may be persuaded to provide the support and the funds. The elected representative cannot preserve his independence of action or judgement in his work in the legislature. The electorate gets disappointed by the mounting problems facing the country and realises that it has no control on its elected delegate. There is only one instance when public demonstration forced the dissolution of the legislature when the government failed to administrate effectively the state concerned. We are perhaps still some where in the eras (1) and (2) described by Feldman, and consequently we are going through all the traumatic experiences that the western countries have already passed through. The necessity for know-how is not yet considered of sufficient importance for the scientists and technologists for them to be able to play any role in leadership or decision-making in the affairs of Society.

Prof. V. F. Weisskopf summarised the Symposium by observing that in his opinion Science has attained the status of adulthood whereas he doubted very much if the scientists have. For the first time Science is on the defensive. The first attack states that Science is an expensive luxury, the expense justifiable only if it led to practical applications for the Society and the State but not if it is study of for its own sake. Weisskopf brushed aside this criticism by refusing to believe that Nature Science is any more expensive than many other fields where money is spent. The second attack is that Science is the source of industrial innovations which lead to deterioration of the environment and to an inhuman way of life ; the logical conclusion of such criticism is the Moratorium argument. Weisskopf believed that here the main point is not a question of stopping Science but of changing it. The long range effects of the innovations were not accounted for, partly because no attention was paid to them, and partly because the essential knowledge was lacking. The pace of discoveries was so fast that it created deep social and psychological consequences whose correct description and formulations have yet to be made. It can not be expected that every scientist must engage himself to these problems. Weisskopf hoped that there would be people who would take up this field in a professional way and study deeply about these matters. For such people very intensive training is still needed in the basic sciences ; one can not replace this system by anything else. The value of Science of course goes beyond its mere use for solution of the problems facing mankind. Why is it then that Science is suspect today, feared despised and attacked, as some thing alien ? Weisskopf believes that there are two reasons for this. The first one is the arrogance of Science with regard to its universality ; the scientist is apt to forget that though Science is universal, it

does not transcend everything. The second reason is in the distortion of Science by scientific establishments ; people forget about the mystery of things and just look on Science as a technique for producing new results. Science has become complicated ; one needs to be a virtuoso in its techniques, and in the process he forgets the main purpose of which is to find the laws, to generate an awareness of the world round him. Weisskopf emphasised his belief that basic and applied sciences belong together ; Science has to be considered as a whole. Weisskopf compared the organisation of Science to a tree, the basic science forming the trunk, the older ones situated at the base, and newer ones near the top, where new growths take place. The branches represent the applied activities which emerge from all the basic sciences. To care for the tree, one cuts the branches, which are no longer healthy, but one does not cut the trunk. The type of pruning necessary raises the question of priorities among various sciences—a very difficult question to answer. Weisskopf ended by ridiculing the attempts of those who try to draw up programmes for a specific number of years, for he feels that this exercise leaves out the unexpected from consideration, which is the main essential thing of the basic sciences. Science cannot develop unless it is pursued for the sake of knowledge and used intensely and wisely for the betterment of humanity. Two powerful elements: curiosity and compassion, Weisskopf said, should work together ; each needs the other to lead to a better human existence.

Prof. Sabin spoke again and brought the Symposium to a close. He referred to the different kinds of fears pervading the world—the fear of Society about the consequences of biological research, the fear of the scientists about a possible loss of freedom. Sabin believed that scientists need have no imparative necessity to be greater humanists than other people ; all that should be demanded is that they do good work. In his opinion the question today is not over production of scientists but of under-utilising them. He then reviewed the speeches of the earlier speakers. He concluded by quoting from Aristotle to the effect that search for truth is easy because no body can miss it wholly, and hard because no body can master it wholly, the ultimate grandeur comes from the work of all. So a significant solution to the problems would emerge from the sum total effort of many people, With regard to the Moratorium question Sabin said that he did not believe that there had ever been such a thing in Science. Moratorium could acquire some meaning perhaps in the sense of balancing between priorities. Sabin stressed the point that the world can not survive, with one third affluent while the remaining part goes on the road to perdition. To solve problems facing the world, no new research is necessary ; the solutions from Science and Technology are already there. What is needed is manpower, capital and organisation, and the replacement of competition by cooperation. This is a challenge that has to be taken up by the new humanist scientists, and they have to be trained and inspired with a new sense of dedication. The knowledge and the power is available but Science and Technology can not act alone. All must work together and the things must be changed soon before it is too late.

What does all this sum up to ? The Symposium certainly demonstrated in a very effective way, the concern of the scientists about their role in the emerging Society, their fear about the loss of their freedom vis-a-vis the State, which is still supreme, and their anxiety about the incompletely known moral aspects of the consequences of their work. These problems are presenting themselves in different ways in different countries, needing urgent solutions if Science has to be saved from extinction. As Katchalsky pointed out Man has incomplete determination and has to select from many possible choices. This makes his personal behaviour and the character of the Society, he belongs to, quite unpredictable. It is difficult to make any predictions about whether the overwhelming boody of knowledge, that is becoming available to him, will give him wisdom to organise more harmoniously the closed system he lives in. Atleast there is a growing awareness in the mind of the scientists of the various kinds of problems that is appearing and will appear in future,about the nature of their work, its possible consequences, etc., in fact about the entire role that they would have to play in the destiny of Man. In the coming years there will be many more discussions, and it is very much to be hoped that some thing definite may emerge ; at the present moment the whole matter is rather vague. The Symposium shows that it is not that the problems are not known, but the question is rather to work out the solutions which are appropriate for the Katchalsky's closed society. And, further, it is not only that the preservation of Science and regulation of its consequences is the question before Man, but that these are only a few among his cultural activities that have to be saved and consequences examined.

A. K. Saha

South Asian Archaeology. Ed. Norman Hammond, Foreword by Sir Mortimer Wheeler, 1974. Pp. 279+Plate and Figures. Noyes Publication, New Jersey. Price 20 dollars.

Three years ago a few archaeologists interested in South Asian Archaeology met at Cambridge in one of the First International Conferences solely devoted to this topic. As Sir Mortimer Wheeler says in his Foreword the representation actually from the orient was less than adequate. Still we should be grateful to the organizers and to the participants for reviewing the state of knowledge and drawing pointed attention to some specific problems. F. R. Allchin tells us how very little attention has been paid in India or outside to the rise of the cities in North India during the last millennium B.C. This and all ancillary questions can be properly studied only if sites like Kausambi, Mathura and Ayodhya, to mention only a few are horizontally excavated by a team of scholars. We should not only have merely an idea of fortification, but layout of the city at different periods. And for this all the three sites would give more than ample opportunity. What is needed is a well thought out plan and dedicated excavation. Unless this is done we shall be touching merely the fringe of the problem, and any number of seminars and models will not make us wiser. Dr. G. K. Corvinus' paper on the Acheulean site at Chirki-Nevasa needs to be supplemented by a preface and a postscript. First she was entrusted with this project under very special circumstances, and then it was made a part of the project for the search of Early Man, originally planned by Dr. M. R. Sahni and the Deccan College and executed with the funds supplied by the Council of Scientific and Industrial Research (CSIR). An inspection of the Chirki site discovered by Dr. Corvinus gave hope that it might turn out to be a true camp site of Early Man. Several seasons of excavations, first by Dr. Corvinus, then by Dr. R. S. Pappu and Dr. Z. D. Ansari, Dr. M. L. K. Murty and the reviewer, showed conclusively that the site was a factory site. Unfortunately no evidence in the shape of boulders kept for a windbreak or any such contrivance could be detected by most careful work. However, our subsequent work did prove that the few tools of jasper, chalcedony and such fine grained materials were not indeed contemporary with the larger tools—handaxes and cleavers—made on varieties of trap. Hence we should not regard them as light-duty tools of Early Man. These indeed belong as now proved stratigraphically and also typologically by the excavations at Patne by S. A. Sali, Bhimbetka by V. N. Misra and V. S. Wakankar and Guptesvar near Gwalior by B. B. Lal. The few pieces found at Chirki have indeed filtered through the thin capping of the Early Stone factory site.

Andrew Goudie's paper on the "Environmental background to early man in the North-western India : The geomorphic evidence for climatic change" makes some large conclusions on very inadequate data. Secondly, even the work already done has not been consulted or wrongly interpreted. For instance, Misra's work

on the Luni, in Western Rajasthan seems to have been missed by Goudie. What he suggests, viz. to examine its alluvial sediments for artefacts, was done by Misra who collected a large number of these (1961). This work has shown that the Luni some 15 year ago did not have the Early Stone Age or it came up only during the Middle Palaeolithic times, and then got choked up by sand dunes. Even then these sand dunes were lived upon as shown by Misra's subsequent excavations at Tilwara and Bagor. This also confirms the reviewer's earlier work for several seasons at Langhnaj. In view of all this one fails to understand Goudie's statement that "microliths were never found within a dune" and the further conclusion that "Mesolithic man arrived after the aridity had largely ceased." (p. 31). What we might reasonably say is that the Mesolithic man had come to live towards the end of the dune phase in Gujarat and Rajasthan, because the microliths with three occupational phases are found within the top 5–6 feet at Bagor and so at Langhnaj.

Bridget Allchin's recognition of the blade and burin tools in the excavated debris of the Sanghao cave, near Mardan, N.W.F.P. Pakistan, is interesting, because it gives us now the northernmost point in the rapidly filled up map of this industry in the sub-continent. Recently the reviewer has covered (1974) the entire ground, and grouped the existing industries into "classical" and "sub-classical;" probably both the *Sanghao*, the *Visadi* and the unpublished *Belan* industry would fall into the latter group. I. C. Glover follows up with a useful recapitulation of the much confused, dispersed, and very much inadequate evidence from the vast area of Southeast Asia, that is Eastern India to Australia. Here some work has been done in Thailand and Cambodia, with very early dates not only for rice, but even pottery, whereas in Australia the Stone Age industries and even cremation go back to about 25,000 predicated But as Glover rightly points out as long as Burma, Sumatra and Java are archaeologically unknown, no tangible links can be postulated between the various regions.

L. S. Leshnik attempts a very intelligent and painstaking comparison between the methods of "Land Use and ecological factors in prehistoric Northwest India" and the present (before 1900), and comes to the conclusion that "Harappan socio-economic organization was predicated upon the production of a grain-surplus," a thing they could do only in Sind and the Punjab, but not east of the Aravallis, where the agriculture was entirely dependent upon dry farming techniques, mainly due to the moisture retaining of the blacksoil. Hence most of the chalcolithic sites are located on such a soil. In fact this reviewer had called these "Black Soil People" as far back as 1953, (Sankalia 1953) an inference based on the limited evidence from Brahmagiri, Nasik, Nevasa and Navdatoli but proved to be indeed prophetic and true. However Leshnik's further conclusion that "None of the peninsular rivers lend themselves for irrigational use in palaeotechnic systems," because the monsoon rains is insufficient for the water to top their banks is not

right. The river floods are at times very heavy, and the rivers do overflow their banks. And it is to guard against such a contingency and also to store the water so collected for irrigation purpose that at Inamgaon, a 1000 ft. embankment was built with boulders on the northern side of the mound, and a channel cut in the murum (disintegrated trap rock). This embankment can be dated to about 1200 B.C. Leshnik's contention that the Lothal's large brick structure was a storage tank from which water was drawn with the help of a *shaduf* for irrigation purposes I have discussed at length in my book (1974). It may be mentioned that inquiries in Kutch and Saurashtra reveal that the *shaduf* is used today for this purpose in the case of *small wells only* and not large tanks. There are other difficulties also in accepting Leshnik's suggestion.

B. K. Thapar presents some new traits in the Indus Civilization as revealed by the excavations at Kalibangan. He also tells us that this civilization appears quite "suddently," and hence should be regarded as colonization, according to the reviewer, and not indigenous development. Secondly, the few new religious traits such as "fire altars" were not noticed before at Mohenjodaro and Harappa; conversely the sites Kalibangan, Lothal, Kot Diji, Surkotata and Gumla have yielded no *lingas* and female figurines like those from Mohenjodaro. Thus there seem to be regional differences in the religious practices in this civilization. Again at a site like Kalibangan one may learn how life in the citadel was different from that in the "Lower Town." So far these are distinguished only architecturally, but it behoves us to look for specific human activity differences, and this can be done only by careful contextual study of finds. To such a study we now look forward (though the fear is not unwarranted that this time both the Harappans and pre-Harappans will be once again deserted.)

Rafaello Biscione discusses the nature and time of Urbanization of Sistan and Southern Turkmenia on the strength of Namazga III type pottery (sherds only) in the earliest layers of Shahr-i-Sokhta. On this limited evidence he comes to the conclusion that in the Chalcolithic period Southern Turkmenia was perhaps a secondary centre of civilization. It was the farthest point reached by the Mesopotamian influence, and later it was also the farthest point reached by the trade of the Indus Civilization. Thus from our point of view Namazga V is important.

As a continuation of this topic Dr. George F. Dales' paper on "Chronologies for Protohistoric South Asia" is important. For with the readjustments of radiocarbon dates proposed by Michael and Ralph with 5,730 as half life, archaeological parallels between India, Afghanistan, Sistan, Southern Turkmenistan, Iran and Mesopotamia are better established than with the unadjusted dates. This "date hike" or "inflation" would place the mature Indus Civilization between 2551 B.C. to 2725 B.C. and its end about 1900 B.C. For archaeologists at least inflation (of dates) is always good and welcome.

J. M. Casal's excavation at Pirak, West Pakistan warns us how misleading surface pottery can be. Pirak instead of turning out to be the earlest site has now provided the earliest date for iron between 575 and 610 B.C.

From the point of view of technology (to which this journal amongst other subjects is devoted) the paper by Mr. Marcello Piperno is most useful. It discusses the excellent data provided for microdrilling at Shahr-i-Sokhta (Sistan) for the making and use of the lithic drill-heads. The evidence supplements and corrects in essential particulars that gathered by Mackay some 40 years ago from his excavations at Chanhudaro and utilized by the reviewer in his *Some Aspects of Prehistoric Technology* (Sankalia 1970). Contrary to what Mackay thought it is now found by a detailed analysis of several of these instruments which still have retouches on their surfaces that they were used as drill-heads independently of the polishing of their own surfaces. The point of some of these tools shows the beginning of a rounding and bevelling of the flaking, probably through their being gradually worn down as they were rotated against the object being drilled (Pl. 9.1).-Pipernos' experiments on the drills also showed that the wear was fairly evident and not slight as Desch's experiments using emery powder and water had indicated. Further, another experiment showed that the use of the tool for drilling deeper holes would spread the wear over the used part and give it the characteristic smooth cylindrical form. The wearing down is apparent to the extent of the depth the drill reached in its boring. (Fig. 1).

Piperno has also attempted to explain the minute hemispheric depression visible at the centre of the tips of many tools (Pl. 9.1). Mackay thought that the cavity probably served to hold some type of abrasive. This is most unlikely con sidering the size of the depression. Hence taking help of the presence of a helicoidal bronze drill (which required a continual rotating motion) from Lothal, Piperno think-that the fundamental innovation in drilling technique had already been introducel in Sistan by about 200 B.C. And noticing the perfection and regularity in the drilled holes, we can explain how the depression was formed by considering the mechanical laws of the movement made by the drills. The cutting speed of a drill that is its rotation round its own axis is in proportion to the distance of the rotating axis; therefore it is theoretically nothing in relation to the height and greatest in relation to the periphery of the axis. Because of its small speed in relation to the height, the Shahr-i-Sokhta drills meet their greatest resistance from the object they are boring right at the central part of the tip. Consequently they suffer, particularly heavy use at this point which could cause the formation of such a depression, and this heavy use that is probably further increased by the considerable heat created at the area of major friction. (Fig. 2).

This explanation is strengthened by the fact that the depression has been observed on some of the used drills, those employed for a longer period, whereas it is invariably absent on the little used pieces. (Figs. 3, 4 & 5).

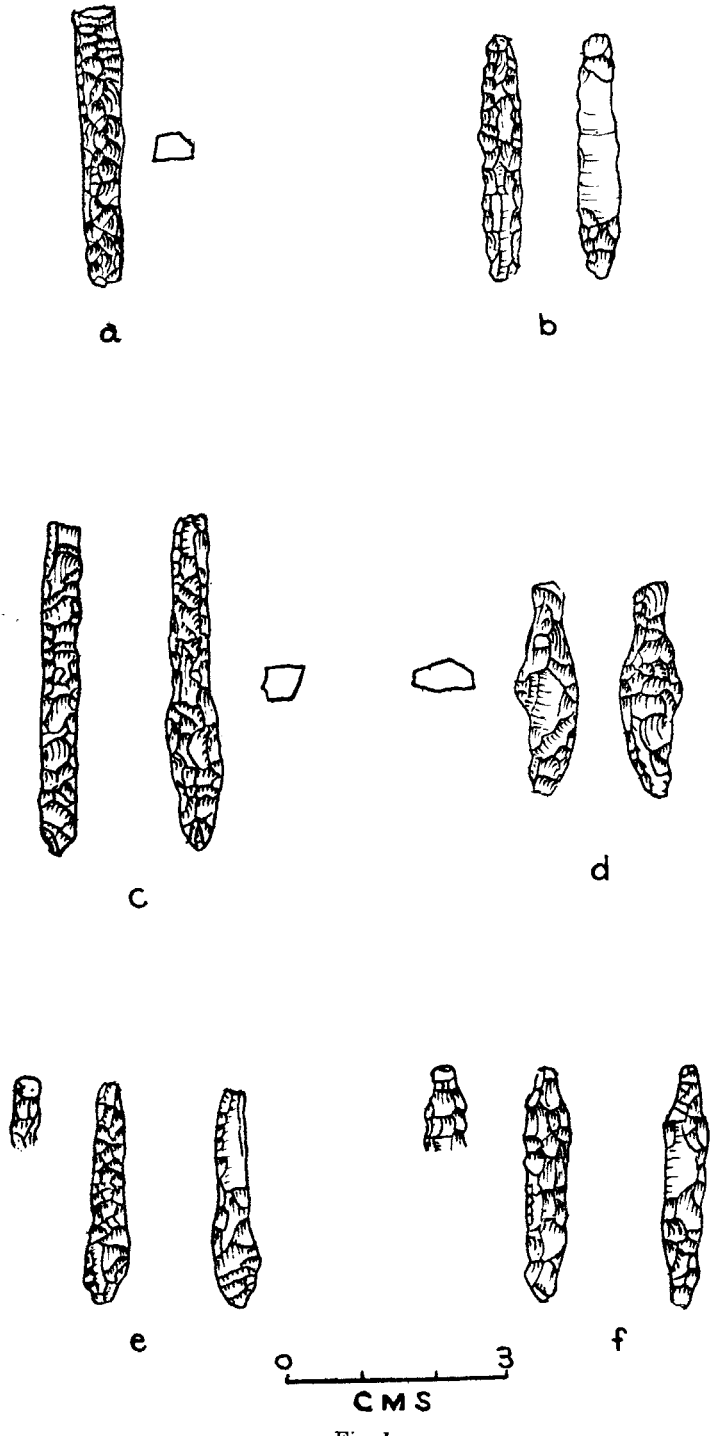

Fig. 1.

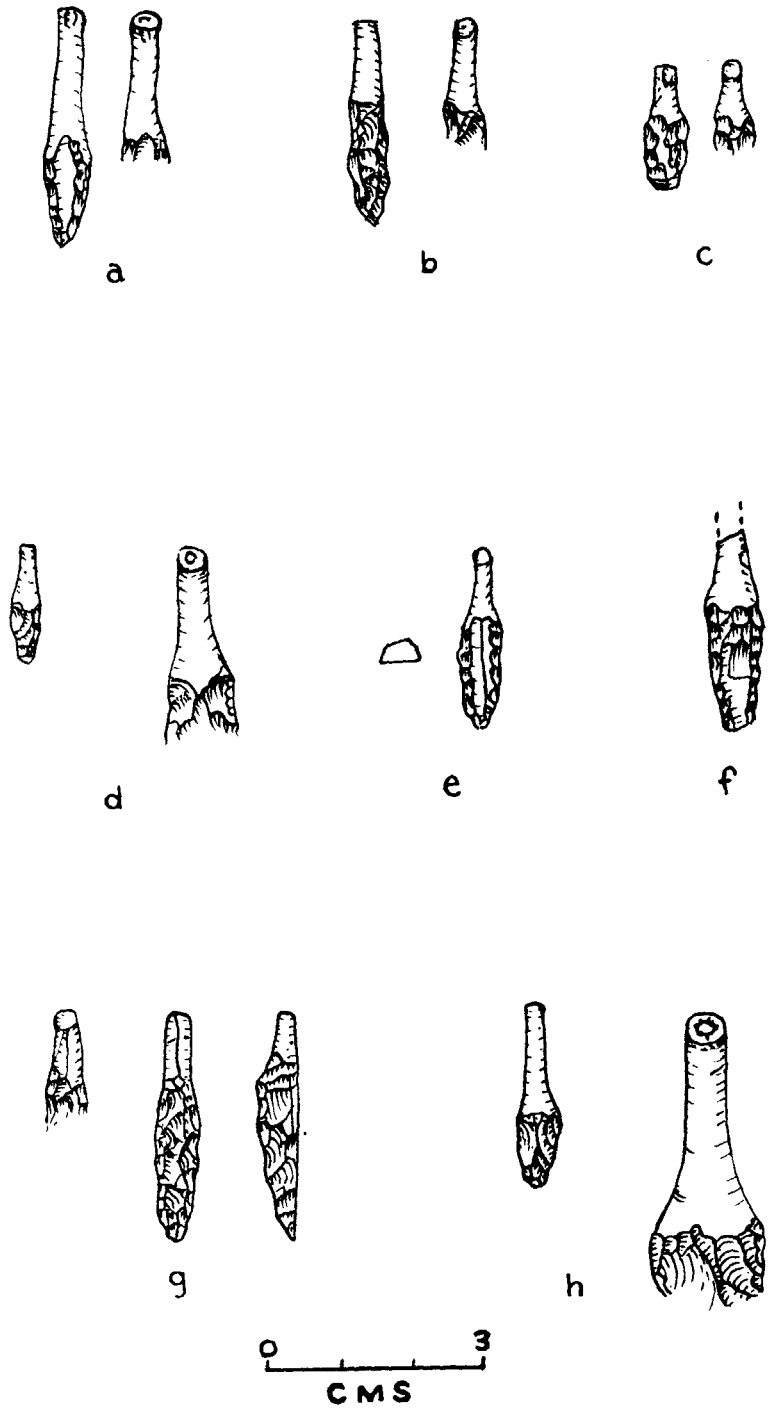

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

All this discussion has been cited here not only with a view to help other scholars to have an insight into the technique of making of beads, of semi-precious stones, but because the number of such drills at Shahr-i-Sokhta shows the part this industry played in the economy of the site and elsewhere. For such drills can now be recognized in our collections from Nevasa, Navdatoli and Inamgaon. And besides bead-making Shahr-i Sokhta specialized in manufacturing steatite and alabaster seals. This was as follows.

"The tablets, varying in thickness between 2 and 4 mm. and that were used for the seals were first reduced to the required shape, often triangular or circular, and all the surfaces smoothed. The geometric motif was then cut on one side with a series of holes about half the thickness of the particular tablet. After the outline of the design had been cut in a series of perforations close to each other, it was sometimes finished off by evening and polishing the holes so that almost no remains of the drill." In the circular seal reproduced in Pl. 9.4 the traces left by the drill-heads

Fig. 6.

show more than 15 perforations. And probably the wooden tablets with a series of irregularly placed holes could have been used to support the beads during drilling (Fig. 6).

It is rarely that such interesting and revealing details about an ancient technique are found in an Indian site. Even the wooden tablets have survived because of the extreme aridity in Sistan today.

Klaus Fischer's paper "Archaeological field surveys in Afghan Seistan 1960–70" continue the story and brings it down to medieval times. These surveys brought to light several mudbrick Islamic and pre-Islamic monuments, sometimees in their skeletal forms, and now almost submerged in masses of sand dunes. The photographs and the maps which accompany this paper are very educative.

J. F. Enault and J. F. Jarrige discuss the significance of the Chalcolithic four in the Bolan area of Baluchistan.

Georgio Stacul discusses a very interesting likely relationship between the cremation graves found in the rock-shelter near Ghaligai, North West Pakistan with the pottery—particularly terracotta box-urns, and urn with bosses and holes—from the cremation graves of the Hungarian Plain, and the likely folk migrations these comparisons suggest, if established by finds from the vast intermediate areas.

Maurizio Taddei's identification of the pieces of a large terracotta female from the eighth century Buddhist Vihara with that of Mahishasuramardini is not only interesting, but artistically it is one of the finest pieces of Indian Art, and hence printed on the jacket. It is also noteworthy for the fairly well-preserved polychromy. "What is not clear to me in the crescent-shaped *Simantaka* hanging above the vertically placed third eye". Is this the "the third eye" ? or "the Kumkum mark"? For such a third eye only Parvati could have besides Siva.

Apart from this iconographic detail, the figure rightly raises the problem whether it is a simple intrusion of Hinduism into the prevailing Buddhism in Gandhara, or whether it is a symbol of Hindu Buddhist syncretism, or whether it is an indication, with some figures cited by the author from Afghanistan of the emergence of Tantric Buddhism—*Vajrayana*—in this part of India as well ? From this point of view the various explorations in Afghanistan as well as the excavation by the Japanese at Tapa Iskankar, north of Kabul are most welcome.

David W. MacDowall tells us that 9 coins (2 silver, 2 copper and 5 copies) of Azes from Shaikhan Dheri, near Charsadda, though useful for throwing light on some aspects of Kusana rule, are not useful enough for deciding the question of the initial date of the Kaniska era.

J. C. Harle discusses on the strength of the newly discovered sculptures (Jina figures) of bearing the name Ramagupta from Vidisa, the question of the relationship between the Late Kusan and early Gupta art.

David Whitehouse offers a preliminary account of the earliest Chinese stoneware found in the excavations at Siraf in the Persian Gulf. This was a leading entrepot in the ninth-tenth centuries A.D. Four kinds of ware were found from the platform of the Great Mosque. So far as known to the reviewer such wares have not been found in India, or if found have not been recognized. These wares are likely to be found in the seaports on the Western Coast, Dwarka, Prabhas, and

ports on the Konkan and Kerala coast. J. E. van Lohuizen-de Leeuw very briefly narrates the recent discoveries of the historical period in India. Of the various discoveries, comments are offered on two only : discovery of a *mandapa* at Guntapalli in A.P. This was probably originally Jaina and later taken over by the Buddhists. Similar was the story elsewhere, for near Poona, where all the caves are known to be Buddhist a cave bearing an inscription in the characters of the first-second century B.C. was found on the hill overlooking the village of Pale. This is extremely significant in fact the first of its kind in Western India (though Professor Leeuw has missed it).

The second is the discovery of a rock-cut cave in Wynad, Kerala bearing prehistoric sculptures. I happened to see this cave, it is a natural one but on either side of its wall it still bears deeply engraved figures, animal, men, and geometrics, which I have not seen so far anywhere else. These were first noticed in the last century but have never been photographically reproduced and systematically studied.

The last but one paper, the twentieth by David McCutchion on "the styles of Bengal temple Terracottas" has indeed a great poignant and posthumous value. This young and promising scholar died before this volume was published and hence it is dedicated to his memory. His paper is indeed on post-mediaeval archaeology—a subject in which very few scholars take any interest today. But as he has shown, and as I believe, and have practised, all phases of human activity —not only prehistoric, ancient or artistic—have a place in the cultural history of a country. Architecturally these temples are based on the design of village huts (*bangla* and *chala*) styles, with their pinnacles (*sikharas*) copying central and upper India Muslim design. These "young" temples were profusely decorated with terracotta figures, originally exhibiting the joyous abandon of the Chaitanya movement, but later, as in the Chandranatha Siva temple at Hetampar, District Birbhum, copies of European portraits, coats of arms and the like are seen. These may be unique for Bengal, but similar thing is witnessed in stone in the Rani Ahalyabai temple at Maheshwar, M.P. Gradually as cement took over, all these rich art traditions began to disappear, though for a time the *Sutradhara* did fall back on carpentry. An excellent creative work devoted to a recently dead art.

Janice Stargardt discusses in the last paper the extent of Indian influence in in the Malay Peninsula, particularly at Kedah. Earlier scholars, particularly Quaritch Wales, explored the region and brought to light the monumental remains in the Bayang Valley. With a view to learn something about the economy, and social background of these monuments, Stargardt carried out small test excavations. These produced mainly potsherds. These were scientifically examined at Cambridge to learn about the technology of pottery making.

The Kedah temples are comparatively small, village shrines and show mixed Hindu and Buddhist influences, though in commercial life both Chinese and Arab influences played an important part.

This rather detailed review would show what useful work is being done in India, Pakistan and Southeast Asia, and how much more remains to be done.

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