the lysozyme of the phage, at present being studied chemically by Dreyer[17] and genetically by Streisinger[10].

At the recent Biochemical Congress at Moscow, the audience of Symposium I was startled by the announcement of Nirenberg that he and Matthaei[18] had produced polyphenylalanine (that is, a polypeptide all the residues of which are phenylalanine) by adding polyuridylic acid (that is, an RNA the bases of which are all uracil) to a cell-free system which can synthesize protein. This implies that a sequence of uracils codes for phenylalanine, and our work suggests that it is probably a triplet of uracils.

It is possible by various devices, either chemical or enzymatic, to synthesize polyribonucleotides with defined or partly defined sequences. If these, too, will produce specific polypeptides, the coding problem is wide open for experimental attack, and in fact many laboratories, including our own, are already working on the problem. If the coding ratio is indeed 3, as our results suggest, and if the code is the same throughout Nature, then the genetic code may well be solved within a year.

We thank Dr. Alice Orgel for certain mutants and for the use of data from her thesis, Dr. Leslie Orgel for many useful discussions, and Dr. Seymour Benzer for supplying us with certain deletions. We are particularly grateful to Prof. C. F. A. Pantin for allowing us to use a room in the Zoological Museum, Cambridge, in which the bulk of this work was done.

[1] Wittman, H. G., Symp. 1, Fifth Intern. Cong. Biochem., 1961, for refs. (in the press).
[2] Tsugita, A., and Fraenkel-Conrat, H., *Proc. U.S. Nat. Acad. Sci.*, **46**, 636 (1960); *J. Mol. Biol.* (in the press).
[3] Brenner, S., *Proc. U.S. Nat. Acad. Sci.*, **43**, 687 (1957).
[4] For refs. see Watson, H. C., and Kendrew, J. C., *Nature*, **190**, 670 (1961).
[5] Crick, F. H. C., Griffith, J. S., and Orgel, L. E., *Proc. U.S. Nat. Acad. Sci.*, **43**, 416 (1957).
[6] Benzer, S., *Proc. U.S. Nat. Acad. Sci.*, **45**, 1607 (1959), for refs. to earlier papers.
[7] Benzer, S., *Proc. U.S. Nat. Acad. Sci.*, **47**, 403 (1961); see his Fig. 3.
[8] Brenner, S., Benzer, S., and Barnett, L., *Nature*, **182**, 983 (1958).
[9] Brenner, S., Barnett, L., Crick, F. H. C., and Orgel, A., *J. Mol. Biol.*, **3**, 121 (1961).
[10] Streisinger, G. (personal communication and in the press).
[11] Feynman, R. P.; Benzer, S.; Freese, E. (all personal communications).
[12] Jinks, J. L., *Heredity*, **16**, 153, 241 (1961).
[13] Champe, S., and Benzer, S. (personal communication and in preparation).
[14] Jacob, F., and Wollman, E. L., *Sexuality and the Genetics of Bacteria* (Academic Press, New York, 1961). Levinthal, C. (personal communication).
[15] Orgel, A., and Brenner, S. (in preparation).
[16] Sueoka, N. *Cold Spring Harb. Symp. Quant. Biol.* (in the press).
[17] Dreyer, W. J., Symp. 1, Fifth Intern. Cong. Biochem., 1961 (in the press).
[18] Nirenberg, M. W., and Matthaei, J. H., *Proc. U.S. Nat. Acad. Sci.*, **47**, 1588 (1961).

SCIENCE AND WORLD AFFAIRS

THE Seventh Pugwash Conference on Science and World Affairs was held at Stowe, Vermont, during September 5–9. Forty-one scientists from twelve countries attended the Conference*.

This Conference had as its theme "International Co-operation in Pure and Applied Science". The previous conferences have been chiefly concerned with ways of preventing the misuse of science in the wholesale destruction of mankind. In this Conference at Stowe, constructive international co-operation in science was discussed, because it is a way to create trust between nations, a trust which develops from common interests and from experience in working together.

Science misused by nations to foster their competitive interests as world powers makes possible the destruction of mankind. Science used co-operatively by all nations for the increase of human knowledge and the improvement of man's productive capacity can give all men on Earth a satisfactory and worthwhile life. Scientists bear a responsibility both to foster the constructive use of science and to help in preventing its destructive use.

The deliberations of the Conference were carried out in plenary sessions and in meetings of working groups. Similar suggestions for co-operative research activities arose independently from different working groups, and this is reflected in several places in the statement. This is a welcome indication of the essential unity in science. The discussions were carried on in a spirit of friendly co-operation, and full agreement was reached by the entire Conference on the suggestions enumerated here.

* Sir John Crawford (Australia); Prof. Hans Thirring (Austria); Prof. C. Pavan (Brazil); Prof. G. Nadjakov (Bulgaria); Prof. G. Burkhardt (Federal Republic of Germany); Sir Edward Bullard, Prof. A. Haddow, Sir Ben Lockspeiser, Prof. J. Rotblat (Great Britain); Prof. F. B. Straub (Hungary); Dr. G. Bernardini (Italy); Prof. T. Toyoda (Japan); Prof. B. V. A. Röling (Netherlands); Academician A. A. Blagonravov, Academician N. N. Bogolubov, Academician M. M. Dubinin, Prof. V. M. Khvostov, Academician N. M. Sissakian, Prof. N. A. Talensky, Academician I. E. Tamm, Academician A. V. Topchiev (U.S.S.R.); Prof. Harrison Brown, Dr. William Consolazio, Prof. Paul Doty, Prof. Bentley Glass, Prof. C. O'D. Iselin, Dr. Martin Kaplan, Prof. Chauncey Leake, Prof. Linus Pauling, Prof. Jay Orear, Prof. W. Pickering, Mr. Gerard Piel, Prof. I. Rabi, Prof. Eugene Rabinowitch, Dr. Roger Revelle, Prof. Alexander Rich, Prof. Walter Rosenblith, Dr. Eugene Staley, Dr. Alvin Weinberg, Prof. Eugene Wigner, Prof. J. R. Zacharias (United States).

(I) Co-operation in the Earth Sciences

The planet Earth is the common abode of all humans. They have a common interest, both intellectual and practical, in increasing the knowledge of the structure and dynamics of the Earth.

The following proposals were made by the Conference.

(*A*) *A survey of the entire ocean in three dimensions.* (1) *The ocean floor.* An international programme was proposed to develop a detailed map of the floor of the world ocean, including sub-bottom reflecting layers.

(2) *Waters of the ocean.* An international programme should be devised to survey and map the three-dimensional distribution of temperatures, salinity, density, dissolved oxygen, and nutrient salts, under average conditions, of the ocean and synoptic surveys to develop the broad picture of seasonal and shorter-period changes in more limited areas, as well as the study of the interactions among the major bodies of water in the ocean.

(3) *Ocean life.* An international survey and mapping showing the major biological provinces of the ocean and determination of the fertility of the waters at all levels in the food chain and the standing crop of food materials available for human use should be undertaken.

(*B*) *Earth's crust and mantle. Deep drilling programme.* The objective of drilling through the

Earth's crust to the mantle at selected points around the globe presents many unsolved technical problems which call for international collaboration. It was agreed, therefore, that the calling of an international conference on these problems is an urgent first step.

(*C*) *Total environmental forecasting.* An international conference should be called to consider and to organize the establishment of a world-wide network of radio-telemetering observational buoys. This system of buoys would render continuous reports on atmospheric conditions and so contribute to the completion of the world weather map. It would also continuously monitor the energy and water vapour energy exchange between the ocean and the atmosphere, and would observe the changes in the flow of ocean currents in three dimensions. Over a sufficiently long time-period, such a network of buoys would help to assign reliable values to the rate of overturn of the ocean as a whole, a key problem in both climatological forecasts and in the safe disposal of radioactive wastes at sea. The hydrographic offices of the major maritime nations, as well as the World Meteorological Organization, should be encouraged to stimulate such a programme.

(*D*) *Resources.* (1) *Fresh water.* The rising world population and the increasing concentration of that population in metropolitan centres is already pressing on the water resources easily available for direct human consumption, for industrial purposes, and for agriculture. It was agreed that an international conference should be called to consider the organization of an international hydrological decade for the study of the many unknowns that surround this ominous development.

(2) *Living resources of the ocean.* Acre per acre the oceans to-day sustain at least as large a plant crop on the average as does the land, yet man now gets only about 1 per cent of his food requirements from the sea. The oceans, therefore, offer a means for the rapid solution of the protein deficiency afflicting two-thirds of the world population. It is apparent that these resources can best be exploited to this end through international co-operation. The ultimate aim should be to elevate the fishing industry from a hunting industry to an agricultural technology.

(3) *Mineral resources of the ocean floor.* Recent investigations of the ocean floor show a vast reserve of minerals, especially nickel, cobalt, copper and manganese. By means of bottom-photography organized on a world-wide basis, the potentiality of this reserve may be more fully assessed. The necessary observational programme could be organized by the Scientific Commission for Oceanographic Research.

(4) *Natural catastrophes.* Earthquakes, tsunamis, volcanic eruptions, hurricanes and tornadoes constitute the principal hazards of this kind.

With respect to the first three, a better international seismological network, including better instrumentation and distribution of stations, is required. More detailed studies of hurricanes and tornadoes would reveal whether or not man can exert some control over these phenomena.

To implement these programmes, it is recommended that in so far as possible existing international organizations be the means of furthering these programmes.

(II) Co-operation in Space Research

Though the Conference felt that there should be close co-operation in space research it should be realized that complete co-operation in this field, as in some others, will become possible only when the arms race is ended, international tensions are reduced, complete and general disarmament becomes a reality, and the need for secrecy disappears. But certain advances in the presently established co-operation in space are possible now, and certain others could be studied now with the hope of realization in the not too distant future.

(*A*) First, an increase in the exchange of scientific information in areas such as the physics of space and the effects of the space environment on life is recommended. It is further recommended that periodic international symposia be devoted to such subjects.

(*B*) The exchange of methods, and of information on instruments, for scientific space studies which have no military importance is also recommended.

(*C*) The orderly assignment and use of radio frequencies in space should be encouraged. Strong support should be given to the initiative in this direction taken by the International Telecommunications Union, and it is to be hoped that a final solution can be reached within two years.

(*D*) The expansion of existing systems of satellite tracking stations is recommended. Bilateral agreements between different nations, including (within the limits of military security) an agreement between the United States and the U.S.S.R., on the common use of tracking stations; such a bilateral agreement could serve as the first step in this direction.

(*E*) International agreement should be reached on a co-ordinated programme for the use of rocket and satellite during the Quiet Sun Year (planned for the second half of 1962).

(*F*) Similar agreement should be reached on co-operation in the use of rockets and satellites in the projected world magnetic survey. This agreement should include arrangements for simultaneous observation from satellites launched into different orbits by different nations. This co-operation could be organized in the framework of the Committee on Space Research.

(*G*) The desirability of international world-wide systems of communications satellites and of meteorological satellites is endorsed by the Conference, since these would clearly be in the interests of all mankind. It is realized that certain difficulties now stand in the way, but it is to be hoped that the Governments of the United States and the U.S.S.R., as well as of other nations embarking on rocket and satellite programmes, will undertake a common study of the ways to overcome them.

(*H*) It is recommended that co-operation should be established in the instrumental study of the Moon, and also that the basic principles of the International Antarctic Treaty be applied to the Moon and other cosmic bodies.

(*I*) The calling of an international conference or symposium to consider how to avoid the biological and radioactive contamination of extra-terrestrial bodies is strongly urged.

(III) Co-operation in the Life Sciences

Among the many fields of biology in which international co-operation is possible, some are particularly well suited by their nature and importance for combined efforts. These, which relate especially to the promotion of human welfare, have been given primary concern by the Conference.

(*A*) *Biological aspects of food resources.* One of the most important problems facing humanity is that of assuring an adequate supply of food. Adequate biological information now exists to enhance considerably food production in low-yield areas. This can be done most effectively by the development of regional agricultural experiment stations, which can deal with the problem of developing agricultural methods suitable to the local terrain, as well as the long-term problem of breeding plants and animals which are able to thrive in the specific locality. These local agricultural experiment stations should be co-ordinated with an international centre.

It is recommended that existing marine biological laboratories be united into an international system, perhaps under the International Union of Biological Sciences, to ensure permanent support and increase in number.

(*B*) *Preservation and promotion of health.* The health sciences offer one of the most rewarding meeting grounds for international co-operation in science. Increased international co-operation and financial support are essential for the realization of important advances in such fields as cancer, cardiovascular disease, immunology, infectious diseases, mental health, environmental sanitation, problems of ageing, nutrition, human genetics, and others.

International institutes of health devoted to these problems should be established in one carefully chosen place to serve as a world centre of medical research. Smaller subsidiary institutes oriented towards more specialized problems or regional needs (space medicine, medical entomology, tropical medicine) should be established in different countries.

(*C*) *The environment and its modification by man.* The exponential growth of human populations and the accompanying industrial, agricultural and scientific activities have given rise to a number of serious problems, including pollution of air and water resources, which are of considerable biological importance. Especially grave are the problems involving contamination of air, soil and water with radioactive substances. Included here, as well as the more obvious problem of fall-out from nuclear explosions, there is the matter of the safe disposal of radioactive wastes. More international attention should also be directed toward the problems of chemical pollution of air and water. International conferences on these topics should be encouraged.

The extinction of many plant and animal species seems possible. There are large forest and game reserves in the newly formed African countries which are seriously threatened to-day because of a shortage of funds and trained personnel. This problem has been considered by a committee on ecology in the International Council of Scientific Unions. A system of world-wide institutes should be established for preserving indigenous strains of plants, animals and micro-organisms.

(*D*) '*Endless frontiers*'. There has been a great development recently in our understanding of the structure and function of biological macromolecules and the central role of the nucleic acids and the mechanism which relates the nucleic acids to the protein molecules. These developments have a significant bearing on the problems of cancer as well as the broader fields of molecular evolution and the origin of life. Intense interest in this field has developed among scientists in all countries, and it may be possible to capitalize on this enthusiasm by developing an intercontinental institute of molecular biology.

Both the United States and the U.S.S.R. have announced that they are planning to carry out manned exploration of space. It is not unreasonable to suggest that some of the biological developmental work be carried out in common. A considerable saving of time and money would ensue from joint research projects in this area. In addition, some of the instruments which man uses in space for his scientific investigations could be included in this co-operative programme. Joint precautions must be exerted to prevent the contamination of extra-terrestrial bodies by terrestrial organisms.

At the present time an International Biological Programme is under discussion by the International Council of Scientific Unions. Many of the projects described above may be included in the Programme, which if carried out broadly and effectively, would have considerable scientific value as well as a favourable impact on public opinion.

(IV) Co-operation in the Physical Sciences

Modern physical science has in many of its aspects become very big and expensive. It therefore lends itself particularly well to intercontinental co-operation in which the costs are shared and the results are made available to all mankind.

Four specific areas of physical science were identified as being ripe for vigorous action on an intercontinental basis. These areas are the following:

(*A*) *High-energy physics.* Co-operation could centre around the establishment of a laboratory the main research tool of which would be an accelerator of not less than 300×10^9 eV. and of a design which would achieve success in the shortest possible time.

(*B*) *Controlled thermonuclear and plasma research.* In the field of controlled thermonuclear research there has been much effective exchange of information and scientists. This development is particularly significant since this research, prior to 1955, was secret. It is urged that such collaboration be broadened; in particular, that the world's thermonuclear laboratories remain open to scientists of all nations who can contribute to this interesting and potentially important field of research.

Although a new, very large thermonuclear device is probably not needed immediately, still there is a large field of general research in plasma physics which could well be advanced by the establishment of an intercontinental laboratory.

(*C*) *Ultra-heavy element chemistry.* Two different devices are needed for such investigations: high-flux reactors, and heavy-ion, high-current cyclotrons.

It is recommended that an intercontinental centre devoted to investigation of the properties of the ultra-heavy elements be established. The centre probably should be equipped with the most powerful available heavy-ion cyclotron and with equipment for handling the materials. The ultra high-flux reactor (10^{16} neutrons/cm.^{2}/sec.), because of its hazard, probably should be located at a different, more isolated site.

(*D*) *Large-scale computers.* The development of the large modern electronic computer with its enormous memory and high speeds represents one of the most significant scientific events of the past two decades. The future development of these computing machines, with larger memories and higher speeds by orders of magnitudes, would be of immense value to science. Such computing machines will cost perhaps as much as 100×10^6 dollars.

The development of such computers would be a suitable project for international co-operation. The utilization of such a machine will advance not only mathematics but also all the physical sciences and the biological sciences, particularly the unravelling of the structure of macromolecules. It would also find great utility in economics and other social sciences.

(*E*) *A globular cluster of big science centres.* It is believed that the separate big science laboratories in high-energy physics, heavy-element chemistry, macromolecular biology, health research, and possibly thermonuclear research, will prosper better if they are reasonably close together than if they are completely isolated from each other. The intercontinental computing centre will be more viable and will be a better centre if it were the nucleus of such a cluster.

The Conference urged that the intercontinental scientific laboratories be located in relative geographical proximity and that they be served by the intercontinental computing centre. Such a centre, comprising much of what is called 'big science', would represent a capital investment of about 5×10^9 dollars. It is believed that the astute location of such a striking epitome of science—the most characteristic theme of our modern civilization—could have extraordinarily great significance in improving the tone of the present political situation.

(V) Co-operation in Assistance to Developing Nations

Assistance to developing countries is a duty and necessity for all countries. This aid should be rendered so that it would not impair the independence of any country.

Greater support for international co-operation in assistance to developing nations is needed. Such co-operation could help to reduce world tensions, to strengthen peace, and to further disarmament. Disarmament would in turn improve the climate for international co-operation in this and other fields and make available additional funds which could and would be used to increase the assistance to developing nations. Clearly, the greatest co-operation and the release of maximum funds for the assistance programme could be achieved by complete disarmament.

Scientists have a definite part to play in the development of assistance programmes and special emphasis should be placed on this subject in subsequent conferences. Such a conference should include a large participation of representatives from the developing nations.

The recommendation from the Economic and Social Council that a conference on science and technology in application to the problems of new nations should be held next summer in Geneva under United Nations sponsorship is to be welcomed.

A subject of interest to scientists is that of natural resources of different areas and of their population trends. Unprejudiced quantitative study of the latter topic should be carried out on an international, co-operative basis. Another topic for similar co-operative research is world nutrition, including the study of reasons for widespread occurrence of avoidable malnutrition in many parts of the world. The problems of energy supply, particularly in areas in which the demand for energy is diffused rather than concentrated in large industrial centres, calls for a similar study. It is suggested that preliminary study groups on these problems be organized prior to the above-mentioned conference.

An international study should also be made of the advisability and practicability of establishing an international fund to which individual scientists from countries in which local funds are insufficient for this purpose could apply for assistance in their scientific research.

(VI) Exchange of Scientists and Scientific Information

By its very nature and tradition science is a universal enterprise. The rapid exchange of information, mutual visits of scientists and their working as guests in the laboratories of other scientists constitute the main pathways of scientific collaboration among scientists all over the world. It is to be noted that there has been substantial progress in recent years in the area of scientific exchange. Yet it is to be regretted that there exists a number of difficulties which interfere in major ways with the further broadening of scientific collaboration and exchange.

(*A*) *Exchange of scientists.* The planned exchange of scientific personnel initiated by the Bronk–Nesmeyanov and similar agreements should be considerably increased. The visits should be extended over periods sufficient for the completion of research projects. In addition to planned exchange, the framework of these agreements should allow for and encourage invitations to scientists in the country in which they are to visit, and for the invited scientists to be able to accept such invitations. Application of the *quid pro quo* principle to visits under the agreement (that is, the exchange of one solid-state physicist for another solid-state physicist, etc.) has tended to hamper fruitful exchange, and it is urged that such regulations be set aside in future agreements.

The role of Government bureaucracies in the administration of these agreements should be minimized. To implement this recommendation, governments should be urged to expedite visas and passports for scientists, since past and present failures in this respect have seriously hampered scientific exchange. The scientific organizations of various nations should consider ways to facilitate the travel of pre- and post-doctoral fellows across national boundaries to study for adequate periods of time (one year or more) at research centres and under teachers where their training and scientific maturation can be best enhanced.

(*B*) *Exchange of information.* Noting the obstacle to the exchange of scientific information presented by the mounting volume of current publication, which is increasing exponentially and doubling about every decade, the situation calls for radical measures of rationalization. Among potentially useful measures are the following: to review and co-ordinate the character and content of journals published in all countries with the view of reducing the number of journals which a scientist must follow to keep abreast of work in his discipline; to institute standard formats for the presentation of scientific papers; to formulate a standard system for the annotation of the contents of published papers suitable for coding and manipulation by machines for the storage and retrieval of information; to institute regional depots under international co-ordination to store complete experimental records and other documentation in support of the brief published papers; to make such material rapidly available to interested scientists; to

consolidate the abstracting services now carried on independently in many countries, a measure that could reduce present duplication of effort by a conservatively estimated factor of three.

The publication of international review journals of two types as follows is recommended: interdisciplinary review journals written in relatively non-technical language for the benefit of scientists in different disciplines, and more specialized review journals which would keep scientists working in a given area abreast of the work going on in the same or related areas all over the world.

All Governments are recommended to open their postal systems to the untrammelled flow of scientific publications whatever their country of origin or destination.

LAND USE IN ARID REGIONS

THE arid zone programme of the United Nations Educational, Scientific and Cultural Organization, one of the Organization's three major projects, has yielded several valuable reviews of research and proceedings of symposia, mostly devoted to hydrology and ecology. The latest in the series, a volume of some 350,000 words reviewing the history of land use in arid regions, is of more general interest*. It deals with all the main dry lands with two main exceptions, those surrounding Abyssinia and those of South America in post-Columbian times.

F. K. Hare explains the widespread aridity in subtropical latitudes in terms of the divergent wind-flow at low levels related to high pressure at 2–3 km., and considers it unlikely that any past climatic epoch can have been free of tropical aridity. He finds it inconceivable that man can significantly alter the régime, the energy transformations involved are on so large a scale. Thus the flooding of desert depressions, for example, would have only very modest effects on neighbouring areas.

A summary by K. W. Butzer of what is known about climatic change in arid lands since the Pliocene sets the regional histories in a longer time perspective. Full aridity was achieved in most arid lands some 15,000 years ago. Since then there has been no progressive desiccation, only minor fluctuations of climate. Of especial interest are those fluctuations which might possibly have affected the environment of man when he was first beginning to manage crops and animals in south-west Asia ten thousand years ago and in Mexico possibly not much later.

Changes in climate over the past two or three thousand years are scarcely detectable with certainty until the fluctuation of the past three centuries. This has involved more than the spectacular rapid advance and current retreat of Alpine glaciers, for it is becoming clear that semi-arid lands in many parts of the world have been receiving less rain in recent decades than in the latter half of the nineteenth century. The dry trend continues, and the further outlook is unsettled.

Prof. Dudley Stamp, the editor of the volume, points out that a knowledge of the climate is not enough to allow a reconstruction of the past vegetation cover. The effects of burning and of a more prolific fauna have also to be taken into account. Ecologists and archæologists working together in the field are beginning to produce fairly reliable pictures of ancient landscapes, and R. O. Whyte, in his contribution on south-east Asia, sees much promise in this type of co-operative research.

South-west Asia is in many ways the most important of the regions and at the same time it produces the greatest difficulties in comprehension because of the mass of information available from widely scattered sites and conflicting interpretations of evidence. Whyte's review is very stimulating but not at all easy to digest. Egypt is of its nature simpler, and the material presented by G. Hamdan will be more familiar to many readers. V. A. Kovda's survey of the Russian plains, the Caucasus and Central Asia (plus a few pages on irrigation in China) naturally lays great stress on the revolutionary effects of introducing socialist methods of production to the steppe. The scale of operations is indeed impressive. Kovda notes the steady increase in the frequency of *sukhovei*, dry dusty winds, but asserts that their effects will be mitigated by new forests and irrigation projects which, he says, are expected to increase precipitation.

J. Despois, writing on North Africa, agrees with Butzer that there is no good evidence that the climate there was much more favourable to farming in the Roman period than in later times. The decline in agriculture can mainly be attributed to eleventh-century and later invasions of Bedouin Arabs from the east. Even their destructiveness seems to have been far exceeded by those other nomadic herdsmen, the Mongols, who descended on western Asia two centuries later. From both, recovery was slow, and in Cyrenaica and parts of Iraq and Iran is still incomplete.

Nomadism is a rational response to those seasonal and year-to-year variations in grazing and surface water typical of arid regions. R. F. Logan describes flocks in the United States being driven in double-decker trucks to summer grazing in upland meadows under Forest Service permits. Everywhere some State control of nomadism seems to be inevitable. Although, as Th. Monod and Ch. Toupet note in the Saharan region, an irreversible process of "sedenterization" has set in since pacification, progress in this direction is likely to be too slow to satisfy administrators and conservationists.

Innovations bring old problems. Perennial irrigation can lead to salt accumulation and waterlogging, as in the Punjab, and to bilharzia and other diseases. Improved water supplies from deep wells can accentuate overgrazing. The balance is delicate in arid lands and the regulating mechanism must work efficiently or disaster comes swiftly. This seems to be the main lesson to be learned from the past.

For the future, the possibilities of industry based on local minerals, with space-cooling and a sunny climate to attract labour, are becoming apparent from recent developments in Arizona and Central Asia. The process of urbanization is not new to the arid lands, it probably began there, and may well go further there than anywhere else in the world.

A. T. GROVE

*United Nations Educational, Scientific and Cultural Organization. Arid Zone Research No. 17: *A History of Land Use in Arid Regions*. Edited by L. Dudley Stamp. Pp. 388. (Paris: Unesco; London: H.M.S.O., 1961.) 37 N.F.; 52*s*. 6*d*.; 10.50 dollars.