from similar latitudes in both the United States (*1*, *4*) and the United Kingdom (*3*). The soil levels of Zr^{95}–Nb^{95}, which are less affected by the 1957 and earlier fallout than are levels of the longer-lived nuclides, show a maximum variation of 20 percent from the New York City cumulative fallout levels. In addition, the results of systematic ionization-chamber measurements of open-field dose rates performed by Vennart (*3*) in Belmont, Surrey, England, closely parallel the Zr^{95}–Nb^{95} dose rate curve of Fig. 3. These observations imply (i) that weathering and roughness of terrain had little effect on doses from fallout activities during the two-year period, and (ii) that the most significant contribution to total-radiation dose rates was made by radioactive zirconium, or possibly by other fission products of comparably short half-life.

Although the beta emitters in fallout are not sufficiently energetic to cause significant external doses except through direct deposition on body surfaces, internal doses do occur through inhalation and ingestion of debris particles (*5*). In addition, the chemical similarity of some of the radionuclides to elements normally assimilated by the body results in concentrated doses to specific tissues. The over-all effect of radiation on the population cannot be known, therefore, until many complex meteorological, physical, chemical, and biological factors are thoroughly understood. It is clear, however, that any valid assessment of the effect of radiation, past or future, must include consideration of fallout and more realistic treatment of the short-lived fission products.

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Conferences on Science and World Affairs

Statements by participants at the seventh and eighth conferences, which met at Stowe, Vermont, in September.

Seventh Conference

The Seventh Conference on Science and World Affairs was held at Stowe, Vermont, 5–9 September 1961. Forty-one scientists from 12 countries attended (see box, page 987).

This conference had as its theme "International Cooperation in Pure and Applied Science." Our 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, we have turned to the discussion of constructive international cooperation in science, 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 cooperatively 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. These groups were six in number, as follows: (i) Cooperation in the Earth Sciences; (ii) Cooperation in Space Research; (iii) Cooperation in the Life Sciences; (iv) Cooperation in the Physical Sciences; (v) Cooperation in Assistance to Developing Nations; (vi) Exchange of Scientists and Scientific Information.

Similar suggestions for cooperative research activities arose independently from different working groups. This is reflected in several places in this statement. This is a welcome indication of the essential unity in science. The discussions were carried on in a spirit of friendly cooperation, and full agreement was reached by the entire conference on the suggestions that will be enumerated in the following paragraphs.

Cooperation 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.

As the work of the IGY has demonstrated, the earth sciences present an especially appropriate and fruitful field in international collaboration. The work in these fields must be carried forward on an international scale, as no one country is likely to provide sufficient funds to conduct on its own the world-wide investigations which are required.

In recognition of the developing sociological and engineering problems posed by the present trends in earth sciences, we recommend the enlisting of the social and engineering sciences in this work.

The following concrete proposals are made.

A survey of the entire ocean in three dimensions.

1) *The ocean floor.* We propose an international program to develop a detailed map of the floor of the world ocean, including sub-bottom reflecting layers. This program would require, in the first instance, international agreements on exchange of data and methods, including intercalibration of instruments.

2) *Waters of the ocean.* An international program 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 short-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.

Prosecution of the foregoing program would necessarily involve the establishment of world-wide navigation and communication systems and allocation of radio frequencies for earth-science measurements, which would serve many other significant objectives. These matters, as well as the new ocean-wide surveys recommended above, fall within the province of the International Oceanographic Commission (IOC).

Earth's crust and mantle.

1) *Deep drilling program.* 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. We agree, therefore, that the calling of an international conference on these problems is an urgent first step. The conference would provide for the exchange and pooling of drilling techniques developed by present national programs and would consider methods for the solution of such unsolved problems as the re-entry and management of high temperatures to be encountered in depth even at oceanic sites. The survey and selection of drilling sites would be a primary responsibility of this conference. The conference could also undertake the establishment of scientific objectives for the drilling program. We further agree that the execution of the program would benefit from the continuous exchange of technique and personnel, and that the full exchange of information and of samples is imperative for the success of the program. It is recommended that when the prime contractor for the United States Mohole Project is selected, arrangements should be made for such meetings and the exchange of accumulated experiences.

Total environmental forecasting. The water-air interface appears to be the primary site of heat, water-vapor, and momentum exchange between the oceans and the atmosphere, and so the key to short-term and long-term forecasting of weather, climate, and changes in the ocean. Together, the oceans and atmosphere constitute a huge and complex heat engine. To some degree the ocean-half of this system acts as the flywheel over both short and long time periods. Studies of these phenomena must necessarily be conducted on a long-term and world-wide basis.

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-vapor 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 the safe disposal of radioactive wastes at sea. The hydrographic offices of the major maritime nations, as well as the World Meteorological Organization (WMO) should be encouraged to stimulate such a program.

Resources.

1) *Fresh water.* The rising world population and the increasing concentration of that population in metropolitan centers is already pressing upon the water resources easily available for direct human consumption, for industrial purposes, and for agriculture. We agree that an international conference should be called to consider the organization of an International Hydrologic Decade for the study of the many unknowns that surround this ominous development.

The proposed conference would institute a world-wide survey of water resources and of the future course of water use. Such a program would have the significant incidental benefit of attracting the interests of scientists to a field in which basic studies have been neglected. Subjects for immediate consideration are the qualities of water, considered from the point of view of various uses; the economical desalting treatment of water; the recycling and the reuse of water. The conference necessary to set such studies in motion should be called by UNESCO.

2) *Living resources of the ocean.* Acre per acre, the oceans today sustain at least as large a plant crop, on the average, as does the land, yet man now gets only about one percent 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 cooperation. The ultimate aim should be to elevate the fishing industry from a hunting industry to an agricultural technology. It has been estimated that existing fishery techniques could easily produce five times the present annual crop of fish, which is at present about 30 million metric tons. This yield could be even more greatly increased by development of means for helping the winds to overturn the oceans more rapidly. This is not an insurmountable undertaking, but experiments to this end must be conducted under international auspices [the Food and Agricultural Organization (FAO) and the Scientific Commission

for Oceanographic Research (SCOR)].

3) *Mineral resources of the ocean floor.* Recent studies 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 program could be organized by SCOR.

4) *Natural catastrophes.* The forecasting, minimizing, or eventual control of violent natural catastrophes is one objective of the earth sciences which will also require continuing international cooperation. 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 programs, we further recommend:

1) That, insofar as possible, existing international organizations such as IOC, UNESCO, FAO, WMO, SCOR, and SCAR (Special Committee on Antarctic Research) be the means of furthering these programs.

2) Since what is suggested here represents a long-term enlargement of their present activities, increased funds may have to be requested to finance continuing international conferences and studies in these various fields. At the outset, at any rate, the funds necessary to finance the travel of specialists to conferences so as to plan productive international programs are relatively small, and within the means of the agencies suggested. If forward-looking programs are ageed to, as was the case during IGY, it is likely that each nation will find means of financing its share of the total long-range program.

3) There is at present no effective means of promoting atmospheric research on a world-wide basis. The World Meteorological Organization remains a data-handling organization. At present, to suggest an international atmospheric research center on a scale considerably larger than the international meteorological research institute at Stockholm would tend to rob national centers. Thus it is recommended that this matter, however desirable, be deferred to one of our subsequent conferences. For the present a considerable acceleration of international atmospheric research seems impractical.

4) Of the many desirable studies suggested the highest priority should be given to three: (i) the world-wide survey of the oceans, including their contents in three dimensions; (ii) the deep drilling program, including systematic samplings of the unconsolidated sediments; (iii) the establishment of a total-environmental—that is to say, atmosphere and ocean—forecasting service.

Cooperation in Space Research

Though believing that there should be close cooperation in space research, we realize that complete cooperation 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.

We believe, however, that certain advances in the presently established cooperation in space are possible now, and that certain others could be studied now with the hope of realization in the not too distant future.

1) First, we recommend 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. We further recommend periodic international symposia devoted to such subjects.

2) We also recommend the exchange of methods, and of information on instruments, for scientific space studies which have no military importance.

3) We recommend the orderly assignment and use of radio frequencies in space. We support the initiative in this direction taken by the International Telecommunications Union, and hope that a final solution can be reached within 2 years.

4) We recommend the expansion of existing systems of satellite tracking stations and 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.

5) International agreement should be reached on a coordinated program for the use of rockets and satellites during the Quiet Sun Year (planned for the second half of 1962).

6) Similar agreement should be reached on cooperation 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 cooperation could be organized in the framework of the Committee on Space Research (COSPAR).

7) We endorse in principle the desirability of international world-wide systems of communications satellites and of meteorological satellites, since these would clearly be in the interests of all mankind. We realize that certain difficulties now stand in the way, but we hope that the governments of the United States and the U.S.S.R., as well as of other nations embarking on rocket and satellite programs, will undertake a common study of the ways to overcome them.

8) We recommend that cooperation 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.

9) We recommend the calling of an international conference or symposium to consider how to avoid the biological and radioactive contamination of extraterrestrial bodies.

Cooperation in the Life Sciences

Among the many fields of biology in which international cooperation 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 our primary concern. It is very evident that world-wide betterment of human welfare could be produced if the already existing biological knowledge were to be properly disseminated and fully utilized. Among the most important considerations are the means of bringing this about, so that local facilities and resources can be optimally exploited. The following recommendations incorporate proposals designed to achieve this end, as well as to promote research for the discovery of new knowledge in the field of biology.

Biological aspects of food resources. One of the most important problems facing humanity is that of assuring an adequate supply of food. While some areas have an abundant food supply, in others there is a low yield of food production and a correspondingly low level of nutrition. Adequate biological in-

Scientists Who Participated in the Seventh Conference

Sir John Crawford, Australia
Hans Thirring, Austria
C. Pavan, Brazil
G. Nadjakov, Bulgaria
G. Burkhardt, Federal Republic of Germany
Sir Edward Bullard, Great Britain
A. Haddow, Great Britain
Sir Ben Lockspeiser, Great Britain
J. Rotblat, Great Britain
F. B. Straub, Hungary
G. Bernardini, Italy
T. Toyoda, Japan
B. V. A. Röling, Netherlands
A. A. Blagonravov, Soviet Union
N. N. Bogolubov, Soviet Union
M. M. Dubinin, Soviet Union
V. M. Khvostov, Soviet Union
N. M. Sissakian, Soviet Union
N. A. Talensky, Soviet Union
I. E. Tamm, Soviet Union
A. V. Topchiev, Soviet Union
Harrison Brown, United States
William Consolazio, United States
Paul Doty, United States
Bentley Glass, United States
C. O'D. Iselin, United States
Martin Kaplan, United States
Chauncey Leake, United States
Linus Pauling, United States
Jay Orear, United States
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Eugene Staley, United States
Alvin Weinberg, United States
Eugene Wigner, United States
J. R. Zacharias, United States

formation now exists to enhance food production in these areas considerably, provided the knowledge is adequately diffused and applied. 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 coordinated with an international center. In this way it will be possible to teach agricultural practices which avoid errors experienced in the development of other areas, such as erosion of the soil, deforestation, and overgrazing. The implementation of this recommendation might be carried out through the establishment under the United Nations of an international center and a large-scale international training program, supplemented by interinstitutional exchanges of personnel between countries. Although some work has been carried out under the United Nations in this area, its program should be strengthened and extended considerably, especially in the newly developing countries.

Even though the majority of all life on this planet is synthesized in the oceans, man has utilized this source of food only to a limited degree. It is quite likely that the oceans can supply ten times more food for man than the total being produced at the present time. This can be done by developing methods for the cultivation of food in the oceans, rather than the use of the inefficient and self-limiting hunting procedures employed today. To do this we must greatly expand our knowledge of marine biology. Fortunately, the international oceanographic research expeditions, such as that now planned for the exploration of the Indian Ocean, can afford a significant opportunity for increasing our knowledge of marine life. Another important means for expanding knowledge in this area is through the work of marine biological laboratories, situated in many countries. Many of these laboratories are now critically short of funds and need a wider basis of support. We recommend that these laboratories be united into an international system, perhaps under the International Union of Biological Sciences, to ensure permanent support and increase in number.

Preservation and promotion of health. The health sciences offer one of the most rewarding meeting grounds for international cooperation in science. Increased international cooperation and financial support is essential for the realization of important advances in such fields as cancer, cardiovascular disease, immunology, infectious diseases, mental health, environmental sanitation, problems of aging, 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 center of medical research. Sufficient financial support of a long-term nature should be provided to permit their efficient operation. Smaller subsidiary institutes oriented towards more specialized problems or regional needs (space medicine, medical entomology, tropical medicine) should be established in different countries.

Other urgent needs in the health sciences characteristically requiring greater international cooperation and support include: (i) more effective and rapid dissemination of information on research and advances in medical knowledge; (ii) increased education and training of physicians and allied scientific and auxiliary personnel at both undergraduate and postgraduate levels; (iii) an extention of epidemiological studies and control of important communicable diseases, such as malaria, tuberculosis, and influenza, as well as of chronic degenerative diseases; (iv) genetic and immunologic studies of human population groups; and (v) problems of reproduction.

The central coordination and administration of these institutes and programs should be entrusted to the World Health Organization of the United Nations, which is the major operating international agency in the medical field. It is realized, however, that these additional tasks in the health sciences cannot be undertaken adequately unless the funds now being spent for these purposes are at least trebled.

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. We now recognize that continual chemical pollution of the air (known as smog) is a characteristic feature associated with most metropolitan areas and, as such, constitutes a problem of worldwide importance. The great increase of industrial growth has brought about extensive water pollution, which is lethal to aquatic organisms and renders the water unfit for human use. 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 fallout from nuclear explosions, is the matter of the safe disposal of radioactive wastes. Even though several agencies of the United Nations have carried

out extensive studies in the field of radioactive contamination, more international attention should be directed toward the problems of chemical pollution of air and water. We recommend that international conferences be scheduled on these topics.

Another of the more serious consequences of man's rapid growth is the extent to which it may bring about the extinction of many plant and animal species. There are large forest and game reserves in the newly formed African countries which are seriously threatened today because of a shortage of funds and trained personnel who can maintain these preserves. This problem has been considered by a committee on ecology in the International Council of Scientific Unions. We believe that action on this problem should be taken by the United Nations in order to bring about prompt and effective results. If this is not done rapidly we will unfortunately suffer irreplaceable losses. Another aspect of this problem should be the establishment of a system of world-wide institutes for preserving indigenous strains of plants, animals, and microorganisms. These may have enormous practical as well as theoretical benefits in future years.

"Endless frontiers." It has been said that the developments in biology during the next century will be as explosive as the growth of the physical sciences in the preceding century. This will undoubtedly offer new opportunities for international cooperation. At least two directions of this advance are already evident.

There has been a phenomenal 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. This work has led to significant insight into the molecular events which underlie cell division, as well as viral infection. These developments have significant bearing on the problem 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. This institute could serve as a research and training center for expediting the development of the subject and as an important continuing channel of communication in the biological field between "East" and "West" countries.

This proposal originated in both the biological and physical science working groups.

Both the United States and the Soviet Union 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. To implement this exploration it will be necessary for these proposed trips to develop a wide variety of equipment needed to maintain the human occupant for a prolonged period in a confined space. 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 cooperative program. Joint precautions must be exerted to prevent the contamination of extraterrestrial bodies by terrestrial organisms. Joint investigations of possible extraterrestrial forms of life and macromolecules should be planned. We propose that these suggestions be forwarded to COSPAR for its consideration. It should be noted that the adoption of even a limited type of cooperation in space research would be of great symbolic value and have substantial popular appeal.

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

Cooperation 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 cooperation 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 were the following.

High-energy physics. The field of high-energy physics is an excellent one for cooperation between all countries of the world. This cooperation could center around the establishment of a laboratory whose main research tool would be an accelerator of not less than 300×10^9 electron volts and of a design which would achieve success in the shortest possible time.

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 thermonuclear research, prior to 1955, was secret. We urge 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.

Ultra-heavy-element chemistry. The production and study of the very heavy elements (atomic number 95 and above) and the resulting extension and elucidation of Mendeleev's periodic chart is a scientific investigation of great interest to mankind. Handling large quantities of the heavy elements is difficult and very expensive, and gives strong reason to pool the world's efforts in this field.

Two different devices are needed for such studies: high-flux reactors and heavy-ion, high-current cyclotrons.

We recommend that an intercontinental center devoted to investigation of the properties of the ultra-heavy elements be established. The center 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 per square centimenter per second), because of its hazards, probably should be located at a different, more isolated site.

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 last two decades. The future development of these computing machines, with larger memories and higher speeds by orders of magnitude, would be of immense value to science. Such computing machines will cost sums of the order of magnitude of a large accelerator—perhaps as much as $\$100 \times 10^6$.

The development of such computers

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

We recommend further study for such an intercontinental center.

A globular cluster of big science centers. It is our belief 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. We particularly believe that the intercontinental computing center will be more viable and will be a better center if it is the nucleus of such a cluster.

We therefore urge that the Intercontinental Scientific Laboratories be located in relative geographic proximity and that they be served by the Intercontinental Computing Center. Such an Intercontinental Science Center, comprising much of what is called "Big Science," would represent a capital investment of the order of $\$5 \times 10^9$. It is our belief 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.

Cooperation in Assistance to Developing Nations

We express the strong belief that 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.

We express our support for greater international cooperation in assistance to developing nations. Such cooperation could help to reduce world tensions, to strengthen peace, and to further disarmament. Disarmament would in turn improve the climate for international cooperation in this and other fields and make available additional funds which could and, we hope, would be used to increase the assistance to developing nations. Clearly, the greatest cooperation and the release of maximum funds for the assistance program could be achieved by complete disarmament.

Assistance, we believe, should be provided on both a bilateral and a multilateral basis, including a substantial expansion of assistance through the United Nations.

The problems of assistance to developing nations are different in different parts of the world and should be studied as such. Scientists could assist in this study through a cooperative program, which should involve not only scientists of different countries but also specialists in different fields—biologists and physicists as well as anthropologists, economists, and engineers.

Several programs have to be undertaken simultaneously if technical assistance is to be successful. These include measures of immediate help as well as programs which require long-range approach. Coordinated study of such programs by scientists from different countries, including both scientists from the developed countries and those from the recipient countries, is required. Useful in this connection may be further spread of "sister" relations such as already exist between some universities in the developed and in the developing nations. Similar relations could be established between research institutes, agricultural stations, and other centers of applied research. Particular attention should be given to problems of adaptation of advanced technology to the needs and resources of an underdeveloped area. Establishment of regional applied science research institutes appears desirable.

We believe that scientists have a definite role to play in the development of assistance programs and therefore suggest that we place special emphasis on this subject in one of our subsequent conferences. We believe that this conference should include a large participation of representatives from the developing nations.

We welcome the recommendation from the Economic and Social Council (ECOSOC) 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.

Among subjects related to assistance to developing nations in which scientists have a particular interest are problems of education in all its aspects—science education and general education, elementary education and higher education. Another 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, cooperative basis. Another topic for similar cooperative 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 centers, calls for a similar study. We suggest that preliminary study groups on these problems be organized prior to the above-mentioned conference.

We suggest that an international study 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.

Exchange of Scientists and Scientific Information

By its very nature and tradition science is a univeral enterprise. Not only does the accumulating knowledge and understanding belong to all mankind, but the work of science moves forward most surely when it engages the collaborative effort of scientists of all nations. The intimate character of this collaboration on questions of profound import to the life of mankind serves to enhance the mutual trust and understanding of the scientific community and of the nations from which its members are drawn.

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. We note that there has been substantial progress in recent years in the area of scientific exchange. Scholars of many nations have the opportunity to meet and discuss scientific questions at international conferences, symposia, and other meetings organized by international scientific organizations as well as by the national organizations of scientists and institutions of higher learning. In this epoch of accelerating progress in science, the fostering of such international contacts and exchanges has become an

Scientists Who Participated in the Eighth Conference

Sir Mark Oliphant, Australia
G. Nadjakov, Bulgaria
J. Polanyi, Canada
G. Burkhardt, Federal Republic of Germany
Francis Perrin, France
Pierre Rosenstiehl, France
P. M. S. Blackett, Great Britain
Sir Edward Bullard, Great Britain
Sir John Cockcroft, Great Britain
Michael Howard, Great Britain
Rt. Hon. Philip Noel-Baker, Great Britain
Sir William Penney, Great Britain
J. Rotblat, Great Britain
F. B. Straub, Hungary
T. Toyoda, Japan
B. V. A. Röling, Netherlands
N. I. Bazanov, Soviet Union
A. A. Blagonravov, Soviet Union
N. N. Bogolubov, Soviet Union
M. M. Dubinin, Soviet Union
V. M. Khvostov, Soviet Union
S. G. T. Korneev, Soviet Union
V. P. Pavlichenko, Soviet Union
N. M. Sissakian, Soviet Union
N. A. Talensky, Soviet Union
I. E. Tamm, Soviet Union
A. V. Topchiev, Soviet Union
Hans Bethe, United States
R. R. Bowie, United States
Donald Brennan, United States
Harrison Brown, United States
Paul Doty, United States
B. T. Feld, United States
Trevor Gardner, United States
Bentley Glass, United States
Amrom Katz, United States
Henry Kissinger, United States
George Kistiakowsky, United States
Charles Lauritsen, United States
Leon Lipson, United States
W. Panofsky, United States
E. M. Purcell, United States
I. Rabi, United States
Eugene Rabinowitch, United States
Matthew Sands, United States
Louis B. Sohn, United States
Leo Szilard, United States
Charles Townes, United States

increasingly urgent necessity. During the past decade, the accomplishments of the International Geophysical Year have provided triumphant demonstration of the fruitfulness of international cooperation in science. Moreover, the development of cooperative research among scientists of many countries and the consequent internationalization of Antarctica has given a concrete demonstration of how such cooperation can set precedents for constructive agreements among nations.

We express regret that there exist a number of difficulties which interfere in major ways with the further broadening of scientific collaboration and exchange.

Exchange of scientists. We recommend that 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. We find that 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, and so on) has tended to hamper fruitful exchange, and we urge 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, we urge governments to expedite visas and passports for scientists, since past and present failures in this respect have seriously hampered scientific exchange.

We recommend that, in addition to exchange via formal arrangements, the other traditional forms of scientific exchange—personal visits and correspondence among scientists, attendance at international scientific meetings and at meetings of scientific societies of other nations, the framing of common plans for joint and parallel research enterprises, and so on—be encouraged and facilitated.

We recommend that the scientific organizations of various nations should consider ways to facilitate the travel of pre- and postdoctoral fellows across national boundaries to study, for adequate periods of time (1 year or more), at research centers and under teachers where their training and scientific maturation can be best enhanced.

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, we feel that the situation calls for radical measures of rationalization, to be designed and carried out through international agreement and cooperation. Among potentially useful measures are the following: to review and coordinate the character and content of journals published in all countries with a view to reducing the number and variety 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 coordination 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 3.

We recommend that measures be taken to bring significant work going forward in all countries to the attention of interested scientists. This objective could be served by the publication of international review journals of two types: interdisciplinary review journals written in relatively nontechnical 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.

We urge that all governments open their postal systems to the untrammeled flow of scientific publications whatever their country of origin or destination.

Eighth Conference

The Eighth Conference on Science and World Affairs was held at Stowe, Vermont, from 11 to 16 September; its general subject was "Disarmament and World Security" (see box above).

It is gratifying that in such troubled times it proved possible for 48 scientists from 11 countries to meet in a friendly atmosphere and to examine together carefully the dangers which face the people of the world.

During the previous week the Seventh Conference, devoted to international cooperation in science, had outlined many important areas where cooperative action would be scientifically productive as well as effective in improving international understanding. In this Eighth Conference, a wide range of topics was discussed in plenary session, in separate working groups, and in private conversation.

The subjects of study which related in one way or another to the problems of attaining stable peace, world security, and general and complete disarmament included: cessation of production of fissile materials for military use and destruction of military nuclear stockpiles; elimination and control of means for weapons delivery; demilitarization of outer space; interdependence of international political settlements and disarmament; nuclear weapons tests; military disengagement, and creation of demilitarized and atom-free zones; international security forces; methods of settlement of international disputes; rules of peaceful coexistence; organization and control and inspection over disarmament; and conditions for creating trust and confidence among nations.

A variety of individual views was expressed. These were often quite divergent but were explored in a frank manner. The participants found the discussions helpful in clarifying points of view, and common understanding was reached on a number of important issues. We hope this will open important avenues for constructive action.

The participants of the conference are united in the realization of the danger of unleashing a nuclear war, which would cause untold destruction and bring death to innumerable people. We hope that the desire for peace and the revulsion against war, which are shared by all peoples, will make possible a peaceful resolution of the conflicts which have led to the present deterioration of the international situation, and make possible the attainment of complete and universal disarmament and the establishment of stable peace on earth.

In the present crisis we reaffirm our belief in the general principles enunciated in the Vienna Declaration of September 1958.

This meeting kept open a much-needed informal channel of communication among scientists concerned with the future of civilization.

For this reason it is hoped that similar conferences will be convened by the Continuing Committee at suitable intervals in the future. In addition, plans have been made to form continuing unofficial East-West study groups in order to devote more detailed attention to problems of the nature of those considered at the present conference.

The National Academy of Sciences and the American Academy of Arts and Sciences were hosts to this as well as the preceding conference. Both conferences were organized by the United States Organizational Committee under the aegis of the International Continuing Committee of these conferences.

The following did not join in the resolution: R. R. Bowie, Donald Brennan, Amrom Katz, Henry Kissinger, and Leon Lipson.

The following were absent during the discussion of the statement: Sir John Cockcroft, Trevor Gardner, Charles Lauritsen, and I. Rabi.

Science and the News

U.S. Disarmament Plan: It Puts Inspection in First, Rather than Third, Stage

History records numerous attempts by hostile nations to reach disarmament. These searches for the "Holy Grail" have been futile, largely because those setting out on the quest have invariably sought to restrict or eliminate the best weapons of the enemy. "One's own weapons never threaten the peace; they are defensive in character," as William R. Frye wrote in the arms control issue of *Daedalus* last fall.

The present chapter in this history opened in the wake of World War II and the introduction of nuclear weapons. These weapons, their subsequent proliferation, their ease of being hidden plus the development of high-speed delivery systems such as missiles, and the interrelation of these factors have enormously complicated the disarmament situation until now the goal poses not only political but highly difficult technical problems. The latest entry in the chapter was made last week when the United States, following the Soviet nuclear test resumption that has brought the world to "thirty minutes from Armaggedon," presented at the United Nations its most detailed and comprehensive proposal to date for "complete and general disarmament."

To appreciate that proposal, some knowledge of background to disarmament is necessary. Disarmament attempts since World War II have gone through three periods. First, in 1946, the U.S. proposed control of atomic energy. Second, in 1952, a United Nations Disarmament Commission was created and worked on and off for a couple of years. Neither got anywhere.

The third period began in 1955 with general disarmament talks. Since then there have been negotiations with the Soviets on limited disarmament measures, such as the nuclear test ban and reducing the danger of surprise attacks; and in March 1960 on broad disarmament again in a ten-nation (five Communist, five Western) conference under U.N. sponsorship. Within a few months, however, in the aftermath of the U-2 flight and the Paris summit break-up, the conference collapsed, and it has been in recess for 16 months. At this writing, despite the new U.S. proposal and an agreement in principle on disarmament ideals between the Soviet Union and the United